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Learning about a serious disease: When a personalized message is harmful unless you are happy

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Abstract

According to the personalization principle, addressing learners by means of a personalized compared to a nonpersonalized message can foster learning. Interestingly, though, a recent study found that the personalization principle can invert for aversive contents. The present study investigated whether the negative effect of a personalized message for an aversive content can be compensated when learners are in a happy mood. It was hypothesized that the negative effect of a personalized compared to a nonpersonalized message would only be observable for participants in a sad mood, while for participants in a happy mood a personalized message should be beneficial. A 2 $\times$ 2 between-subject design with mood (happy vs. sad) and personalization (personalized vs. nonpersonalized message) was used ($N = 125$ University students). Mood was experimentally varied prior to learning. Learning outcomes were measured by a retention and a transfer test. Results were essentially in line with the assumption: For participants in the sad mood condition, a negative effect of a personalized message was observable for retention and transfer. For participants in the happy mood condition, a positive effect of personalized message was observable for retention, but no effect for transfer. Note that the manipulation check measure for the mood induction procedure did not detect differences between conditions; this may be due to a shortcoming of the used measure (as indicated by an additional evaluation study). The study emphasizes the importance to consider the inherent emotional content of a topic, such as its aversive nature, since the emotional content of a topic can be a boundary condition for design principles in multimedia learning. The study also highlights the complex interplay of externally induced and inherently arising emotions.

KEYWORDS
cognitive load, emotional design, mood, multimedia learning, personalization principle

1 | INTRODUCTION

Several design principles have evolved over the last decades on how to present text and illustration in a comprehensible way. These principles are based upon influencing theories such as the Cognitive Theory of Multimedia Learning (CTML; Mayer, 2020; Mayer, 2014) and the Cognitive Load Theory (CLT; Sweller et al., 2011). More recently, these theories also integrated emotional factors. This is reflected in the Cognitive Affective Theory of Learning with Media (CATLM, Moreno, 2006; Moreno & Mayer, 2007), which is a further development of the CTML. Likewise, it is reflected in considerations about how emotional factors can be incorporated in CLT (Plass & Kalyuga, 2019). The research about emotional factors in multimedia learning focuses on adding emotionality to learning. This can be done either by inducing moods prior to the learning phase (e.g., Knörzer et al., 2016; Navratil & Kühl, 2019; cf. Plass & Kalyuga, 2019) or by internal mood induction procedures, such as by adding emotional aspects to illustrations or text (cf. emotional design; e.g., Plass et al., 2014; Um et al., 2012; for meta-analyses see Brom et al., 2018; Wong & Adesope, 2020). However, what is mostly neglected so far is that some topics are inherently emotional loaded, for instance topics about serious diseases. There is some preliminary evidence that some design principles may not hold true for such emotional loaded topics. Particularly, a recent study showed that the personalization principle was inverted when participants learned about serious diseases (Kühl & Zander, 2017). The current study investigated whether this inverted personalization effect for an aversive topic can be replicated and whether the negative impact of an aversive topic on the personalization effect can be compensated by a happy mood (cf. Raghunathan & Trope, 2002).

1.1 | Personalization principle and its inversion for aversive content

According to the personalization principle (cf. Mayer, 2020; Mayer, 2014), learners benefit when a multimedia message is presented in a conversational style (i.e., personalized message) compared to a multimedia message that is presented in a formal style (i.e., nonpersonalized message). A personalized message can for instance be implemented when personal pronouns such as ‘you’ and ‘your’ are used, whereas such personal pronouns are non-existent in a nonpersonalized message. One explanation of the personalization principle effect refers to self-referencing. According to this explanation, information can be better organized and elaborated when it is referenced to the self as compared to when information is not referenced to the self (cf. Klein & Loftus, 1988; Rogers et al., 1977; Symons & Johnson, 1997). By using a personalized message, the likelihood increases that learners reference the message to themselves (cf. Moreno & Mayer, 2000, 2004), and as a consequence, learners will be more engaged in processing the content. This should in turn result in better learning outcomes. The personalization principle is empirically well supported for learning outcomes (cf. Ginns et al., 2013; Mayer, 2017, 2020) across various domains, such as physics (Kartal, 2010), psychology (Reichelt et al., 2014; Riehemann & Jucks, 2018), and anatomy (e.g., Dutke et al., 2016; Ginns & Fraser, 2010; Lin et al., 2020; Mayer et al., 2004; Schworm & Stiller, 2012; Stiller & Jedlicka, 2010). In these studies, however, the topic can be considered as emotionally neutral.

As is pointed out in the CATLM (Moreno, 2006; Moreno & Mayer, 2007) and similarly in the Integrated Cognitive Affective Model of Learning with Multimedia (ICALM; Plass & Kaplan, 2016), affective factors can play a crucial role in multimedia learning by influencing cognitive processes. Thereby, affective factors may also have an impact on the validity of design principles, such as the personalization principle. A recent study showed that the personalization principle can reverse when the topic is emotionally aversive (Kühl & Zander, 2017). In two experiments, the Kühl and Zander (2017) used information about cerebral haemorrhage as an aversive topic. An inverted personalization effect for the learning outcome measure of transfer was found: Learners profited when the topic was presented as a nonpersonalized message compared to when a learner's self was addressed by means of a personalized message. As an underlying mechanism for this effect, it was initially assumed that participants with a personalized message would experience a higher increase in state anxiety than participants with a nonpersonalized message. However, this was not the case. In both experiments, learners' state anxiety increased equally during learning, irrespective of personalization. This means that state anxiety could not directly explain differences found in the learning outcomes.

This observed pattern of results for learning outcomes and state anxiety may be explained by learners' need to repair their negative mood (Bless & Fiedler, 2006) before investing their resources in processing aversive information. As observed, state anxiety may generally increase when learning about an aversive topic. However, if the message referred to the self of the learners, then learners might have invested additional resources for mood repair, in this case in preventing an exaggerated increase in state anxiety. In the terminology of CLT, mood repair is a type of task-irrelevant processing which constitutes extraneous cognitive load (Plass & Kalyuga, 2019). Participants receiving a personalized message thus may have been more engaged in repairing their mood. Correspondingly, they have been less engaged in processing the aversive content. This might have resulted in the observed inverted personalization effect while differences in state anxiety were not observed. It follows from these considerations, that when learners' need for repairing their mood is relieved, the negative impact of referencing an aversive topic to the self may vanish and self-referencing may even be beneficial again (cf. Agrawal et al., 2007). This reasoning is linked to the mood-as-resource hypothesis (Raghunathan & Trope, 2002) and will be explicated in more detail next.

1.2 | Positive mood as a resource to counteract an inverted personalization effect

In general, the mood of a person can foster or hinder the processing of emotionally aversive and threatening content (e.g., Aspinwall, 1998; Keller, 1999; Raghunathan & Trope, 2002). According to the mood-as-a-resource hypothesis (Raghunathan & Trope, 2002), a positive mood can serve as a buffer against the affective costs of thoroughly processing negative information. A positive mood will deteriorate by processing the negative information, however. In a happy mood, learners have some resources to process negative information, but they will balance their investment of resources with respect to the decrease of mood. People are willing to process negative information at the costs of their positive mood, thereby possibly allowing state anxiety to increase, particularly when the information has a direct connection to themselves, as may for instance be the case for self-referenced information. For information that is no related to themselves, the negative information may be less intensively processed in return for maintaining a positive mood and to avoid an increase in state anxiety. Learners in a negative mood have hardly any resources left to cope with negative information. This is particularly true when the information is connected to oneself. Under such circumstances, the prior goal is to repair the negative mood at the cost of processing the negative information.

Based upon this reasoning, the impact of mood on self-referencing was investigated in a study about the effectiveness of health messages (Agrawal et al., 2007; Exp. 3). In this study, participants were asked to refer an aversive health message about hepatitis C either to oneself or to others. By inducing different emotions to participants, the authors could show that a sad mood led to less recall about the health message, less time spent reading additional information about hepatitis C as well as to a worse performance on a knowledge test in the self-referencing group compared to the group that referred the information not to oneself. For a happy mood, the opposite was true: Participants recalled more information about the health message, spent more time reading additional information about hepatitis C and performed better on a knowledge test about this additional information in the self-referencing group.[1]

In the context of multimedia learning, self-referencing can be achieved by using a personalized compared to a nonpersonalized message. When relating the just mentioned findings to the personalization principle in multimedia learning, and particularly to the observed inverted personalization effect for aversive content, it can be assumed that the inverted personalization effect may be moderated by mood. When participants are in the negative mood of sadness, they may lack resources to refer an aversive content to oneself, but rather need to invest more resources in repairing their mood, also to counteract an exaggerated increase in state anxiety. In this case, a personalized message may be less thoroughly processed, resulting in worse learning outcomes compared to a nonpersonalized message. This would correspond to the inverted personalization effect. However, when participants are in a happy mood, they might have the resources available to relate the aversive content to oneself. Thus, with a happy mood, a personalized message about an aversive topic might be more thoroughly processed and will result in better learning outcomes than a nonpersonalized message. This would correspond to the personalization effect. Looking at affect, thoroughly processing of the personalized aversive information in a happy mood might come at the cost of a more exaggerated decrease of the happy mood and in an increase in state anxiety.

1.3 | The present study: hypotheses and research questions

In the present study, we chose the emotionally aversive topic of cerebral haemorrhage. In two previous experiments, an inverted personalization effect was found with this material (Kühl & Zander, 2017). It was examined whether the factor mood (happy vs. sad mood) would act as a moderator for the inverted personalization effect. The mood induction procedure consisted of asking participants to either recall a happy or a sad event of their life, like in the abovementioned studies (Agrawal et al., 2007; Raghunathan & Trope, 2002). Building directly up upon previous studies that used this instructional material (Kühl & Zander, 2017; Zander et al., 2017), we assessed next to learning outcomes, measures of state anxiety and cognitive load as well as learning times.

The primary research question concerned learning outcomes. As explained above, we hypothesized an interaction of mood and personalization (Hypothesis 1): An inverted personalization effect should be observable for participants in a sad mood (Hypothesis 1a). For participants in a happy mood, however, an inverted personalization effect should not be observable anymore, but the beneficial effect of personalization might be re-established (Hypothesis 1b).

The secondary research questions addressed the possible mechanisms for the hypothesized interaction. Thereby, changes in affective states (mood and state anxiety) as well as indicators of processing the content (cognitive load and learning times) were explored. Concerning changes in affective states, we examined whether the hypothesized interaction would also be observable for mood (Hypothesis 2) and state anxiety (Hypothesis 3): For participants in a happy mood, mood might more strongly deteriorate (Hypothesis 2a) and state anxiety might more strongly increase (Hypothesis 3a) if they learn with a personalized compared to the nonpersonalized message. For participants in a sad mood, however, these assumed differences between personalized and nonpersonalized messages should neither be observable for mood (Hypothesis 2b), nor for state anxiety (Hypothesis 3b). Moreover, it was explored whether the hypothesized interaction would also be mirrored for cognitive load and learning times (Hypothesis 4 and 5): In a sad mood, a personalized message might be perceived as more difficult and be processed with less effort (Hypothesis 4a) as well as for a shorter time (Hypothesis 5a) than a nonpersonalized message. In a happy mood, a personalized message might be perceived as less difficult, be processed with more effort (Hypothesis 4b), and for a longer time (Hypothesis 5b) than a nonpersonalized message.

2 | METHOD

2.1 | Participants and design

One hundred thirty-one students from a German university participated either for course credit or payment in the study. The study was advertised on bulletin boards in the university building as well as by means of existing mailing lists for students who are generally interested in participating in studies. Participants were randomly assigned to one of four conditions that resulted from a 2 × 2 between-subject design, with mood (happy vs. sad) and personalization (personalized vs. nonpersonalized) as independent variables. One participant aborted the study. Furthermore, due to technical problems, the instructional material was presented incomplete (i.e., without pictures) to five participants. The data of these six participants were excluded from data analyses and the analyses were conducted for the remaining 125 students (94 females and 31 males; average age: $M = 22.39$ years, $SD = 3.72$).

2.2 | Mood induction

To induce a happy or a sad mood, respectively, participants were asked to recall and to write down in detail either a happy or a sad life event. Thereby, a cover story stated that the following tasks would be about remembering emotional life events and that this part of the study was conducted to construe an inventory about life events for future studies (e.g., Bless et al., 1996; Krauth-Gruber & Ric, 2000). The positive mood induction procedure asked the participant to remember and write down a life event that made him/her happy, while the negative mood induction procedure asked about a life event that made him/her sad. Participants were given 8 min and the answer could be typed in an empty field below the respective instruction.

2.3 | Instructional material

The computerized instructional material, which had been used in an almost identical way in a previous study (Kühl & Zander, 2017), dealt with the topic cerebral haemorrhages. It consisted of five pages. The text was presented in written format and contained approximately 470 words. The text was illustrated by two pictures. In the introductory part of the instructional material, the structure of the skull and brain were described. This part was not subject to experimental manipulation, since it was not considered to be emotional aversive. After this introductory part, the definition, symptoms, effects as well as possible causes of a cerebral haemorrhage were conveyed. These last four sections were subject to experimental manipulation and hence presented either as a personalized message or as a nonpersonalized message. For the personalized message, personal pronouns such as ‘you’ and ‘your’ were used,[2] while no personal pronouns were used for the nonpersonalized message. The two text versions differed only with regard to the use of personal pronouns. Extracts for the personalized and nonpersonalized messages are provided in Table 1. Participants could navigate to the next page by using a ‘next’ button (i.e., self-paced). The instructional material was presented in the lab via the web-based software Unipark (www.unipark.com).

2.4 | Measures

The computer-based measures consisted of (1) a participant questionnaire including a test about prior knowledge of cerebral haemorrhages, (2) scales intended to assess mood, (3) a scale

TABLE 1 Extract of the two different versions of the instructional material (Section: ‘Symptoms’)

Personalized message	Nonpersonalized message
With a cerebral haemorrhage you get a severe headache of unprecedented intensity. Furthermore, you develop dizziness and nausea and you probably have to vomit. Depending on which of your brain areas is affected, a cerebral haemorrhage can cause that you experience neurological failure. In the further course, a cerebral haemorrhage can cause a clouding of your consciousness (vigilance dysfunction) up to coma. The latter one would go along with life threatening respiratory dysfunction. The pressure in your brain can increase. This increase can go along with a circulatory collapse, but also leads to death in many cases.	With a cerebral haemorrhage a severe headache of unprecedented intensity occurs. Furthermore, dizziness and nausea develop and probably lead to vomiting. Depending on which of the brain areas is affected, a cerebral haemorrhage can cause neurological failure. In the further course, a cerebral haemorrhage can cause a clouding of consciousness (vigilance dysfunction) up to coma. The latter one would go along with life threatening respiratory dysfunction. The pressure in the brain can increase. This increase can go along with a circulatory collapse, but also leads to death in many cases.

Note: The original instructional material was in German.

assessing state anxiety, (4) cognitive load items, (5) a knowledge test about the topic of the instructional material, and (6) learning time. Further measures were assessed for exploratory purposes after the knowledge test ended so that they could not influence the results for the essential research questions. These measures will not be further explored within this article (the measures were: cognitive avoidance, motivation, disgust, perceived efficacy, self-risk, threat, health anxiety, personal relevance, personal connection to cerebral haemorrhages, as well as comments to the study).

2.4.1 | Participant questionnaire including a prior knowledge test

Next to demographic data, participants were asked about their self-rated knowledge on the topic of cerebral haemorrhage and were asked about their interest in this topic, which they each had to rate on a five-point Likert scale (1 = very low; 5 = very high). In addition, participants were asked about their final school exam grade. Prior knowledge was assessed by one open question that asked participants to write down everything they know concerning a cerebral haemorrhage. The answers to this prior knowledge test were corrected by two independent raters according to a predefined coding scheme. Inter-rater agreement was very good (Krippendorff's $\alpha = 0.90$; cf. Hayes & Krippendorff, 2007). The final score of this prior knowledge test was obtained by using the arithmetic mean of the scoring of the two raters (with an observed maximum score of six points).

2.4.2 | Mood assessment

A shortened version of the Positive and Negative Activation Schedule (PANAS[3]; Watson et al., 1988) was used, namely the International PANAS Short Form (I-PANAS-SF; Thompson, 2007). The I-PANAS-SF consist of 10 items, five items for measuring the Positive Activation subscale (PAS) and five items to measure the Negative Activation subscale (NAS). The five items of the PAS are 'active', 'determined', 'attentive', 'inspired', 'alert'; the five items of the NAS are 'afraid' 'nervous', 'upset', 'hostile', 'ashamed'. Participants were asked to indicate how they currently feel by rating these 10 items on a five-point Likert scale ranging (from 1 = not at all to 5 = very much). The PAS and the NAS were both assessed twice: Once directly after the mood induction procedure (in the following PAS 1 and NAS 1, respectively), and once after the learning phase ended (in the following PAS 2 and NAS 2, respectively). The internal consistency of the PAS 1 ($\alpha = 0.75$), PAS 2 ($\alpha = 0.87$), NAS 1 ($\alpha = 0.79$) and NAS 2 ($\alpha = 0.75$) were acceptable to good.

2.4.3 | State anxiety

State anxiety was measured with a six-item short-form (Marteau & Bekker, 1992) consisting of six statements (e.g., 'I am relaxed') that had to be rated on a four-point Likert scale (1 = not at all; 4 = very much so). A higher score indicated a higher state anxiety. The internal consistency of the STAI was acceptable ($\alpha = 0.68$ for the first measurement; $\alpha = 0.78$ for the second measurement).

2.4.4 | Cognitive load measures

Subjective cognitive load ratings that are associated with difficulty were measured with seven items (based on Koch et al., 2008) and were also used in a previous study by Kühl and Zander (2017). These items were: (1) 'How easy or difficult do you consider the topic of cerebral haemorrhage?'; (2) 'How easy or difficult was it for you to connect new information to what you already knew about the topic?', (3) 'How easy or difficult was it for you to work with the instructional material?', (4) 'How easy or difficult is it for you to distinguish between important and unimportant information in the instructional material?', (5) 'How easy or difficult is it for you to collect the information necessary to understand the instructional material?', (6) 'How easy or difficult was it to understand the instructional material?' and (7) 'How easy or difficult was it for you to imagine the process of a cerebral haemorrhage?' All items had to be rated on a seven-point Likert scale (1 = very easy; 7 = very difficult). All items were summed up to one score (min = 7; max = 49). The internal consistency of this questionnaire was very good ($\alpha = 0.88$). Moreover, one item about mental effort (cf. Paas, 1992) had to be rated on a seven-point Likert scale (1 = very little; 7 = very much).

2.4.5 | Knowledge tests

Learning outcomes were measured by a retention test and a transfer test (that was quite similar to the one used by Kühl & Zander, 2017). The retention question was identical to the question of the prior knowledge test ('Please write down everything you know about the medical processes of a cerebral hemorrhage'), but there were no time restrictions in answering this question. Transfer performance was assessed by four transfer tasks: (1) 'What kind of treatment could you imagine for dealing with a cerebral haemorrhage? Please write down all plausible answers'. (2) 'How could medical innovations prevent that a severe cerebral haemorrhage occurs?' (3) 'What could be reasons that some people survive for the first hours after a cerebral haemorrhage occurs without medical care? Write down all plausible answers'. (4) 'How would a permanently low blood pressure affect the probability of suffering a cerebral haemorrhage? Please explain your answer'. To give an impression for correct answers, using the example of the first transfer task, acceptable answers could for instance address that blood may be aspirated by a tube or that the skull could be opened temporary. The answers of the retention question and the transfer tasks were corrected by two independent raters according to a predefined coding scheme. Inter-rater agreement was very good for retention (Krippendorff's $\alpha = 0.96$) as well as for transfer (Krippendorff's $\alpha = 0.96$). The score for retention and for transfer were determined by the arithmetic mean of the scores of the two raters. For retention, the observed maximum score was 12 points and for transfer, the observed maximum score was nine points.

2.4.6 | Learning time

Via the web-based software Unipark, the time participants had spent on each computerized page, and thereby with the instructional material, was logged. These data are an estimate of the time learners actually spent with the instructional material.

2.5 | Procedure

The study took place in a computer lab at the university. Per session, up to six participants could take part. Before starting the experiment, each participant received a written informed consent, stating that it was possible for them to quit the experiment with no repercussions or disadvantage at any time. With the exception of the written consent form, all materials and measures were computerized and presented on a computer screen via the web-based software Unipark (www.unipark.com). The random assignment of participants to conditions was governed by the software. After consenting to participate, participants completed the participant questionnaire, followed by the prior knowledge test, for which participants were given a maximum of 5 min to answer. Then the mood induction procedure started and lasted 8 min. The actual purpose of the mood induction was not explained to avoid demand effects. Subsequently, the I-PANAS-SF and then the STAI were given for the first time. Thereafter, participants could learn with the instructional material at their own pace. Then, participants received the I-PANAS-SF and the STAI for a second time, followed by the questions about cognitive load. Participants then took the knowledge tests. There was no time restriction for answering the knowledge test. After the knowledge test was completed, participants received the aforementioned measures that were assessed for exploratory purposes. Finally, participants were debriefed. A session lasted approximately 40 min. The experiment was approved by the local ethics committee of the University. During the entire procedure, we followed American Psychological Association guidelines for the ethical treatment of human research participants.

3 | RESULTS

First, the control variables were checked for differences between conditions. Second, it was examined whether mood as well as state anxiety changed between conditions. Third, for the dependent variables of cognitive load, learning outcomes and learning time, it was analysed whether the conditions would differ. Table 2 provides an overview of means and standard deviations (SD) for the different condition.

3.1 | Control variables

2 × 2 between-subject ANOVAs with mood (happy vs. sad) and personalization (personalized vs. nonpersonalized) as independent variables were conducted. Results revealed neither differences for mood, nor for personalization, nor an interaction for the following control variables: interest (all *F*s < 1.16, all *p*s > 0.28), final exam grade (all *F*s < 1, all *p*s > 0.49), or prior knowledge (all *F*s < 1.16, all *p*s > 0.28). For self-estimated knowledge, there were no main effects (both *F*s < 1, both *p*s > 0.54), and a marginal interaction, $F(1, 121) = 3.60$, $p = 0.060$, $\eta^2_p = 0.029$.

3.2 | Mood

The PAS 1 and NAS 1 served as the manipulation check for the mood induction procedure. For the PAS 1 or the NAS 1 - which were assessed directly after the mood induction procedure – 2 × 2 ANOVAs with mood and personalization as independent variables revealed no main effects of personalization, both *F*s < 2.15, both *p*s > 0.14, and no interactions, both *F*s < 1.58, both *p*s > 0.21. Surprisingly, however, no differences were observable for the factor mood, both *F*s < 1.39, both *p*s > 0.24. Thus, the mood induction procedure had no significant impact on the assessed manipulation check measures PAS 1 and NAS 1. In the hindsight, this missing effect for mood may be a problem of the two scales for adequately measuring a happy and a sad mood, rather than a failure of actually inducing mood with the described procedure. This limitation will be taken up in a following evaluation study (Section 4) as well as in the Discussion (Section 5).

The research question associated with the mood measures was to examine whether the mood for participants receiving the happy mood induction would more strongly deteriorate when they received the

TABLE 2 Means (and SD) as a function of mood induction and personalization

Mood induction Personalization	Happy Personalized (*n* = 33)	 Nonpersonalized (*n* = 32)	Sad Personalized (*n* = 30)	 Nonpersonalized (*n* = 30)
Control variables				
Interest	2.88 (1.02)	3.06 (1.05)	2.87 (1.04)	2.67 (1.12)
Self-rated prior knowledge	1.45 (0.71)	1.84 (0.95)	1.77 (0.97)	1.57 (0.82)
Prior knowledge	1.48 (1.43)	1.63 (1.40)	1.97 (1.33)	1.65 (1.06)
Affect-related scales				
PAS 1	17.79 (3.38)	16.19 (3.20)	16.53 (4.42)	16.47 (2.34)
NAS 1	6.67 (2.41)	7.78 (2.98)	7.63 (3.09)	8.03 (3.06)
PAS 2	17.06 (3.66)	15.75 (4.12)	16.60 (4.67)	18.03 (3.00)
NAS 2	6.09 (1.70)	6.94 (2.58)	7.57 (3.13)	6.63 (1.71)
STAI (before learning)	11.00 (2.65)	12.03 (2.78)	11.77 (3.16)	11.27 (2.65)
STAI (after learning)	11.15 (2.95)	12.31 (2.97)	12.97 (3.69)	12.20 (2.80)
Cognitive load				
Difficulty	21.58 (7.53)	21.25 (6.29)	20.87 (6.60)	19.63 (6.06)
Effort	4.58 (1.23)	4.09 (1.53)	5.00 (1.70)	4.83 (1.34)
Learning outcomes				
Retention	7.29 (3.04)	5.55 (3.07)	6.32 (3.35)	7.93 (3.07)
Transfer	4.32 (1.65)	4.02 (1.99)	3.42 (1.95)	4.52 (1.92)
Learning time (in seconds)	214.85 (91.32)	188.22 (87.34)	186.20 (75.09)	226.80 (81.60)

personalized compared to the nonpersonalized message (Hypothesis 2a). In contrast, these differences between personalized and nonpersonalized messages should not be observable for participants receiving the sad mood induction (Hypothesis 2b). Mixed-design ANOVAs with the between-subject variables personalization and mood and the within-variable PAS (PAS 1 to PAS 2) or NAS (NAS 1 to NAS 2), respectively, were conducted. For PAS, results revealed no main effect of mood, or of personalization, or of changes from PAS 1 to PAS 2, no interaction of PAS and personalization, and no three-way interaction between PAS, mood and personalization, all *Fs* < 2.58, all *ps* > 0.11, but a marginal interaction between personalization and mood, $F(1,121) = 3.24$, $p = 0.074$, $\eta^2_p = 0.026$, and a significant interaction between PAS and mood, $F(1, 121) = 6.31$, $p = 0.013$, $\eta^2_p = 0.050$. For the interaction between PAS and mood, pairwise comparisons showed that there was no change from PAS 1 to PAS 2 for participants who received the happy mood induction procedure, $p = 0.134$, $\eta^2_p = 0.018$, while participants who received the sad mood induction procedure had higher score on PAS 2 than on PAS 1, $p = 0.044$, $\eta^2_p = 0.033$, indicating that their positive activation increased.

For the NAS, the mixed ANOVA revealed no main effects of mood, or of personalization, no interaction between mood and personalization, no interaction of NAS and mood, and no three-way interaction, all *Fs* < 2.30, all *ps* > 0.13. There was a main effect for changes in the score from NAS 1 to NAS 2, $F(1,121) = 9.93$, $p = 0.002$, $\eta^2_p = 0.076$, with a significant decrease in negative activation from the first to the second measurement. This main effect was qualified by a marginal interaction between NAS and personalization, $F(1,121) = 3.06$, $p = 0.083$, $\eta^2_p = 0.025$. Pairwise comparisons revealed that there was only a significant decrease from the first to the second measurement for participants receiving the nonpersonalized message, $p = 0.001$, $\eta^2_p = 0.090$, while there was no significant decrease for participants with the personalized message, $p = 0.321$, $\eta^2_p = 0.008$. Overall, these results for the PAS and the NAS are not in line with the assumptions of Hypothesis 2.

3.3 | State anxiety

It was explored whether for participants with the happy mood induction there would be a higher increase in state anxiety when they received the personalized compared to the nonpersonalized message (Hypothesis 3a). In contrast, these differences in the increase of state anxiety between participants with the personalized and nonpersonalized messages should not be observable for participants receiving the sad mood induction (Hypothesis 3b). A mixed-design ANOVA with the between-subject variables personalization and mood and the within-variable STAI (first to second measurement) was conducted. The results revealed no main effects of mood or of personalization, no interaction of state anxiety and personalization, and no three-way interaction, all *Fs* < 1, all *ps* > 0.38. A marginal interaction between mood and personalization was observable, $F(1,121) = 3.10$, $p = 0.081$, $\eta^2_p = 0.025$, which could however not reasonably be traced back by pairwise comparisons, all *ps* > 0.11. There was a main effect of changes in state anxiety, with an increase in state anxiety from the first to the second measurement, $F(1,121) = 10.13$, $p = 0.002$, $\eta^2_p = 0.077$. This main effect was qualified by a significant interaction of state anxiety and mood, $F(1,121) = 4.45$, $p = 0.037$, $\eta^2_p = 0.035$. Pairwise comparisons showed that the increase in state anxiety was only evident in conditions where participants received the sad mood induction procedure, $p < 0.001$, $\eta^2_p = 0.100$, but not in conditions where participants received the happy mood induction procedure, $p = 0.440$, $\eta^2_p = 0.005$. These results are only partly in line with Hypothesis 3: The equal increase in state anxiety for those participants with personalized and nonpersonalized messages that received the sad mood induction is in line with the Hypothesis 3b. However, the generally missing increase for participants receiving the happy mood induction is not in line with the Hypothesis 3a, as an increase was expected for participants receiving the personalized message.

3.4 | Cognitive load

In Hypothesis 4, it was asked whether participants in a sad mood might perceive the personalized message as more difficult and process it with less effort than a nonpersonalized message (Hypothesis 4a), while the opposite may be the case for participants in a happy mood (Hypothesis 4b). Concerning subjective ratings of difficulty, a 2×2 ANOVA showed no main effects of personalization or of mood and no interaction between mood and personalization, all *Fs* < 1, all *ps* > 0.33. For effort, a 2 x 2 ANOVA showed no main effect of personalization and no interaction of personalization and mood, both *Fs* < 1.55, both *ps* > 0.21, but a main effect of mood, $F(1, 121) = 4.98$, $p = 0.028$, $\eta^2_p = 0.039$, with participants receiving the sad mood induction procedure stating to have invested a higher amount of mental effort than learners in a happy mood induction procedure. However, effort did not correlate with retention, $r = 0.07$, $p = 0.45$, or transfer, $r = 0.03$, $p = 0.76$, while difficulty was negatively associated with retention, $r = -0.40$, $p < 0.001$, and with transfer, $r = -0.29$, $p = 0.001$. All in all, the results for perceived difficulty and effort are not in line with the assumptions of Hypothesis 4.

3.5 | Learning outcomes

An interaction of mood and personalization was hypothesized for the major dependent variable, namely learning outcomes (Hypothesis 1). An inverted personalization effect was assumed to be observable for participants that received the sad mood induction procedure (Hypothesis 1a). However, for participants that received the happy mood induction procedure, the beneficial effect of personalization might be re-established (Hypothesis 1b). Concerning retention, a 2×2 ANOVA revealed neither a main effect of personalization, nor a main effect of mood, both *Fs* < 1.59, both *ps* > 0.20, but a significant interaction, $F(1, 121) = 8.97$, $p = 0.003$, $\eta^2_p = 0.069$. This interaction was traced back by means of pairwise comparisons: Participants that received the sad mood induction procedure performed better when they learned with the nonpersonalized compared to the personalized version, $p = 0.048$, $\eta^2_p = 0.032$, while participants that received the happy mood induction procedure performed better when they learned with the personalized compared to the nonpersonalized version, $p = 0.027$, $\eta^2_p = 0.040$.

Similarly, for transfer, a 2 x 2 ANOVA showed no main effects of personalization or of mood, both *F*s < 1.43, both *p*s > 0.23, but a significant interaction, $F(1, 121) = 4.29$, $p = 0.040$, $\eta^2_p = 0.034$. Pairwise comparisons showed that participants that received the sad mood induction procedure performed better when they learned with the nonpersonalized compared to the personalized version, $p = 0.025$, $\eta^2_p = 0.041$, while participants in the happy mood induction procedure performed equally in the personalized compared to the nonpersonalized version, $p = 0.529$, $\eta^2_p = 0.003$. These results are essentially in line with Hypothesis 1.

3.6 | Learning time

Hypothesis 5 explored whether participants in a sad mood would process a personalized message for a shorter time than a nonpersonalized message (Hypothesis 5a), while participants in a happy mood would process a personalized message for a longer time than a nonpersonalized message (Hypothesis 5b). A 2 × 2 ANOVA for learning time showed no main effects of personalization or of mood, both *F*s < 1, both *p*s > 0.64, but a significant interaction, $F(1, 121) = 4.96$, $p = 0.028$, $\eta^2_p = 0.039$. Pairwise comparisons showed that participants who received the sad mood induction procedure tended to learn a longer time with the nonpersonalized compared to the personalized version, $p = 0.065$, $\eta^2_p = 0.028$, while participants who received the happy mood induction procedure learned equally long in the personalized and the nonpersonalized version, $p = 0.205$, $\eta^2_p = 0.013$. Learning time marginally correlated with retention, $r = 0.16$, $p = 0.08$, but not with transfer, $r = 0.06$, $p = 0.52$. In line with Hypothesis 5a, participants in a sad mood tended to process a personalized message for a shorter time than a nonpersonalized message. Contrary to Hypothesis 5b, participants in a happy mood did not process a personalized message longer than a nonpersonalized message.

4 | EVALUATION STUDY: MEASURING A HAPPY OR SAD MOOD

One limitation was that the mood induction procedures had no significant impact on the manipulation check measure I-PANAS-SF. However, a missing effect for a manipulation check does not necessarily mean that mood was not induced, as the used mood induction procedure is usually quite successful (cf. Westermann et al., 1996). A possible alternative explanation is that the manipulation check measure was not sensitive enough for the scope of the current study. This evaluation study was conducted ex post in order to test the sensitivity of the measure for the induction procedure.

The same mood induction procedures as in the experiment as well as the I-PANAS-SF (and STAI) were applied. Moreover, two questions that directly asked for a happy and sad mood were additionally administered. If no significant differences between the mood induction procedures would be observable for the I-PANAS-SF, but for the questions that directly ask for a happy and sad mood, respectively, this would strengthen the case for the claim that a happy and sad mood were also induced in the main study, but were not detected by the I-PANAS-SF.

4.1 | Method

4.1.1 | Participants, design and measures

Fifty German university students took part in this study. They were randomly assigned to either the happy or sad mood induction procedure. The data of 10 participants were excluded (see below for more details). Of the remaining 40 participants (age: $M = 21.35$, $SD = 2.71$), 29 were female and 11 were male. The mood induction procedure (including cover story) was the same as in the main experiment. The internal consistency of the PAS ($\alpha = 0.79$), NAS ($\alpha = 0.80$) and STAI ($\alpha = 0.70$) were acceptable to good. Next to these measures, additionally one question asked about how happy participants felt at the moment and one further question asked about how sad participants felt at the moment. Participants had to indicate on two 9-point scales ($1 =$ not at all to $9 =$ very) how happy and how sad they felt. These two items were summed up to one score (after recoding the item about sadness; $\alpha = 0.88$), with a higher score reflecting more happiness or less sadness, respectively. Three evaluation questions asked participants, (1) whether they already took part in a study where this mood induction procedure was used (yes or no), (2) whether they seriously took part in this study so that their data can be reasonably be used (yes or no) – with the hint that the answer will not affect their course credit and (3) whether they have comments about this study. Participants who answered the first question with yes ($N = 9$) were excluded from data analyses. The data of one further participant who refused to write down an emotional event were also excluded from data analyses. No participant indicated that he/she did not seriously took part in this study.

4.1.2 | Procedure

Before taken part in this evaluation study, participants first took part in an unrelated study that lasted approximately 20 min. Thereafter, first, the I-PANAS-SF, then the two questions concerning happiness and sadness, and then the STAI were given. Subsequently, the evaluation questions were given. Finally, participants were debriefed. All materials and measures of this online study were computerized and presented via the web-based software Unipark (www.unipark.com).

TABLE 3 Means (and SD) as a function of mood induction

	Happy ($n = 21$)	Sad ($n = 19$)
PAS	16.86 (3.15)	15.47 (4.39)
NAS	7.57 (2.71)	9.00 (4.75)
Happy-Sad	13.10 (3.19)	10.26 (5.14)
STAI	11.71 (3.16)	13.58 (3.40)

4.2 | Results and discussion

Means and standard deviations are presented in Table 3.

T-test for independent samples revealed no significant differences between the happy and sad mood induction procedures for PAS, $t(38) = 1.15$; $p = 0.26$, $d = 0.37$, bias corrected accelerated 95% confidence interval (BCa 95%) CI [− 0.77, 3.59], nor for NAS, $t(38) = -1.18$; $p = 0.24$, $d = -0.37$, BCa 95% CI [− 4.22, 1.23]. Also, there were no significant differences for STAI, $t(38) = -1.80$; $p = 0.08$, $d = -0.57$, BCa 95% CI [− 3.98, 0.49]. However, there was a significant difference for the two questions about happiness and sadness, with participants in the happy mood condition scoring higher than participants in the sad mood condition, $t(29.52) = 2.12$; $p = 0.048$, $d = 0.67$, BCa 95% CI [0.20, 5.51].

To sum up, while asking about happiness and sadness was appropriate to detect differences between the two mood induction procedures, the usage of the I-PANAS-SF was not, indicating that the I-PANAS-SF may not be well suited to detect a happy or sad mood, respectively.

5 | SUMMARY & DISCUSSION

The present study investigated whether a previous observed inverted personalization effect for an aversive topic (Kühl & Zander, 2017) would be moderated by mood. The main goal was to test this assumption for learning outcomes. Based on the mood-as-a resource hypothesis as well as previous findings in the area of health messages (Agrawal et al., 2007; Raghunathan & Trope, 2002), we hypothesized that an inverted personalization effect would be observable when participants were in a sad mood, while a beneficial effect of a personalized message might be observable for participants in a happy mood. As a subordinate goal, we examined whether the pattern of results for learning outcomes would be mirrored by respective changes in affective states as well as by corresponding process data.

5.1 | Learning outcomes

Our primary research question concerned learning outcomes. In line with Hypothesis 1, we observed a moderating role of mood for an inverted personalization effect. For participants in the sad mood conditions, a personalized compared to a nonpersonalized message resulted in lower performance for the learning outcomes of retention and transfer, indicating the inverted personalization effect. These results of the sad mood conditions basically replicate the findings from a previous study (Kühl & Zander, 2017). For participants in the happy mood conditions, however, a personalized compared to a nonpersonalized message was beneficial, particularly for retention, while for transfer a personalized message was at least not harmful anymore. These results point to the importance to closer investigate the interplay of different affective factors that can occur during learning.

5.2 | Mood and state anxiety

It can be claimed that the mood induction procedure in the main experiment was successful, even though direct evidence is missing. First, the mood induction procedure of remembering a happy or sad life events is a common method that is typically successful (e.g., Bless et al., 1996; Krauth-Gruber & Ric, 2000; for a meta-analysis see Westermann et al., 1996). Second, the manipulation check measure I-PANAS-SF (Thompson, 2007), turned out to be unsuitable to differentiate between participants that received either the instruction to recall a happy or to recall a sad life event. The results of the evaluation study substantiate this claim. Third, the differentiated findings for the learning outcome measures were essentially in line with expectations about the impact of mood (and previous research; cf. Agrawal et al., 2007), and are thus quite unlikely to appear by chance. Taken together, this indirect evidence corroborates our claim that a positive and a negative mood have been actually induced in the mood induction conditions of the main experiment. Given the limitations of the I-PANAS-SF for measuring a happy and sad mood in the current study, we refrain from interpreting the observed results for the PAS and NAS scales.

State anxiety increased from before the learning phase started to after the learning phase ended only for participants that had received the sad mood induction procedure. This increase was not differently pronounced between participants receiving a personalized compared to a nonpersonalized message. The results for participants in the sad mood conditions also replicate the results of the previous published study with respect to state anxiety (Kühl & Zander, 2017) and are in line with Hypothesis 3b. For participants receiving the happy mood induction procedure, there was however no increase in state anxiety between the first and second measurement. This may be seen as a hint that the happy mood served as a buffer against the negative affective costs in processing aversive content (Raghunathan & Trope, 2002). Due to this buffer function, a personalized message was not disadvantageous anymore, but could rather unfold its potential for learning again, thereby enabling participants receiving a personalized message to deeper process the aversive content. However, contrary to Hypothesis 3a, there was no specific increase in state anxiety for participants in the happy mood condition that had received the personalized message. This indicates that the more thorough processing of the personalized message was not at the expense of an increased state anxiety.

5.3 | Processing aversive content: learning time and cognitive load

To gain further insights about how the aversive content was processed in the different conditions, we assessed the dependent variables learning time and cognitive load. Participants in the sad mood condition tended to learn a longer time with the nonpersonalized compared to the personalized message, in line with Hypothesis 5a. Contrary to Hypothesis 5b, however, participants in the happy mood condition took the same time when learning with a personalized compared to a nonpersonalized message, thereby especially mirroring results from the transfer test. However, learning time did not correlate with transfer and it was only marginally related with retention. Thus, learning times per se may not be able to explain the results. In this respect, learning time might be considered rather as a necessary, but not sufficient factor.

Concerning cognitive load, the difficulty questionnaire as well as the mental effort item did not mirror the results for learning outcomes and were thus not in line with the assumptions of Hypothesis 4. It may be that the used questionnaire of the current study was not optimal for measuring cognitive load. In this respect, it should be noted that there is no measurement which has received unanimous recognition yet. However, recently some promising measures evolved (Klepsch & Seufert, 2020) that may be used in future studies.

5.4 | Limitations and outlook

A clear limitation of this study is that the mood manipulation check by means of the I-PANAS-SF was not successful. It can be argued that it is fair to assume that the mood induction procedure worked, but was simply not detected by the I-PANAS-SF. Nevertheless, the usage of a valid manipulation check, such as in the evaluation study, would have been desirable and should definitively be applied for ongoing studies.

As explicated by Westermann et al. (1996), it is sometimes argued that measuring affective states makes participants aware that the influence of affective states is examined. This in turn can lead to demand effects that undermine the validity of the observed results. This possibility can be diminished by deceiving participants about the true purpose of the experiment. Therefore, we used a cover story that framed the mood induction procedure as an independent study (see Section 2.2). Thus, we do not think that our results are considerably influenced by our assessed measures. Nevertheless, this issue may be investigated more systematically in future studies.

5.5 | Conclusion

The present study showed that mood moderated learning with a personalized compared to a nonpersonalized message. The results replicated an inverted personalization effect for an emotionally aversive topic, but only for participants that were asked to remember a sad life event prior to learning. For participants who were asked to remember a happy life event, no inverted personalization was found, but the beneficial effect of personalization appeared, at least for the learning outcome measure of retention.

These results stress on the one hand the importance to consider the inherent emotional content of a topic, such as its aversive nature, since the emotional content of a topic can be a boundary condition for design principles in multimedia learning. This impact of the emotional content of a topic is rather neglected yet. Moreover, the results emphasize the complex interplay between affective factors, such as externally induced as well as inherently arising moods and emotions that can emerge during learning an emotionally loaded content (e.g., Um et al., 2012). By taking these factors into account, more precise guidelines can be derived when several design principles in multimedia learning may hold true, be invalid or even reverse. The present results support the CATLM (Moreno, 2006; Moreno & Mayer, 2007) and the ICALM (Plass & Kaplan, 2016), as these theories pave the way in considering affective factors and how they can impact cognitive processing and design principles in multimedia learning. Even though recently the impact of affective factors in multimedia learning has received increased attention (e.g., Chung & Cheon, 2020; Endres et al., 2020; Mayer & Estrella, 2014; Plass et al., 2014; Um et al., 2012; for meta-analyses see Brom et al., 2018; Wong & Adesope, 2020), understanding the complex interplay of these factors and their impact on learning with multimedia is still at an early stage and needs to be further examined in future studies.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ENDNOTES

[1] Agrawal et al. (2007) also induced positive and negative emotions that did not focus on the self, but on others (peacefulness and agitation). They could show that the abovementioned finding on self-referencing was only true for the self-related emotions of happiness and sadness.

[2] In the German language, the conversational style can be distinguished in second-person singular and second-person plural. For this study, the second-person singular form was chosen (e.g., "Du" or "Deine"), since it is better going with a conversational style for students and is less formal.

[3] The PANAS was originally named Positive and Negative Affect Schedule, but renamed in Positive and Negative Activation Schedule, since the reference to affect was considered to be misleading (Tellegen et al., 1999).

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1111/jcal.12571.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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