Health Professions Education

Volume 5 | Issue 2 Article 1

2019-06-01

Investigating the Impact of Emotions on Medical Students´ Learning

Telma Kremer
Institute of Medical Education Research Rotterdam, Erasmus Medical Centre, Rotterdam, Netherlands

Silvia Mamede
Institute of Medical Education Research Rotterdam, Erasmus Medical Centre, Rotterdam, Netherlands, Department of Psychology, Erasmus University Rotterdam, Rotterdam, Netherlands

Milton A. Martins
School of Medicine, University of São Paulo, São Paulo, Brazil

Patricia Tempski
School of Medicine, University of São Paulo, São Paulo, Brazil

Walter W. van den Broek
Institute of Medical Education Research Rotterdam, Erasmus Medical Centre, Rotterdam, Netherlands, Psychiatric Department, Erasmus University Rotterdam, Erasmus Medical Center, Rotterdam, Netherlands

Recommended Citation

Kremer, Telma; Mamede, Silvia; Martins, Milton A.; Tempski, Patricia; and van den Broek, Walter W. (2019) "Investigating the Impact of Emotions on Medical Students´ Learning," *Health Professions Education*: Vol. 5: Iss. 2, Article 1.
DOI: 10.1016/j.hpe.2018.12.003
Available at: https://hpe.researchcommons.org/journal/vol5/iss2/1

Available online at www.sciencedirect.com

ScienceDirect

Health Professions Education 5 (2019) 111–119

www.elsevier.com/locate/hpe

Investigating the Impact of Emotions on Medical Students' Learning

Telma Kremer[a,*], Silvia Mamede[a,b], Milton A. Martins[c], Patricia Tempski[c], Walter W. van den Broek[a,d]

[a]*Institute of Medical Education Research Rotterdam, Erasmus Medical Centre, Rotterdam, the Netherlands*
[b]*Department of Psychology, Erasmus University Rotterdam, Rotterdam, the Netherlands*
[c]*School of Medicine, University of São Paulo, São Paulo, Brazil*
[d]*Psychiatric Department, Erasmus University Rotterdam, Erasmus Medical Center, Rotterdam, the Netherlands*

Received 16 January 2018; received in revised form 8 December 2018; accepted 30 December 2018
Available online 3 January 2019

Abstract

Purpose: Medical students' negative emotions have the potential to hinder their learning, but there is no experimental evidence that this happens. This study investigated the effect of negative emotions on students' learning processes and outcomes.
Method: Eighty-five 5th-year students from a Brazilian medical school were randomly allocated to perform a priming task consisting of reading either (1) a diary describing a patient who died due to inappropriate care caused by unprofessional behaviours (emotional group); (2) a diary describing the same patient receiving appropriate care (neutral group) (3) an irrelevant extract of a local newspaper (control group). Subsequently, emotional reactions were measured, all students studied a medical text, and two tests were administered. Main outcome measures were time spent in studying the text and situational cognitive engagement with study (learning process), and mean scores in the two tests (learning outcomes).
Results: The priming task triggered higher levels of emotions in the emotional group relative to both the neutral and the control groups though levels were low. The experimental conditions did not significantly differ in learning processes and outcomes.
Discussion: Two tentative explanations for the lack of difference in the performance of three conditions are raised: (1) the level of emotions triggered by the vicarious experience was too low to affect learning, (2) the tests may have been not sensitive enough to capture eventual differences. Methodological choices that may be related to the two explanations are discussed.

Keywords: Emotion; Learning; Medical education; Priming task; Research methods

1. Introduction

Medical education has been consistently described as emotionally challenging, because students encounter, on a regular basis, situations that tend to trigger emotions. Although occasions for positive emotions to arise certainly exist, negative emotions appear to be frequent. Several types of situations that tend to raise negative emotions have been brought to light by recent research, with adverse consequences for students' well-being[1–3]: physicians' disrespect and hostility towards patients,[4] entering a new rotation,[5] unfamiliar supervisor relationships,[6] treatment failures and problematic

*Correspondence to: Fanny-Blankers Koenlaan 35, 1183WR Amstelveen, the Netherlands.
E-mail address: t.kremer@erasmusmc.nl (T. Kremer).
Peer review under responsibility of AMEEMR: the Association for Medical Education in the Eastern Mediterranean Region

https://doi.org/10.1016/j.hpe.2018.12.003

relationships with senior doctors,[7] dealing with uncertainty,[8] medical errors with consequences for the patient and careless doctor's behaviour toward patients.[9]

However, if it seems clear that certain emotions triggered by such experiences may be deleterious for students' well-being, a less explored issue is whether they affect students' learning. This question has been largely ignored until recent years when it started raising considerable discussion in the medical education literature.[4,10] The type of relationship between learning and emotions seems to be a very complex one and empirical research on the problem is scarce and badly needed. This is so because medical educators could benefit from a better understanding of the consequences of emotions for learning, if any, as a starting point to develop educational strategies to address the problem.

Emotions can be understood as psychophysiological changes in response to an object or event including expressive, behavioural and physiological aspects.[3] Different approaches have been adopted to investigate emotions. For instance, while some researchers aim to study discrete emotions, differentiating between emotions, others have focused on dimensions such as valence and arousal. Moreover, research has also differentiated between the sources of emotions. Integral emotions are those directly related to the situation whereas incidental emotions are those derived from another, unrelated source.[3] This distinction is particularly important when studying the impact of emotions on learning, because while integral emotions appear to promote focus and enhance performance in memory tasks,[11] facilitating future retrieve of this information from memory,[12] incidental emotions deviate attention from the task, hindering performance.[10]

Indeed, the mechanisms through which emotions influence learning remain under investigation, but it seems reasonable to expect that students' emotional reactions to difficult situations may influence what information they attend to and later remember from it.[10] Cognitive processes such as *attention* and *perception* work as "filters" to what, from the immense realm of information available around us, will be processed. Therefore, factors influencing attention and perception will automatically impact the subsequent steps of the learning process. If proper attention and processing occur, new information will be *encoded* in memory. *Encoding* is the process through which we register new information, combining it with what has been previously stored, a process that directly impacts our ability to retrieve this information from memory in the future.[12] Negative emotions can intervene in different stages of this learning process. For example, the person may not pay enough attention to (parts of) the to-be-learned material, because negative attitudes towards it are automatically activated from memory, triggering a tendency to avoid it.[13] Without enough attention, processing of the material will be hindered, with adverse consequences for learning. Even if the learner is paying attention to the learning material and trying to make sense of its content, his emotions can still hinder learning if, for example, thoughts connected to these emotions keep coming to his mind disturbing processing of the new information and hindering its encoding in memory.[14] These are only two examples of how emotions may have a negative influence on cognitive processes involved in learning, but other mechanisms have been reported.[15] The present study is not concerned with the processes through which emotions influence learning but only with what comes out from such influence. We refrain therefore from any attempt to perform mediation analysis. What matters for the present study is that, although different in nature, these mechanisms have in common the potential to adversely affect learning. Whether this potentially deleterious influence actually occurs remains, however, to be determined.

Although these mechanisms have been the focus of extensive attention within the domain of cognitive psychology, there are only a few experimental studies on the effect directly on medical students' learning. The present study experimentally investigated the effects of incidental negative emotions, triggered by an emotion inducing procedure (EIP), on learning processes and learning outcomes in subsequent tasks. Fifth-year medical students were requested to read a diary-entry describing a working-related situation that developed either in a non-emotional (neutral group) or in an emotional way (emotional group). A control group read an extract of the daily newspaper on a subject that do not relate to their professional activities. All participants subsequently studied a complex medical text. Time on task and cognitive engagement were measured as indicators of the learning process. To measure their learning outcomes, a multiple choice questions test (MCQ) and a concept recall test were administered.

We expected negative emotions triggered by the vicarious experience of reading a diary-entry to hinder learning processes and learning outcomes of participants in the emotional condition relative to the neutral and control groups. We hypothesized that participants in the emotional condition would spend less time reading the learning material and be less involved with the task, reporting lower scores in the cognitive engagement scale. Consequently, they would learn

less, thereby obtaining lower scores in the MCQ test and recalling a lower number of concepts from the text that they studied.

2. Method

2.1. Overview

The experimental study consisted of three phases: 1) *an emotion induction procedure*, in which participants were asked to read either a diary-entry describing a professional situation faced by a student like them (emotional version and neutral version) or an extract from a newspaper with no connection to their daily routines (control version) depending on the experimental condition to which the student had been assigned; 2) a *learning phase*, in which a medical text was studied by all participants, and time spent on the reading and level of situational cognitive engagement were measured; 3) a *testing phase*, in which an MCQ test and a concept recall test were applied to measure participants' learning outcomes.

2.2. Participants

Participants were 85 5th-year students at the Medical School at University of São Paulo, Brazil. All 88 students enrolled in the 5th-year of the program were invited by two of the authors (T.K., M.M.) to voluntarily participate in the study, and eight-five (96%) accepted and were recruited as participants. As the nature of the study prevented prior disclosure of its objectives, participants were informed about their tasks before starting the study and were debriefed later.

All participants signed an informed consent for use of their data. The study protocol was approved by the Research Ethics Committee of the University of São Paulo (659.347 in 21/05/2014).

2.3. Materials and procedure

The study was presented as two separate, unrelated studies. The emotion inducing procedure (EIP) was presented as a study aimed at checking the realism of diaries to be used in medical education. The learning phase and the testing phase were presented as part of a second study, whose aim was to compare two possible different strategies to evaluate medical student's learning. Each one of the purportedly independent studies had the materials in a separate envelope, and participants were instructed on how to use the second envelope only when they finished with the first "study". Care was taken, therefore, to avoid that participants realized that the study was concerned with the consequences of the emotions triggered by the EIP. We did so because previous research using inducing techniques has outlined the importance of avoiding participants' awareness about their own emotions, eventual manipulations that are part of the study, and their expected effect.[3] The rationale for this is that participants would probably try to exert control over their emotions to avoid that effect, and therefore cover stories are usually included.[16,17]

First, participants were randomly assigned to one of the three conditions (emotional, neutral or control, defined by the type of text used in the EIP) using electronical randomization by the RANDOM Program (www.random.com/ NA MEDIA®/ 2016). The reason we included a control condition was to check if the reading of a text related to their professional activities per se could have affected performance in the subsequent study and tests, regardless of the emotions triggered. With the exception of these texts (diaries and newspaper extract), all other materials and procedures used (see below) were the same for all groups. Participants of each condition were tested in separate auditoriums of the university building where one researcher coordinated the data collection (TK, MM, PT) and one research assistant assisted with the distribution and collection of envelopes (see below). Researchers were blind to the experimental condition and only learned about participants' condition once envelopes were returned.

2.3.1. Emotion induction procedure

For the emotional and the neutral conditions, the emotion induction procedure consisted of a short text (approx. 150 words) describing the experience of a 5th-year student during a common working situation at the emergency room when a patient needed cardiopulmonary resuscitation (diary-entries). The emotional version described the physician in charge of the case showing disrespectful and unprofessional behaviour and the patient dying before she received care. The neutral version described the same patient being saved by appropriate care received from the medical team. For the control condition, the text consisted of an extract from the local newspaper describing a research done with local habitants regarding their quality of life in the neighbourhood.

The situations described in the diaries were taken from a previous study by Kremer and colleagues[9] in which medical students evaluated diary-entries rating how frequently they had encountered similar situations

and the emotions triggered by the reading. The insights provided by this study were confirmed in a review of pertinent literature.[8,18] The advantage of this particular inducing technique is the possibility to trigger emotional reactions within a controlled context. In addition, the use of this vicarious experience to trigger emotions in the participants instead of trying to trigger 'real personal' emotions has obvious advantages when ethical concerns are taken into consideration.

Participants were asked to read the diary-entry or newspaper extract and then answer a 3-itens questionnaire (Appendix) which aimed to identify whether they had previous experience with a situation similar to the one portrayed (Q1, Appendix), if they found the description realistic (Q2, Appendix) and to what extent our manipulation strategy had worked in triggering negative emotions (Q3 – Appendix).

To assess the latter, we used an adaptation of the PANAS checklist (a 20-item positive and negative activation scale shown to be reliable and the subscales uncorrelated),[19] removing the 10 items referring to positive emotions, as our study focused on the impact of negative emotions.

2.3.2. Learning task

After having completed the questionnaire and handed in the first envelope (purportedly, Study 1), participants were asked to open the second envelope (purportedly, Study 2) containing a medical text (930 words) on "*Cardiac arrest associated with pregnancy*". The text was related to the diary (EIP) since it described a patient who suffered a heart attack. This text was prepared by two board-certified internists (MM; PT) who have extensive clinical and teaching experience in the medical school where the study took place and are, therefore, very familiar with the students' level of training. To ensure that the text was sufficiently complex for the participants, it was also previously tested with four beginner 1st-year residents who were not participating in the study but were considered close to the participants in terms of prior knowledge.

The instructions accompanying the medical text requested the participants to read it in the same way they would read any chapter in a medical textbook. Participants were informed that they had up to 15 min to read but the objective was not to read as quickly as possible. A digital clock was visible in the room and participants were asked to write down the starting and ending time of their reading.

After reading the medical text, participants were requested to move to the second page and fill in the situational cognitive engagement scale (SCES), an instrument devised and validated by Rotgans and Schmidt.[21] This instrument consists of three elements, measured by four items: 1) engagement with the task on hand (item: "I was engaged with the task on hand"); 2) effort and persistence (items: "I put in a lot of effort"; "I wish we could still continue with the work for a while"); and 3) having been totally absorbed by the activity (item: "I was so involved that I forgot everything around me"). Response to each item was provided on a 5-point Likert scale: 1 (not true at all for me), 2 (not true for me), 3 (neutral), 4 (true for me) and 5 (very true for me).

2.3.3. Testing task

After they finished reading the text, participants put the text and the completed SCES back in the envelope. They were then asked to answer a 7-question MCQ test. This test was prepared by one of the board-certified internists (MM) who have prepared the learning text, with vast experience in teaching these students and working on content definitions for the educational program.

Participants were asked to return the test to the envelope after completing it and then performed a concept recall task, a test that has been frequently used as a measure of learning.[21,22] It requested participants to write down as many concepts as they could remember that were present in the text that they had read. To establish a score for the concept recall test, a list of all relevant concepts present in the learning material was prepared beforehand (the 'answer key') and agreed upon by two researchers (TK; PT). The final list of concepts contained 91 items and was used to score each participant's test, with one point given to each correct concept mentioned by the participant. The total number of points was the individual participant's final score.

2.4. Statistical analysis

A one-way ANOVA and a Chi-square test were performed to check for differences between the three experimental conditions, respectively, in age and gender. Two other potential confounders were also examined: previous experience with similar situations (first question, Appendix), using Chi-square test of independence; and perception of realism of the situation reported in the text (second question, Appendix), checked by performing one-way ANOVA.

The 'emotional manipulation' was measured by computing, for each participant, an average score for the PANAS-adapted scale that measured the emotions

triggered by the vicarious experience portrayed in the diaries. Subsequently, a mean score of emotions was computed for each experimental condition and means were compared by performing a one-way ANOVA.

Two measurements were used to evaluate the learning processes. First, a one-way ANOVA with experimental condition as a between-subjects factor was performed on the time spent in reading the text. For each participant, the scores in the four items of the SCES were averaged, and a mean score was computed for each experimental condition. The SCES mean scores for experimental conditions were compared with a similar, separate ANOVA.

Finally, the learning outcomes, as measured by the performance in the MCQ test and the concept recall test, were compared. Each correct answer made in the MCQ test was given a point, and the total number of points was the individual participant's final score. Group mean scores were then calculated.

Two separate one-way ANOVAs with experimental condition as between-subjects factor were performed on the MCQ test group means and on the group means scores obtained in the concept recall test.

Chi-square tests of independence were performed to compare the responses to the last two items of the questionnaire ("Did you have any previous knowledge about the subject presented at the text *Cardiac arrest associated with pregnancy?*" and "Is the material presented in the text new for you?").

For all comparisons, the level of significance was set at $p < 0.05$.

Statistical analyses were performed with SPSS version 25 for Macintosh.

3. Results[1]

There were no significant differences in age between participants assigned to the emotional, neutral and control conditions during the induction procedure [$F_{(2, 82)} = 1.25$, $p = .29$]. The chi-square test showed no significant difference between the three experimental conditions for gender ($\chi^2_{(1, N = 84)} = 4.82$, $p = .09$) (Table 1).

Participants in two conditions (emotional and neutral) reported significantly different levels of familiarity with the situation portrayed in the diaries as showed by the Chi-square test ($\chi^2_{(1, N = 84)} = 10.24$, $p = .006$) with those that read the emotional version of the diary reporting higher levels of similar experiences when compared to the neutral group. Participants from these two conditions reported a similar perception of how realistic the diaries were on describing the situation [$F_{(2, 82)} = 0.78$, $p = .46$]. Note that the analysis did not include the control group since they read a newspaper extract.

Table 1
Participants' gender and age as a function of experimental condition.

	n	Gender				Age (years)	
		Male	%	Female	%	Mean	SD
Control	28	11	39	17	61	23.57	1.597
Neutral	29	17	59	12	41	23.62	1.613
Emotional	28	19	68	9	32	24.25	2.137
Total	85	47	55	38	45	23.81	1.803

n = number of students that evaluated this version
SD = standard deviation

The Chi-square tests showed no significant difference between the three experimental conditions for previous knowledge ($\chi^2_{(1, N=84)} = 0.47$, $p = .79$) and novelty of material ($\chi^2_{(1, N=83)} = 2.06$, $p = .36$).

The scores of level of emotions triggered by the EIP were significantly different between the three experimental conditions [$F_{(2, 82)} = 51.24$, $p < .001$]. Post hoc comparisons using Bonferroni correction indicated that the mean score for the neutral condition (M = 1.61; SD = 0.55) and the control condition (M = 1.36; SD = 0.45) did not significantly differ ($p = .35$); participants in the emotional condition (M = 2.88; SD = 0.77) reported significantly higher levels of emotions when compared to those in the control condition ($p < .001$) and neutral condition ($p < .001$), demonstrating that our manipulation worked.

Regarding the measures of learning process, participants from the three experimental conditions did not significantly differ in the time spent studying the medical text (Table 2). Participants from the three conditions also did not differ in their ratings of situational cognitive engagement with the task of studying the new medical material (Table 2).

Participant's learning outcomes, as measured by the scores obtained in the free recall task, did not show a significant difference between the three conditions. No significant differences were found in the performance in the MCQ test: the total score obtained by participants in the three conditions was similar, (Table 3). Participants also performed similarly in the other measure of learning outcomes, recalling a similar number of concepts from the text (Table 3).

[1]Not all students responded to all measures, which is the reason for the different number of participants in the several analyses.

Table 2
Learning process - Time spent in studying the text (in minutes) and scores in the situational cognitive engagement scale (range 1–5) as a function of experimental condition.

	Control version			Neutral Version			Emotional version			Statistics
	n	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	
Time (min)	28	7.43	2.57	29	6.38	2.09	27	7.04	2.23	$F_{(2,\ 81)} = 1.51$, $p = .23$
SCES (1–5)	28	3.54	0.61	29	3.36	0.52	28	3.41	0.65	$F_{(2,\ 82)} = 0.64$, $p = .53$

Table 3
Learning outcomes – Score in the concept recall test (number of right concepts recalled) and the multiple choices question test (range 1–7) as a function of experimental condition.

	Control version			Neutral Version			Emotional version			Statistics
	n	Mean	SD	n	Mean	SD	n	Mean	SD	
REC total	27	16.63	6.01	28	18.04	5.78	28	19.18	6.67	$F_{(2,\ 80)} = 1.18$, $p = .31$
MCQ (1–7)	28	6.07	1.39	29	6.34	0.77	28	6.07	1.18	$F_{(2,\ 82)} = 0.55$, $p = .58$

n = number of students that evaluated this version
SD = standard deviation

4. Discussion

The purpose of the present study was to investigate the effect of medical students' negative emotions on their learning processes and outcomes. Students were randomly allocated to an emotion induction procedure that differed in its expected potential of triggering emotions. Subsequently, all students studied the same medical text and took a MCQ test and a concept recall test. It was expected that relative to the other conditions, students who carried out the emotional version of the induction procedure would be hindered in their learning processes, measured by time spent and situational cognitive engagement with the learning task, and performance on the two tests.

The induction procedure was successful on triggering higher levels of emotions on the emotional group when compared to the neutral and the control groups though the level of emotions was in general low. However, our hypothesis that students under the influence of emotions would perform differently from those in the other conditions was not confirmed by the findings. There were no significant differences between the three experimental conditions neither in learning processes nor in learning outcomes.

Before we start considering what could possibly explain why the negative emotional response that has been apparently successfully triggered by the EIP did not affect learning, we should make a remark about how complex the relation between emotions and learning seem to be. For instance, positive emotions were reported to improve learning by augmenting motivation[23] and promoting integration of new information,[24] but research has also found it to be inversely associated with learning.[23] Negative emotions can intervene in different stages of the learning process, depending on quality and intensity of emotions. For example, negative emotions were reported to have an adaptive function, triggering more systematic processing when situations are perceived as demanding increased attention and care.[25] However, other studies point to an opposite direction. Under the influence of negative emotions, individuals may not pay enough attention, because negative attitudes are automatically activated from memory, triggering a tendency to avoid it.[13] Without enough attention, processing (and consequently, learning) will be hindered. Even if the learner is paying attention, thoughts connected to these emotions come to his mind, disturbing processing of the new information and hindering its encoding in memory.[14] These are only some of the examples, but other mechanisms have been reported.[15] Nevertheless, in our study, the adverse effect of negative emotions did not show.

Tentative explanations for these results can be raised by looking into the study methodological choices. First, the emotional arousal may have been insufficient to

interfere with learning. Although a significant difference was found between the three experimental conditions, the level of emotions reported by all participants was very low, ranging from a mean of 1.36 to 2.88 in a 1–5 Likert scale. According to the definition of this scale provided to the participants (see scale on Appendix), even the higher mean suggests that they were only "a little" emotionally touched by the diary-entry reading.

This low level of emotional arousal can possibly be related to the fact that medical culture (or hidden curriculum) promotes de idea of emotions as a hazard to adequate medical reasoning and practice,[26] so that soon enough students understand that emotions must be controlled, if not extinguished. In this case, participants could have experienced more intense emotions in the emotional condition, but were able to reappraise them, lowering their effect on learning. Medical schools in Brazil provide emotionally charged learning opportunities since the first year of training and it is possible that by the 5th year, students have developed some ability to deal with situations such as the one presented in the induction procedure. The fact that the situation described was considered familiar to participants suggests that they might have been eventually exposed to similar circumstances before.

Second, it may also be that the low level of emotions is due to the induction procedure that was used. Experimental research in psychology has been using vicarious experiences instead of real ones because of ethical issues and variable control.[17] For example, autobiographical reports are cited as efficient tools for inducting emotions,[17] but if participants had been asked to recall an emotionally charged life event, a wide variety of situations would probably appear. The use of vicarious experiences was chosen to avoid this potential drawback. Moreover, we looked for an emotion induction procedure somehow related to the material to be learned – CPR and its consequences - presenting a case of a patient who had a heart attack and needed CPR. It is reasonable to expect that having a connection between the induction procedure and the learning material would increase the chances of the emotion triggered being activated and impact learning. The low levels of emotional arousal show that this expectation was however not fulfilled.

A third possible explanation to explore, is the interplay of different emotions on sub-sequential learning. We decided to focus and analyse one group of emotions only (i.e. the negative affect axis of the PANAS scale). Our emotional induction procedure presented one (negative) emotional version and one neutral version of a diary. But it might be that students at this level of maturity, who reappraise emotions, would also experience other emotions as interest, determination or curiosity. These set of positive emotions would then trigger an opposite effect on their sub-sequential learning, neutralising or at least significantly diminishing the possible negative effect.

A fourth explanation to consider when exploring our unexpected results is that the tests used to measure the learning outcomes have not been sensitive enough to capture subtle differences in performance. This may have been the case with the MCQ test. Although it had been previously piloted, the questions were apparently too easy for our participants' population, even though they reported lacking previous knowledge on the subject studied. Participants scored between 6 and 7 (in a 7-items test), resulting in a ceiling effect. The concept recall test, however, has been proved to be a sensitive measure of differences in learning outcomes,[21,27] and participants performed equally well on it. In addition, no differences emerged in the measures of learning process. If participants spent similar amount of time in studying the text and reported to be equally engaged with the task, it is unlikely that differences in learning outcomes existed but were not captured by the tests. This points to the low level of emotions as a more plausible explanation.

Our study has not shown significant differences regarding the influence of emotions on subsequent learning. However, it brings a contribution to the methodological discussion in a field where there are relatively few experimental studies. First, it provides some insights on methodological difficulties researchers face when inducting emotions in medical students. Although their training is embedded in a large range of emotional-triggering experiences, and perhaps for that very reason, it seems to be difficult to experimentally induct sufficiently high levels of emotions under controlled and ethically appropriate conditions. We were able to trigger emotions to a limited extent, but they were probably too low or too short-lived to actually impact learning.

This raises the question of the amount and the duration of emotions that may be necessary to affect learning of highly capable students as the ones of our population.

Researchers interested in investigating the influence of emotions on medical students' learning would need

therefore to try other, more potential methods for emotions triggering and more sensitive tests.

Acknowledgements

This study could not have been performed without the help and cooperation of the group of 5th-year students (2015) at the School of Medicine at University of São Paulo, Brazil for their participation and effort in completing the study tasks.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

None.

Declaration

This study was carried out in accordance with the Declaration of Helsinki, including but not limited to the anonymity of participants being guaranteed and the informed consent of participants being obtained. There was no conflict of interest, financial gains or personal interests involved in any phase of the study.

Ethical approval

Ethical approval has been granted from the Research Ethics Committee of the University of São Paulo (659.347 in 21/05/2014).

Appendix. Questionnaire of Experimental Study

Think about the facts described in the text you read and answer the following questions. For the questions with a numbered scale: please mark the score that best represents your impression of the situation as experienced by the student portrayed in the diary-entry.

1. You (or someone you know) has experienced a similar situation during your medical training? Please note: it does not have to be exactly the same situation, but an experience in which the student sees himself or herself in a situation similar to that portrayed in the diary-entry.

   Yes □ No □ I am not sure □

2. The diary-entry shows a realistic situation that commonly occurs during medical studies.

1	2	3	4	5
Totally disagree	Disagree	Neither agree nor disagree	Agree	Totally agree

3. This scale consists of a list of words representing different emotions and feelings. Read each word and choose the number that better represents the way you feel after reading the student's diary. Consider the following scale:

   1 = absolutely not.
   2 = a little.
   3 = somehow correct.
   4 = very much.
   5 = extremely.
   _____ stressed.
   _____ guilty.
   _____ hostile.
   _____ irritated.
   _____ ashamed.
   _____ nervous / upset.
   _____ afraid.
   _____ anguished.
   _____ sad.
   _____ anxious.

References

1. Shapiro SL, Shapiro DE, Schwartz GER. Stress management in medical education: a review of the literature. *Acad Med* 2000;75: 748–759.
2. Elnicki DM, Curry RH, Fagan, M, et al. Medical students' perspectives on and responses to abuse during the internal medicine clerkship. *Teach Learn Med* 2002;14:92–97, https://doi.org/10.1207/S15328015TLM1402_05.
3. McConnell MM, Eva KW. Emotions and learning: cognitive theoretical and methodological approaches to studying the influence of emotions on learning. In: Cleland J, Durning SK, editors. *Researching Medical Education*, 1st ed., West Sussex: John Wiley & Sons; 2015. [181-19].
4. Shapiro J. The feeling physician: educating the emotions in medica training. *Eur J Pers Cent Healthc* 2003;1:310–316.
5. Raat ANJ, Schonrock-Adema J, Ally van Hell E, Kuks JBM, Cohen-Schotanus J. Student distress in clinical workplace learning: differences in social comparison behaviours. *Adv Health Sci Educ* 2015;20:101–111, https://doi.org/10.1007/s10459-014-9513-9.
6. Edgoose JYC, Regner CJ, Zakletskaia LI. BREATHE OUT: a randomized controlled trial of a structured intervention to improve clinician satisfaction with "difficult" visits. *J Am Board Fam Med* 2015;28(1):13–20, https://doi.org/10.3122/jabfm.2015.01.130323.

7. Firth-Cozens J. Emotional distress in junior house officers. *Br Med J* 1987;295(6597):533–536.
8. Nevalainen MK, Mantyranta T, Pitkala KH. Facing uncertainty as a medical student - a qualitative study of their reflective learning diaries and writings on specific themes during the first clinical year. *Patient Educ Couns* 2010;78:218–223.
9. Kremer T, Mamede S, Roriz-Filho JS, Leite AJM. Emotionally difficult experiences faced by medical students during training. *Health Prof Educ* 2016;2:24–32.
10. LeBlanc VR, McConnell MM, Monteiro SD. Predictable chaos: a review of the effects of emotions on attention, memory and decision making. *Adv Health Sci Educ* 2015;20:265–282.
11. Lindström BR, Bohlin B. Emotion processing facilitates working memory performance. *Cogn Emot* 2011;25:1196–1204, https://doi.org/10.1080/02699931.2010.527703.
12. Ormrod JE. *Human Learning: Principles, Theories, and Educational Applications*, 5th ed., Upper Saddle River (NJ): Pearson Education; 2009.
13. Chen M, Bargh JA. Consequences of automatic evaluation: immediate behavioral predispositions to approach or avoid the stimulus. *PSPB* 1999;25(2):215–224.
14. Seibert PS, Ellis HC. Irrelevant thoughts, emotional mood states, and cognitive task-performance. *Mem Cogn* 1991;19(5):507–513.
15. Baumeister RE, Bratslavsky E, Muraven M, Tice DM. Ego depletion: is the active self a limited resource?. *J Pers Soc Psychol* 1998;74(5):1252–1265.
16. Pratto F, John OP. Automatic vigilance: the attention-grabbing power of negative social information. *J Pers Soc Psychol* 1991;61(3):380–391.
17. Lench HC, Flores SA, Bench SW. Discrete emotions predict changes in cognition, judgment, experience, behaviour, and physiology: a meta-analysis of experimental emotion elicitations. *Psychol Bull* 2011;137(5):834–855.
18. Kasman DL, Fryer-Edwards K, Braddock III CH. Educating for professionalism: trainees' emotional experiences on IM and pediatrics inpatient wards. *Acad Med* 2003;78:730–741.
19. Watson D, Clark AL, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. *J Pers Soc Psychol* 1988;54(6):1063–1070.
20. Rotgans JI, Schmidt HG. Cognitive engagement in the problem-based learning classroom. *Adv Health Sci Educ* 2011;16(4):465–479.
21. Zaromb FM, Roediger IHL. The testing effect in free recall is associated with enhanced organizational processes. *Mem Cogn* 2010;38(8):995–1008.
22. Fraser K, Ma I, Teteris E, Baxter H, Wright B, McLaughlin K. Emotion, cognitive load and learning outcomes during simulation training. *Med Educ* 2012;46:1055–1062, https://doi.org/10.1111/j.1365-2923.2012.04355.x.
23. Estrada CA, Isen AM, Young MJ. Positive affect facilitates integration of Information and decreases anchoring in reasoning among physicians. *Organ Behav Hum Dec* 1997;72(1):117–135, https://doi.org/10.1006/obhd.1997.2734.
24. Loewenstein G, Lerner JS. The role of affect in decision making. In: Davidson RJ, Scherer KR, Goldsmith HH, editors. *Handbook of Affective Sciences*. Oxford: Oxford University Press; 1997. p. 619–642.
25. McNaughton N. Discourse (s) of emotion within medical education: the ever present absence. *Med Educ* 2013;47(1):71–79.
26. Glaser R, Bassok M. Learning theory and the study of instruction. *Ann Rev Psychol* 1989;40:631–666.

Telma Kremer, MSc, is a clinical psychologist graduated at São Paulo University and a PhD student at the Institute of Medical Education Research Rotterdam, Erasmus MC, The Netherlands.

Sílvia Mamede, MD, PhD, is associate professor at the Institute of Medical Education Research Rotterdam, Erasmus MC and at the Department of Psychology, Erasmus University Rotterdam, The Netherlands.

Milton A. Martins, MD, PhD is professor of medicine at the Department of Medicine of the School of Medicine, University of São Paulo, Brazil.

Patricia Tempski, MD, PhD is coordinator of the Center for Development of Medical Education of the School of Medicine, University of São Paulo, Brazil.

Walter W. van den Broek, MD, PhD, is the Director of Medical Education, Director of psychiatric residency training, Erasmus University Rotterdam, The Netherlands