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Effects of Expressive Writing Effects on Disgust and Anxiety in a Subsequent Dissection

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Abstract Emotions influence motivation and achievement, but negative emotions have rarely been assessed in science education. In this study, we assessed the influence of two different expressive writing assignments on disgust and anxiety in university students prior to the dissection of a trout. We randomly assigned students to one of two expressive writing tasks and measured specific state disgust and state anxiety after writing and after the dissection. Specific state disgust was measured a third time after 3 weeks. One writing task was concerned with the dissection, and the other was related to behavioral experiments with mice. We used two general linear models with repeated measures. In the first model, specific state disgust (pre, post, and follow-up) was used as the dependent repeated measure and experimental group as the independent variable. In the second model, state anxiety was used as the dependent repeated measure (pre, post) with experimental group as the independent variable. The repeated testing showed a highly significant effect of experimental group on the repeated measures of disgust. Writing about worries and emotions concerning the dissection leads to higher disgust scores compared to writing about mice. These higher scores persisted even 3 weeks later in the follow-up test. Concerning anxiety, there was a clear influence of the repeated measure of state anxiety, but anxiety was not influenced by the experimental group. We suggest that positive writing should be used in educational contexts to reduce disgust.

Keywords Anxiety · Expressive writing · Disgust · Dissection

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Introduction

In the context of science education, dissections are rated as very disgusting by students (Holstermann et al. 2009; Randler et al. 2013). Therefore, we aimed at reducing disgust before a dissection of a fish, and we assessed the influence of an expressive writing assignment onto the negative emotions "anxiety" and "disgust." The idea was based on Frattaroli's (2006) meta-analysis. The results of a random effects analysis indicated that "expressive writing" (or experimental disclosure) is effective and produced a positive and significant average *r* effect size of 0.075. "Expressive writing" or "experimental disclosure" is defined as allowing individuals to confront upsetting topics (Smyth 1998). However, writing has been used in science education only for the purpose of increasing reasoning skills and competencies (Keys 1994; Keys et al. 1999; Hand et al. 2004) but never to influence disgust and/or anxiety in the form of "expressive writing." More generally, emotions have rarely been explored in education—negative emotions have received some attention, e.g., boredom (mathematics; Pekrun et al. 2010) and anxiety, with the latter one often referring to a high stakes testing situation (Ramirez and Beilock 2011).

Background

Emotions

We define emotions following Pekrun et al. (2011) as "sets of interrelated psychological processes, whereby affective, cognitive, motivational, and physiological components are of primary importance. For example, anxiety can comprise uneasy and tense feelings (affective), worries (cognitive), impulses to escape from the situation (motivational), and peripheral activation (physiological)" (Pekrun et al. 2011, p. 37). Further, emotions can be conceptualized in trait-like or state-like ways. "The defining characteristic of the trait versus state distinction is the temporal generality of the emotion under consideration. For example, habitual test anxiety as measured by test anxiety scales is regarded as a trait emotion (Zeidner 1998); anxiety experienced an hour before a specific exam would be viewed as a state emotion" (Spielberger, Anton, and Bedell 1976; Pekrun et al. 2011, p. 38). In our study, we define the emotions as state-like.

Emotions influence intrinsic motivation (Krapp 2005) and achievement (Gläser-Zikuda et al. 2005). Interest, for example, has received much attention in research about academic emotions, and interest is an important predictor of the level of learning, academic performance, and the quality of the learning experience (Hidi and Renninger 2006; Randler and Bogner 2007; Schiefele et al. 1993). Other emotions—such as enjoyment, hope, pride, relief, anger, anxiety, shame, hopelessness, and boredom (Pekrun et al. 2011)—have attracted less attention, but these emotions have also been found to influence academic performance (Gläser-Zikuda et al. 2005; Pekrun et al. 2010).

Disgust and anxiety are important variables showing an influence on learning and instruction, particularly in science education. Disgust and anxiety play a role, for example, during dissection (Holstermann et al. 2009; Randler et al. 2012a; 2012b) or during encounters with living animals (Hummel and Randler 2012; Bixler and Floyd 1999; Randler et al. 2005). During a zoology course, Randler et al. (2013) showed that the dissection of a fish elicited the highest disgust in comparison to other topics, e.g., compared to behavioral observations of living animals. Further, they asked for disgust ratings of their students immediately after the respective lessons (state-approach). Bixler and Floyd (1999) analyzed an outdoor educational

setting with middle-school pupils. They found a low interest in activities that required manipulation of organic substances, which, in turn, had the highest disgust ratings. Holstermann et al. (2009) used the dissection of a pig's heart to measure disgust and self-efficacy. Participants who felt more disgusted saw themselves as less effective at mastering the dissection, and these participants reported lower interest. In another study, Holstermann et al. (2012) showed that interest was negatively related to disgust prior to and during the dissection of a pig's heart. Concerning the dissection of a fish, Randler et al. (2012a, 2012b) showed correlations between anxiety and disgust on the one side and motivational variables on the other. Interest and competence during a dissection were positively predicted by low disgust and low anxiety, and high pressure/tension was predicted by high disgust and anxiety. These studies consistently show a negative influence of disgust and anxiety on motivation, interest, and achievement. Therefore, reducing disgust might be an important aim.

Disgust

Disgust is conceptualized as a basic negative emotion with distinct cognitive, physiological, and behavioral dimensions (Izard 2007; Holstermann et al. 2012) including a state and a trait component (Tolin et al. 2006; Petrowski et al. 2010). Disgust involves turning away from the offensive viewpoint (Holstermann et al. 2012). In biological and psychological terms, disgust is related to avoidance of certain animals, ill humans, feces, vomit, sexual substances, and other harmful events (Rozin et al. 2000). Disgust is adaptive in evolutionary terms because it reduces the probability of transmission of infectious diseases and helps to avoid contamination with harmful substances (Curtis et al. 2004; Oaten et al. 2009; Prokop et al. 2010; Tybur et al. 2009). Some studies in science education aimed at reducing disgust when students encountered living animals (Killermann 1996; Randler et al. 2012b).

Anxiety

Freud (1924) defined anxiety as a specific unpleasant emotional state or condition that includes feelings of apprehension, tension, worry, and physiological arousal. Anxiety has a state and a trait component, and the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger et al. 1970, 1976) is one of the most frequently used measures of anxiety in applied psychology research. It is so popular that researchers around the globe are able to compare their results with those of others (Marteau and Bekker 1992; Barnes et al. 2002). Anxiety is an important emotion in learning settings and especially when dealing with test anxiety (Pekrun et al. 2002). Students' academic anxiety is negatively correlated with their intrinsic motivation (Gottfried 1985), and it is associated with lower academic performance (Richards and Hadwin 2011; Galla and Wood 2012). Anxiety has been reported, e.g., in medical students in different settings such as breast inspections (Pugh and Salud 2007) and anatomy (Boeckers et al. 2010). Pugh and Salud (2007) used models to prepare students for their tasks. In medical students, anxiety decreased from the first to the last dissection day by support from friends, family, and workmates as well as by a funeral ceremony (Boeckers et al. 2010). Concerning state anxiety during dissection, Horne et al. (1990) reported a lower anxiety after the dissection. This was confirmed by Arraez-Aybar et al. (2004) and Randler et al. (2012a, 2012b). Arraez-Aybar et al. (2004) further showed that a repeated or gradual exposure (e.g., by detailed verbal information on the situation, visits to dissecting rooms when no cadaver was present, videos showing pictures of human dissections, etc.) before carrying out the first dissection reduced the students' anxiety.

Dissection

Dissection of animals or their organs in university and at school is considered as a useful tool for learning and instruction. However, some studies reported that declarative knowledge may be even better when alternatives to dissections were taught (e.g., video instruction, virtual dissection; De Villiers and Monk 2005; Dewhurst 2004; Strauss and Kinzie 1994), and some science educators suggested that not all learners in biology should carry out dissection when alternatives may be available and adequate (De Villiers and Monk 2005). However, in addition to cognitive aspects, methodological skills are also an important part in education (Lord 1990). In an American survey, 79 % of the teachers used dissection to teach biology and only 31 % believed that alternatives were as good as dissections. The main reason was that the dissection fosters methodological skills (hands-on aspects; King et al. 2004).

Expressive Writing

When experiencing stressful events, expressing one's deepest thoughts and feelings in writing, also known as "expressive writing" or "experimental disclosure," may be a useful tool in protecting or improving one's well-being and general functioning (Frattaroli 2006; Frattaroli et al. 2011). Expressive writing or experimental disclosure allows individuals to confront upsetting topics, such as trauma (in the past) or anxiety related to a test (in the future; Smyth 1998). The participants "disclose" their emotions, and this treatment should help in reducing the constraints or inhibitions associated with not talking about or verbalizing this event (Smyth 1998). There is a long history of research on the effects of expressive writing about emotional experiences and traumatic events (Baikie et al. 2012; Baikie and Wilhelm 2005; Bugg et al. 2009; D'Mello and Mills 2014; Pennebaker and Chung 2014). Expressive writing was used in clinical and therapeutic settings, and most studies focused on events in the past rather than in the near future. Experimental disclosure or expressive writing is effective in promoting health, well-being, and physiological functioning (Smyth 1998; Frattaroli 2006). For example, Mercer et al. (2010) showed that visual journaling was a promising intervention for stress reduction in medical students. Further, there is evidence that expressive writing helps young adults in smoking cessation (Ames et al. 2007). Positive writing was revealed as an influential tool for reducing distress in affective disorders (Baikie et al. 2012). Some studies used positive and others negative writing (Baikie et al. 2012; Piolat and Bannour 2010). However, no difference between the two was reported by Baikie et al. (2012), while Piolat and Bannour (2010) reported higher anxiety after the use of negative valence lexicon and lower anxiety following the use of lexicon of positive valence. Expressive writing leads to significantly higher test scores and significantly lower pre-exam depressive symptoms than neutral writing, but no differences in test anxiety were found (Frattaroli et al. 2011; Ramirez and Beilock 2011).

Despite the well-established evidence of expressive writing in clinical settings, it is less common in educational settings. Writing assignments in science education have been used to increase competencies and skills (Keys 1994), to improve scientific writing skills (Libarkin and Ording 2012), or to increase attitude in biology (Steglich 2000). Science writing heuristic was discussed by Keys et al. (1999) to connect conceptual understanding with laboratory work. It is intended to facilitate the production of meta-knowledge about laboratory investigations (Keys et al. 1999) and to encourage students to examine laboratory activities much more carefully to justify their research questions, claims, and evidence (Hand et al. 2004). To our knowledge, writing has never been used in advance of a disgusting task in order to reduce disgust.

Research Question

This study tested if expressive writing about a forthcoming dissection resulted in lower levels of disgust and anxiety compared to expressive writing about a topic unrelated to the dissection. Therefore, two different writing tasks were compared. To assess this question, we used a quasi-experimental approach.

Methods

Design

One week prior to the study, we assessed trait disgust. This was to assess if our treatment groups are comparable in their general disgust as a personality measure. The study was conducted as an experimental randomized trial (Table 1). Immediately prior to the dissection, the expressive writing was randomly assigned (mouse versus dissection, see "Expressive Writing" section). The writing assignments were distributed in a pre-determined order: two different questionnaires were distributed alternately from the same staple of paper to avoid students noticing the different questionnaires. The questionnaires differed only slightly in the instruction to the writing task (see Appendix 1). After the writing task, specific state disgust (trout) and STAI-S were assessed (pretest). Then, the dissection followed. Immediately after the dissection, we applied the posttest (specific state disgust) and STAI-S again. With a delay of 3 weeks, specific state disgust was measured again.

Expressive Writing

Two different writing tasks were used in the experimental setting. Group 1 wrote in retrospect about their worries and emotions concerning the last course day. During this course, behavioral experiments with mice had been carried out. Group 2 wrote about their worries and emotions with respect to the forthcoming dissection task. Both writing assignments were structurally equal to avoid the students recognizing the different sets of questionnaires. Students' writing needed about 5 min. The instructions are presented in Appendix 1. As expressive writing may elicit a distress response (Smyth 1998), we used two writing groups rather than a control group without writing. We chose the course with mice (*Mus musculus f. domesticus*) because in many studies, these mammals elicit positive emotional responses and low disgust (Hummel and Randler 2012; Randler et al. 2013). For example, Hummel and Randler (2012) reported a

Table 1 Study design

Measurement instruments		
One week in advance	Trait disgust	
Intervention 1: expressive writing Random assignment to writing about mouse or trout		
Pre: immediately afterwards	Specific state disgust (trout)	State anxiety (STAI-S)
Intervention 2: trout dissection For all participants		
Post: immediately afterwards	Specific state disgust (trout)	State anxiety (STAI-S)
Follow-up: 3 weeks after the intervention	Specific state disgust (trout)	

mean value of 4.5 on a five-point-Likert scale (with a maximum of 5) for interest about mice after a lesson dealing with living mice. Additional unpublished data (2009) showed that well-being was significantly higher after the mouse lessons compared to the dissection. Therefore, the writing about mice served as a control group.

Dissection Task

The lesson lasted 100 min and the first 10 min were covered by a videotape introducing basic biological facts and the life history of the trout. Then, a lecturer explained the handling and gave some background information about the biology, anatomy, and internal and external structure (30 min) of the rainbow trout (*Oncorhynchus mykiss*, Walbaum, 1792; family Salmonidae). Lectures for all students were carried out by the same person. The trouts were bought from commercial rearing. Afterwards, the students dissected the trout in groups of usually two persons. In the last 5 min, students again filled in an immediate post-questionnaire while still in the dissection laboratory.

Participants and Data Collection

The participants of the winter term 2012/2013 were pre-service biology teachers who had all completed 13 years of schooling prior to commencing the course. One hundred students (86 females, seven males, seven sex unspecified) participated in the study. Forty-one females and four males (five sex unspecified) received the writing task about mice, and 45 females and three males (two sex unspecified) wrote about the trout dissection. Participation was unpaid, voluntary, and anonymous. The students were informed that we planned a study to gain some insight into our teaching. They were advised to fill in the writing task on the first page and then move to the next questions overleaf (pretest). The students were advised not to talk to each other during completion of the questionnaires which took place in the room where the dissection was carried out. However, the trouts were not present in the room, and students could not see or smell them.

Measurement Instruments

Trait Disgust

We measured disgust as a trait measurement (personality) with 37 items one week before the dissection. The measures were based on three domains: core disgust (15 items), animal remainder disgust (nine items), and contamination disgust (13 items). All items were five-point Likert scaled, and the participants responded to how disgusted they assessed the different questions. We used the German version of the scale which has good psychometric properties (Petrowski et al. 2010). The reliabilities of the present sample are core disgust α=0.76, animal reminder disgust α=0.81, and contamination disgust α=0.76.

Specific State Disgust (Trout)

Specific state disgust was measured three times—immediately after the expressive writing, immediately after the dissection, and three weeks later (Table 1)—with a scale (seven items) related to the dissection of the rainbow trout (see Randler et al. 2012a). The scale was constructed following a qualitative study in 2009. In that study, students were asked after a dissection "What was the most disgusting aspect?". The students mentioned appearance,

smell, and mucus. We used this prior study (unpublished) to construct the items of the specific state disgust scale. In addition, we used theoretical considerations based on different facets of disgust (following Petrowski et al. 2010), which contains items dealing with smell, feel, appearance, and taste. The specific state disgust scale covers all these facets. The original scale is in German and the items are presented in both German and an English translation (see Appendix 2). The scale is sensitive to changes (Randler et al. 2012a) and thus is considered to measure state disgust as a situational variable. Also, the scale is devoted to measure a specific disgust toward the trout and was labeled therefore "specific state disgust." The items were rated on a five-point Likert scale and two of the seven items are reverse coded. Cronbach's α was 0.79 for pretest, 0.77 for posttest, and 0.76 for follow-up. Convergent validity was tested by correlations with the three dimensions of the trait disgust scales. Specific state disgust correlates significantly with core disgust (r=0.425, p<0.001), animal remainder disgust (r=0.515, p<0.001), and contamination disgust (r=0.395, p<0.001).

State Anxiety (STAI-S)

State anxiety is measured by the STAI (Spielberger et al. 1970, 1976). The STAI is a brief self-report assessment designed to measure and differentiate between anxiety as a trait and a state (Spielberger et al. 1970). State anxiety fluctuates and is a function of the stressors on an individual. State anxiety should be low in non-stressful situations (Barnes et al. 2002). State anxiety was measured with a scale (20 items) that is sensitive toward changes (STAI-S; Laux et al. 1981). The items are four-point Likert scaled and ten items are positive and ten items are negative coded. Students rated how they felt at a particular moment (e.g., calm, tense). The reliability of the state anxiety scale was high in the present sample (pretest: α=0.93/posttest α=0.87). State anxiety was measured immediately prior to and after the dissection.

Statistical Analyses

We used general linear models (repeated measures ANOVA) to assess changes in specific state disgust (trout) and state anxiety. In the first model, specific state disgust (pre, post, and follow-up) was used as dependent repeated measures and experimental group as independent variable. In the second model, state anxiety (STAI-S) was used as dependent repeated measure (pre, post) with experimental group as independent variable.

Qualitative Analyses

We used MAXQDA to analyse the writings of the students and for categorisation. All texts were input into the program and classified into categories.

Results

There were no significant differences between the two groups in trait disgust one week before our experimental intervention (Pillai's trace=0.052, F=1.508 p=0.219, eta^2=0.052); thus, we considered the treatment groups as comparable. The repeated testing of specific state disgust (trout) showed a highly significant effect (see Table 2): the mean disgust scores were significantly lower immediately after the dissection (Table 3 and Fig. 1). The interaction with experimental group was not significant (Table 2). There was a significant effect of experimental group (writing assignment: trout versus mouse) on the repeated measures of disgust

Table 2 Results of the multivariate general linear model with repeated measures

Specific state disgust	Pillai's trace	*F*	*P*	eta^2
Time: repeated testing of specific state disgust	0.191	9.221	<0.001	0.191
Interaction: time × experimental group	<0.001	0.002	0.998	<0.001
State anxiety				
Time: repeated testing of state anxiety	0.184	21.857	<0.001	0.184
Interaction: time × experimental group	0.006	0.538	0.465	0.006

(F=4.886, p=0.034, eta^2=0.058, Fig. 1): Writing about worries or emotions concerning the forthcoming dissection elicited higher disgust scores compared to writing about mice (Table 2). These higher scores persisted even three weeks later in the follow-up test.

Concerning anxiety, there was a significant influence of the repeated measures of STAI-S (Table 2) with decreased anxiety immediately after the dissection (Table 3). The interaction between STAI-S and experimental group was not significant (Table 2). Anxiety was not influenced by the experimental groups (F=0.244, p=0.623, eta^2=0.003), suggesting that the expressive writing had an effect on disgust but not on anxiety.

We analysed the data of the expressive writing qualitatively (Fig. 2). The students wrote about disgust more often in the fish writings compared to the mouse writings. Interest and curiosity appeared more often in the mouse writings. Questions concerning one's self-efficacy occurred more often in the fish writings, while descriptions such as "sweet" or "cute" were reported in the mouse writings but did not appear in the trout writings. Anxiety received a similar amount of notations.

Discussion

After the expressive writing intervention, disgust was lower in the experimental group that wrote about the mouse compared to the group that wrote about the dissection. This suggests that it is the context about which the students write which is important. As this study was designed as a randomised-controlled trial, we infer causality and suppose that the writing about the mouse lowered disgust scores. Students writing about the task in advance (dissection of a fish) had higher disgust scores which were contrary to our expectations (see below). Previous work showed that students rated the behavioral mouse experiments less disgusting than the trout

Table 3 Descriptive means and standard deviations of study variables

	Mouse		Trout	
	Mean	SE	Mean	SE
Specific state disgust (trout)				
Pretest (after writing)	2.079	0.124	2.412	0.116
Posttest	1.838	0.119	2.173	0.112
Follow-up	1.996	0.119	2.336	0.112
State anxiety (STAI-S)				
Pretest (after writing)	1.913	0.072	1.909	0.072
Posttest	1.730	0.055	1.657	0.055

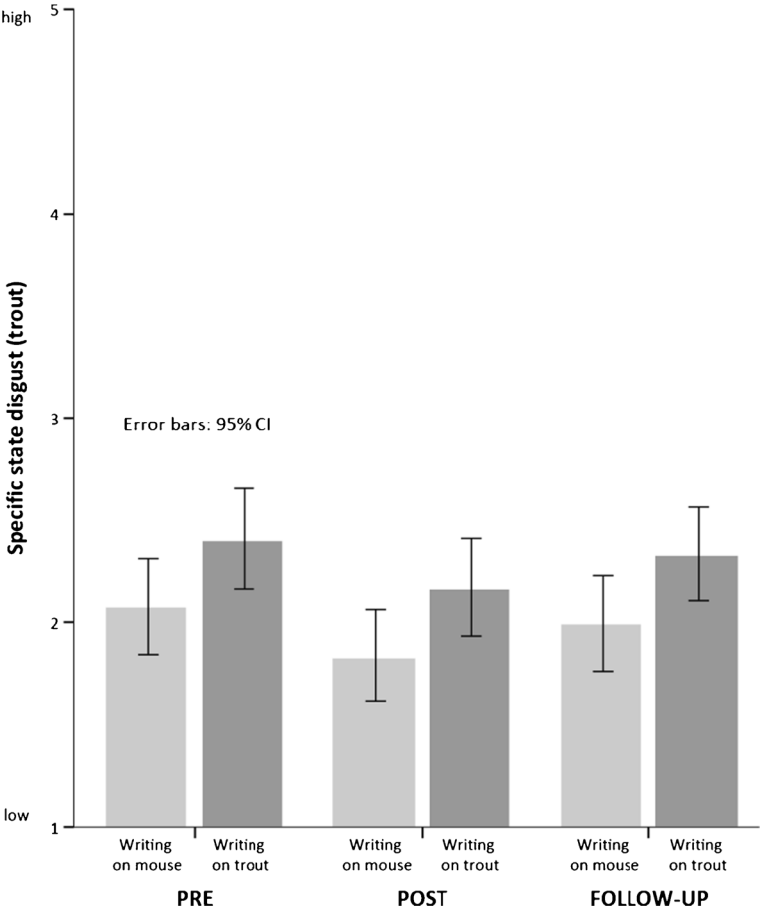

Fig. 1 Differences in specific state disgust (trout) between the two expressive writing groups ((A) positive (hindsight, mouse) and (B) negative (prospective, trout)). Pretest was administered after the expressive writing and immediately before dissection, posttest immediately afterwards, and follow-up after 3 weeks

dissection (Randler et al. 2013). This was supported by our qualitative analysis (Fig. 2). As we applied a strict randomised experimental design, we suppose that our two treatment groups are comparable and that the differences are real. Also, the prior assessment of trait disgust one week in advance of the dissection revealed no differences between both treatment groups supporting the view that the groups are comparable. We found a positive impact of positive writing in our study. Others also reported a positive impact of positive writing tasks on well-being (Baikie et al. 2012). This suggests that it is not the writing per se that elicits an effect.

The expressive writing with the focus on the dissection task may have had an influence on disgust scores. The imagination of a disgusting object can evoke disgust (cf. Gebhard 1994, p. 188). Our data suggest that—at least in education—a positive expressive writing session might be as effective if not even more effective when it comes to disgust. However, studies about this topic seem rather nonexistent, but given the various activities that may elicit disgust in a "modern" science education classroom or in out-of-school-settings, such as field trips, future studies should consider this aspect. Disgust was also lower after the dissection than before—this is the same pattern as found in anxiety (see below).

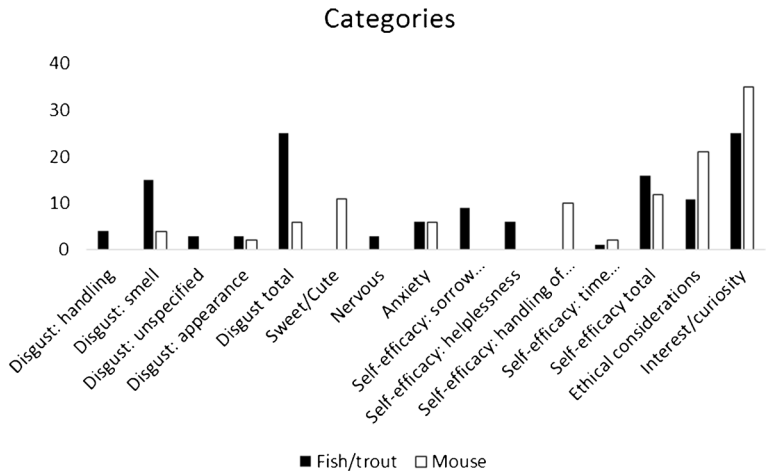

Fig. 2 Categories of the expressive writings and number of notations for every category

There was no effect of the type of expressive writing on state anxiety which is somewhat counterintuitive (e.g., Smyth 1998; Frattaroli 2006). In therapeutical contexts, expressive writing about a past traumatic experience can decrease anxiety and depression (Schoutrop et al. 1997). However, our nonsignificant result may arise from the difference between a traumatic experience and a dissection task. A traumatic experience should have a stronger impact on emotions. In the qualitative analyses, anxiety was mentioned in six cases in both treatments, so there was no difference between both. This might explain why anxiety was also not rated differently in the STAI-S questionnaire. Another aspect might be that the measurement of anxiety was not sensitive toward changes. However, this does not seem to be the case for two reasons. First, the STAI-S was especially designed as a state scale and applied in many studies around the globe. The reliability and validity of this scale have been tested in many languages and cultural contexts. Second, the STAI-S scores were significantly lower after the dissection which clearly indicates that the scale is sensitive toward changes.

Stress and anxiety decreased during anatomical dissections (Boeckers et al. 2010; Arraez-Aybar et al. 2004). Disgust could also be reduced in school students during an encounter with living animals (Randler et al. 2012b) as well as during a dissection task with university students (Randler et al. 2012a). Thus, these educational interventions follow the results and suggestions of behavioural therapies (confrontation therapy). For example, in spider fear and disgust sensitivity, scores were lower after an exposition to spiders (de Jong et al. 1997). Although test anxiety did not decrease in previous studies (Frattaroli et al. 2011), in our study, anxiety also decreased during dissection. This can be viewed as some kind of relief for the student after finishing the task and, more generally, should encourage students to participate in such tasks rather than avoiding them.

A further question that should be addressed is whether the writing task should be given as homework for students (both school and university) in advance or whether it should be carried out immediately before in the classroom. Most studies had students complete the writing task immediately before the dissection in the classroom (Ramirez and Beilock 2011) so that it had an immediate relation to the dissection.

We also wonder if expressive writing is influenced by time? One task was set in hindsight (mouse) while the other one was set with a prospective task (the dissection) in mind. Concerning trauma, there was no difference whether participants were instructed to write

about past, current, or either past or current traumas (Smyth 1998). Trauma patients have experienced strong negative life events, and this is not comparable to the negative event experienced in a university course, so that the trauma overrides the time perspective. However, in our study, time may have played a role, but we cannot control this aspect because of our experimental design (both groups had the dissection ahead). The expressive writing about the past course (about mice) could have reminded the students of their prior good performance. This could have influenced their perceived competence and self-efficacy which could have reduced disgust. King (2001) found in a study with 81 undergraduates that writing about the best possible future was significantly less upsetting than writing about traumatic experiences, and it was associated to an increase in well-being. Perhaps writing about the prior course in our study could in a similar way lead to an increase in well-being, and this could have reduced disgust.

A final question is whether writing provides the optimal intervention. Perhaps it might also be helpful using visual journals as suggested by Mercer et al. (2010), and this could be investigated in further studies and may offer a better solution for adolescent pupils. Perhaps showing a video demonstration prior to the dissection may be a way to reduce anxiety and disgust. There is evidence from medicine that suggests that patients who watched a video dealing with colonoscopy were significantly less anxious before their colonoscopy than those who did not (Luck et al. 1999). Similarly, following the work of Arraez-Aybar et al. (2004), talking about the dissection with a classmate before doing it, may be an interesting option.

Limitations of the Study

One limitation of the study might be that the students did not all respond honestly during the expressive writing task, and perhaps they did not report their inner feelings and emotions. This might be different from therapeutic expressive writing. Further, we did not apply a control group. Future studies should apply a control group without any writing. For such a study, our randomized-controlled design is not applicable because our questionnaires were similar in length but contained two different writing tasks. Another idea might be to assign writing that is not expressive and that deals with a less emotional but more cognitive aspect. Also, a writing task unrelated to the course content could be used as a control. Future studies could use a larger sample size or some of the students could be followed with video during the dissection to gain additional data. In addition, the design should include a measure of the two groups' mean anxiety and disgust levels prior to any intervention, i.e., before the first writing task. Further studies might measure the trait component of the STAI in advance.

Implications

As dissections are still an integral part of science education and of the curriculum, we suggest to lower disgust by making use of a writing assignment that is related to past positive emotions during previous lessons (in our case, the mouse lesson), which may increase the self-confidence of students because they have a memory of a task that they have already mastered. Other aspects of future work might be the use of videos showing how to handle the fish to reduce anxiety and disgust. In addition, it may be worthwhile using plastic models for training dissections.

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Appendix 1

Table 4 Instructions for the writing task

Mouse	Bitte notieren Sie innerhalb der nächsten 5 Minuten so offen wie möglich Ihre Gedanken, Sorgen und Gefühle bezüglich des vergangenen Seminartags (Maus). Schreiben Sie frei "von der Leber weg". Sie können Ihre Gedanken auf ähnliche Situationen beziehen.
	Please note within the next 5 min as expressive as possible your thoughts, sorrows and emotions concerning the last course day (mouse). Please write frankly. You can refer to similar situations.
Trout	Bitte notieren Sie innerhalb der nächsten 5 Minuten so offen wie möglich Ihre Gedanken, Sorgen und Gefühle bezüglich der anstehenden Forellenpräparation. Schreiben Sie frei "von der Leber weg". Sie können Ihre Gedanken auf ähnliche Situationen (Präparation) beziehen.
	Please note within the next 5 min as expressive as possible your thoughts, sorrows and emotions concerning the forthcoming trout dissection. Please write frankly. You can refer to similar situations.

Appendix 2

Table 5 Items of the specific state disgust scale relating to the trout

Original German version	English translation
1. Wenn ich eine ganze Forelle (samt Kopf und Augen) im Restaurant serviert bekäme, würde ich keinen Bissen runterbekommen.	If I would get served a whole trout (including head and eyes) in a restaurant, I would not be able to eat a thing. (SDS1)
2. Forellen sind eklig.	Trouts are disgusting. (SDS2)
3. Es macht mir nichts aus, eine tote Forelle anzufassen.	I don't mind touching a trout. (reverse coded) (SDS3)
4. Wenn wir eine Forelle präparieren, würde ich am liebsten den Raum verlassen.	I would rather leave the room when we dissect a trout. (SDS4)
5. Forellen sind schöne Tiere.	Trouts are beautiful animals. (reverse coded) (SDS5)
6. Der Schleim der Forelle widert mich an.	The trout's mucus nauseates me. (SDS6)
7. Bei der Forellenpräparation würde ich am liebsten eine Nasenklammer verwenden, um den Geruch zu vermeiden.	During trout dissection, I would rather use a nose clip to avoid the smell. (SDS7)

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