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The more severe the merrier: Severity of error consequences stimulates learning from error

Nina Keith[1]*, Dorothee Horvath[1] and Alexander Klamar[2]
[1]Technical University of Darmstadt, Germany
[2]Leuphana Universität Lüneburg, Germany

Errors at work can lead to learning but little is known about error attributes and person attributes that make learning more or less likely. This research tested the role of severity of error consequences (error attribute) and trait negative affectivity (person attribute) for learning from error. In two experimental vignette studies, participants responded to written error scenarios that typically happen to university students (Study 1, N = 216) or to employees at work (Study 2, N = 121). In support of the view that error consequences need to be severe enough to attract attention, severity of error consequences increased both affective learning (perceived utility of the error; Studies 1 and 2) and cognitive learning (correctly recalled error scenarios; Study 2). In both studies, trait negative affectivity was associated with decreased affective learning when error consequences were severe (interaction effect). The results suggest that some errors at work – at least errors with minor consequences – may not receive much attention and are easily forgotten. To fully exploit learning opportunities, organizations should give attention to all errors and take them seriously, irrespective of severity of immediate error consequences.

Practitioner points

- Whether errors in organizations receive attention seems to depend on severity of error consequences, rather than on errors per se and their informational value.
- This implies that valuable learning opportunities of errors may be missed.
- To fully exploit learning opportunities, managers should encourage open communication and learning from error and avoid unproductive blaming.
- This particularly applies to dispositionally anxious individuals who may feel threatened by errors more easily and who may, in turn, respond defensively.

Much of human learning is learning from error. Toddlers learn how to walk by falling; in education, students learn – or are at least expected to learn – from errors they make; and in working life, individuals, teams, and organizations can improve by learning from error (Edmondson, 1999; Sitkin, 1992). Even on a societal level, learning from error may be described as a substantial contributor to the development of culture (Frese & Keith, 2015).

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**Correspondence should be addressed to Nina Keith, Organizational and Business Psychology, Technical University of Darmstadt, Alexanderstr. 10, 64283 Darmstadt, Germany (e-mail: keith@psychologie.tu-darmstadt.de).*

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Given this pervasiveness of learning from error, one may expect an extensive literature on learning from error in various areas of applied psychology. In fact, research generally demonstrates that making errors may improve learning in educational (e.g. Kapur, 2014; Metcalfe, 2017) and in occupational training settings (e.g. Keith & Frese, 2008). Also, in organizational and managerial psychology, errors are increasingly acknowledged as being both a by-product and an elicitor of learning and innovation (e.g. Baumard & Starbuck, 2005; van Dyck, Frese, Baer, & Sonnentag, 2005; Sitkin, 1992).

Yet, apart from this general evidence indicating that errors can lead to learning, research is scarce on particular error attributes that make learning from error more or less likely. It seems intuitive that not every error automatically leads to learning but that learning from error occurs only under certain conditions (Frese & Keith, 2015; Madsen & Desai, 2010; Metcalfe, 2017; Tucker & Edmondson, 2003). Similarly, not all individuals may effectively learn from error, depending on certain person attributes (cf. Carter & Beier, 2010; Keith, Richter, & Naumann, 2010; Loh, Andrews, Hesketh, & Griffin, 2013). A better understanding of these conditions and attributes may contribute to a better exploitation of the potentially rich information inherent in errors.

The present research focuses on one error attribute and one person attribute and their role in learning from error. In particular, we propose that learning increases as the severity of error consequences increases (i.e. error attribute) and that trait negative affectivity (i.e. person attribute) may negatively contribute to learning from error. We tested our predictions in two experimental vignette studies in which participants responded to carefully developed error scenarios that systematically differed with regard to severity of error consequences (cf. Aguinis & Bradley, 2014). To assess learning from error, we used one affective and one cognitive learning measure. We also assessed participants' trait negative affectivity.

Our research contributes to the existing literature in the following ways. First, with few exceptions (Homsma, van Dyck, De Gilder, Koopman, & Elfring, 2009; Zakay, Ellis, & Shevalsky, 2004), error attributes and their relation to learning have not been explored in previous research. Our study adds to this relatively small body of research. Second, previous studies in this domain have mostly used non-experimental field data (Homsma *et al.*, 2009; Madsen & Desai, 2010). This field data are useful in describing errors in their natural context and their potential associations with learning. Yet, they remain inconclusive with regard to causality. Establishing causality is important, because errors observed in the field may have several possibly unknown and potentially confounded attributes that affect learning (Frese & Keith, 2015). For example, severity of error consequences may be confounded with other undetected error attributes (e.g. system complexity) that are the actual drivers of learning. An experimental manipulation of isolated factors helps to clarify whether an error attribute is the actual cause or merely a correlate of learning. We, therefore, view our experimental approach as a valuable complement to existing correlational research. Experimental research alone may raise issues regarding generalizability and applicability to employees in their organizational context. However, convergence of results of non-controlled field studies and of controlled but less natural experimental studies would raise confidence in the validity of findings and their implications. Third, by explicitly including a person attribute (i.e. trait negative affectivity), we extend previous research which, to our knowledge, has not simultaneously considered error attributes and person attributes in view of learning from errors at work. Research from so-called error management training, which is an exploratory training method that explicitly encourages making errors and learning from them during training, indicates that not all individuals equally benefit from making errors during

training. Rather, there may be aptitude–treatment interactions, that is, learning from errors during training may be contingent upon certain person attributes (e.g. Carter & Beier, 2010; Loh et al., 2013). In a way, we adopt this basic idea from formal training research to the informal setting of learning from errors at work. From studying effects of error attributes, person attributes, and their potential interactions on learning from error, we expect valuable insights for how learning from error can be maximized in organizational practice. In the following section, we define and distinguish pertinent concepts and we develop our hypotheses in more detail.

Theory and hypotheses

Errors and learning from error

Errors occur in goal-directed actions and involve deviations from plans or goals that were unintended and potentially avoidable (e.g. Frese & Keith, 2015; Reason, 1990; Zhao & Olivera, 2006). The subjective experience of errors is associated with the feeling that one 'should have known better' (Hofmann & Frese, 2011, p. 8). *Violations*, in contrast, involve intended deviations from standards or norms (e.g. a deliberate violation of safety protocol in order to save time; Hofmann & Frese, 2011; Zhao & Olivera, 2006). Errors also need to be distinguished from their consequences, because not all errors necessarily lead to adverse outcomes, depending on the particular circumstances under which they occur (Frese & Keith, 2015; Hofmann & Frese, 2011). For example, administering the wrong drug to a patient may or may not lead to adverse effects, depending on the patient's health condition and on the particular drug that was administered erroneously (Homsma *et al.*, 2009). Also, some errors (e.g. a typo, a miscalculation, or an incomplete procedure) may be detected and corrected immediately, before any negative error consequences can unfold (Frese & Keith, 2015).

Within the tradition of action regulation theory (e.g. Frese & Zapf, 1994; Hacker, 1973, 2003; Zacher & Frese, 2018), errors are thought to have a pivotal role for learning. Action regulation theory considers humans as active agents. By acting and interacting with the (work) environment, humans develop and refine their mental models of the system or task at hand (Frese & Zapf, 1994; Hacker, 1973, 2003; Heimbeck, Frese, Sonnentag, & Keith, 2003). In this context, erroneous actions serve important informatory functions; they constitute negative but informative feedback that predicts learning and personal development, even more so than positive feedback (Frese & Keith, 2015; Zacher & Frese, 2018). Errors pinpoint where one's mental models are incorrect (Heimbeck *et al.*, 2003; Keith & Frese, 2005, 2008.) Other scholars, too, have described errors as a valuable source of information 'about ways in which the system is not working' (Tucker & Edmondson, 2003, p. 57) or as 'negative surprises' (Cannon & Edmondson, 2005, p. 300) that 'prompt learners to stop and think about the causes of the error' (Ivancic & Hesketh, 1995/1996, p. 1968). Errors encourage conscious and deeper level processing which in turn increases learning and retention (Craik & Lockhart, 1972). From a motivational perspective, too, errors may lead to learning, because errors interrupt the flow of action and signify that something is wrong and needs to be changed (Heimbeck *et al.*, 2003; Keith & Frese, 2011).

In line with this theorizing, research has shown that training methods that explicitly encourage making errors during training can be more effective than error-avoidant training methods (for an overview, see Keith & Frese, 2008), particularly for higher-ability trainees (e.g. Carter & Beier, 2010; Loh et al., 2013) and individuals higher in openness to

experience (Gully, Payne, Koles, & Whiteman, 2002). Also, organizations that explicitly adopted a culture of error management (involving, among other aspects, open communication and discussions of errors) were more successful (van Dyck *et al.*, 2005). In sum, on a general level, theory and research indicates that errors can lead to learning and that individuals may differ in the extent to which they benefit from error encouragement. As we will argue next, learning from error may be enhanced (or hindered) both by certain error attributes and by person attributes. Of these attributes, we consider severity of error consequences and trait negative affectivity.

Our focus on these two attributes is not meant to imply that other error attributes or other person attributes are unimportant for learning from error. In the present research, we chose to focus on severity of error consequences and trait negative affectivity for the following reasons (in the discussion section, we will discuss further potentially relevant person and error attributes). (1) We chose to focus on negative affectivity, because scholars agree that errors are aversive, negative events (e.g. Hajcak & Foti, 2008; Khanna, Guler, & Nerkar, 2016; Metcalfe, 2017; Nelson, Malkoc, & Shiv, 2018) and that immediate negative affective responses to errors are typical (e.g. Edmondson, 1999; Ivancic & Hesketh 1995/1996; Keith & Frese, 2005, 2008; Zhao, 2011). Also, research indicates that negative affect during learning interferes with learning because it diverts attention away from the task (Kanfer & Ackerman, 1989; Kluger & DeNisi, 1996) and that, conversely, successfully controlling negative affect is related to learning in a training situation in which errors are likely (Bell & Kozlowski, 2008; Keith & Frese, 2005). We were, therefore, particularly interested in the role of negative affectivity as a trait for learning from error. (2) We chose to focus on severity of error consequences for two reasons. First, the distinction between errors per se and their potential consequences is fundamental to error management theory (Frese & Keith, 2015; Hofmann & Frese, 2011). Should the severity of error consequences indeed affect learning, this would clearly underline the importance of this theoretical distinction and this would also have practical implications in terms of maximizing learning from error in organizations. Second, although severity of error consequences is, to the best of our knowledge, the only error attribute that has been explicitly considered in previous research (e.g. Homsma *et al.*, 2009; Zakay *et al.*, 2004), more systematic research is needed. We seek to provide more systematic research by experimentally testing the effects of severity of error consequences on learning from error. We will now develop our hypotheses in more detail.

Severity of error consequences and learning from error

We posit that it is not the error per se but the severity of consequences associated with the error what affects learning from error. As described above, errors interrupt the flow of action and act as surprises that prompt individuals to stop and think, which may ultimately lead to learning. Yet, this chain of events presupposes that errors attract attention at all. If error consequences are severe and visible, they will obviously attract attention. Errors with minor consequences, in contrast, can be easily overlooked or discarded as 'minor mistakes or isolated anomalies' (Cannon & Edmondson, 2005, p. 301). This phenomenon of devoting more attention to clearly negative information, which has also been termed *negativity bias* (Vaish, Grossmann, & Woodward, 2008; Zakay *et al.*, 2004), can not only be found in individuals and organizations but on a societal level as well: Typically, public discussions and large investigations are initiated after visible and serious disasters such as the Chernobyl meltdown, the tragedy of the Challenger space shuttle, or, more recently, the Boeing 737 Max 8 crashes. In contrast, incidents that may be quite similar in structure

but that did not lead to serious consequences typically do not receive much public attention (Homsma *et al.*, 2009; Madsen & Desai, 2010; Tucker & Edmondson, 2003). While this negativity bias may be understandable and evolutionarily adaptive (Vaish *et al.*, 2008), it comes at the expense of missing out on valuable learning opportunities, because whether an incident leads or does not lead to serious consequences may be due to chance factors (cf. Zakay *et al.*, 2004) rather than actual learning implications of an error. At the time a serious failure occurs, learning opportunities from errors with minor consequences have already been missed (Cannon & Edmondson, 2005).

Empirical evidence supports the view that not the error per se but the associated error consequences attract attention, which in turn increases learning. For example, Homsma *et al.* (2009) surveyed operators of a chemical process company. Severity of error consequences predicted learning behaviours as reported by operators six weeks later (e.g. generation of new ideas and insights, implementation of improvements to prevent similar errors in the future). Madsen and Desai (2010) used archival data on orbital launches and found failures (i.e. highly negative error consequences) to lead to more learning than successes in terms of a reduced likelihood of future failures.

Note, however, that the literature is equivocal on the role of severity of error consequences for learning from error. In particular, Sitkin (1992) and other researchers (e.g. Hayward, 2002; Khanna *et al.*, 2016) have advanced the so-called hypothesis of small losses. This hypothesis suggests that learning is maximized after errors or failures of modest magnitude (i.e. small losses) but impeded after severe errors. According to this hypothesis, error consequences need to be severe enough to attract attention and to create openness for change. At the same time, error consequences should not be too severe and too threatening as to evoke maladaptive responses such as rigidity, defensiveness, and denial, which in turn impedes learning (Sitkin, 1992). Empirically, the hypothesis of small losses has received some supportive (Hayward, 2002; Khanna *et al.*, 2016) and some less supportive results (Homsma *et al.*, 2009; Madsen & Desai, 2010; Zakay *et al.*, 2004). We do not claim to ultimately resolve this issue with the present research. Yet, we tend to favour the former position, because the research supporting the latter position (i.e. the hypothesis of small losses) focuses on learning from failure on the level of organizations in specific settings and, therefore, uses a somewhat different argumentation and level of analysis than our research (e.g. Khanna *et al.*, 2016, argue that large failures are less valuable for organizational learning than small failures, because the existence of the firm and its decision makers is threatened by large failures). We predict:

Hypothesis 1. Severity of error consequences increases learning from error.

Trait negative affectivity and learning from error

We posit that learning from error will be impeded in individuals high in trait negative affectivity, at least if error consequences are severe. Trait *negative affectivity* describes the dispositional tendency to experience negative affect such as anxiety, worry, and embarrassment (Barrick & Mount, 1991; Watson, Clark, & Tellegen, 1988). Errors are, to begin with, aversive events (Hajcak & Foti, 2008; Metcalfe, 2017) that typically evoke such negative affective reactions (Carmeli & Gittell, 2009; Edmondson, 1999; Ivancic & Hesketh 1995/1996; Keith & Frese, 2005, 2008; Khanna *et al.*, 2016; Zhao, 2011). We suggest that people who are already susceptible to experience negative affect (i.e. who are high in trait negative affectivity) will feel particularly threatened by errors they make. This

increased threat then leads to maladaptive responses, including rigidity and defensiveness which, in turn, impedes learning (Holmer, 2014; Staw, Sandelands, & Dutton, 1981; Vaes & Wicklund, 2002). This mechanism may apply to errors in general (which would imply a negative relationship between trait negative affectivity and learning from error) or may be confined to errors that develop severe consequences (which would imply an interaction between severity of error consequences and trait negative affectivity on learning from error). The former perspective is consistent with a trait-based view. The latter perspective is consistent with an interactionist view, proposing that severe error consequences – but not mild or moderate error consequences – act as situational triggers that activate individuals' disposition to experience negative affect (cf. Tett & Burnett, 2003; Tett & Guterman, 2000) which, in turn, impedes learning. While we concede that a definite prediction (i.e. either a main effect of trait negative affectivity or an interaction) is difficult, we tend to favour the latter, interactionist view. We predict:

Hypothesis 2. Trait negative affectivity and severity of error consequences interact such that trait negative affectivity negatively relates to learning from error when error consequences are severe.

Overview of studies

We conducted two experiments that used vignette methodology. In vignette experiments, participants respond to carefully constructed fictitious but realistic scenarios, for example, written scenarios that describe particular work situations. These scenarios, or specific parts thereof, are systematically varied according to the research question and experimental factors. A major advantage of experimental vignette methodology is that relatively rare and irregular phenomena which are difficult to observe in the field – for example, errors with severe consequences, as in the present research – can be studied with a high level of experimental control. As such, experimental vignette methodology offers an elegant way to increase internal validity while at the same time being more naturalistic than classical laboratory research (Aguinis & Bradley, 2014). Our two studies differed with regard to the participant samples, experimental material, and dependent variables included. Study 1 used a sample of university students and presented the focal independent variable (i.e. severity of error consequences) in three levels (i.e. mild, moderate, severe). Study 2 used a more basic research design (i.e. only two levels of severity of error consequences) but used an employee sample and a second more objective dependent variable to assess learning than Study 1, as well as a measure of cognitive ability. Both studies assessed trait negative affectivity of participants. The aim of combining these two studies was to test the stability of the proposed effects across samples, error scenarios, and dependent variables.

STUDY 1

Method

Sample

Participants of Study 1 were 216 university students of various subject areas at two mid-sized German universities. Mean age was 23.57 (SD = 3.54) and 73% were female. Some participants (15.7%) reported having work experience of 5.06 years on average

(*SD* = 3.32). Participants were recruited on campus and in classes. Participation was voluntary, with psychology students (75%) receiving course credit for participation.

Experimental design and procedure

This experiment used a one-factorial within-subjects design, in which the experimental factor (i.e. severity of error consequences) had three levels (mild, moderate, or severe error consequences). Participants read three different error scenarios that included either mild, moderate, or severe consequences. We systematically varied the order of presentation and the combinations of error situations and consequences to control for potential material effects. For later statistical analyses, we used material version as control variable.

Study 1 was a paper-and-pencil experiment. Participants were first welcomed and briefly introduced to the study's purpose and procedure. They were then presented with the first experimentally manipulated error scenario. Participants were asked to read the error scenario carefully and to imagine themselves in the described situation. Subsequently, participants responded to items that constituted the manipulation check and the dependent variable. These items involved participants' hypothetical reaction in the described situations. This procedure (i.e. presentation of error scenarios and items) was repeated for each successive error scenario. Participants then completed questionnaires on person characteristics and demographics. Finally, participants were thanked and debriefed.

Experimental material

We developed experimental vignettes (i.e. error scenarios) that described errors that can typically happen to university students. All scenarios were developed and pilot tested with the two goals to arrive at (1) as realistic a scenario as possible and (2) as clear a distinction as possible between degrees of the experimental factor *severity of error consequences* (i.e. mild, moderate, or severe). The manipulation of this independent variable was implemented by systematically varying the endings of error scenarios. More specifically, the baseline vignette that described the error and the situation in which the error occurred was identical across experimental conditions, but the consequences that developed from the same error varied. For example, in one of the scenarios, a student needs to apply for an internship as a curriculum requirement. Shortly before the deadline, the student notices that a document that should have been obtained from a governmental agency is missing. In the condition representing *mild* error consequences, the student can complete the application without the missing document and is given the opportunity to submit the missing document later. In the condition representing *moderate* error consequences, the student cannot complete the application to the desired organization but is given the opportunity for an internship at an alternative, less attractive organization for which the missing document is not a requirement. In the condition representing *severe* error consequences, the student cannot complete the application and, as a consequence, cannot complete the mandatory internship in time, which ultimately postpones graduation.

Measures

Dependent variable

Observing and measuring learning from error is not a trivial issue. One obvious way would be to assess behavioural change after an error, for example in terms of secondary error

prevention (i.e. avoidance of the same error in the future; van Dyck *et al.*, 2005). However, apart from practical difficulties of such a measurement, learning from error may take several, broader forms and is not confined to learning how to avoid *specific* errors (Frese & Keith, 2015). Also, as some scholars have pointed out, learning may also occur without observable changes in behavioural outcomes (e.g. Argote & Miron-Spektor, 2011; Edmondson, 1999). Finally, organizational training research widely acknowledges that 'learning is multidimensional' (Bell, Tannenbaum, Ford, Noe, & Kraiger, 2017, p. 315; Kraiger, Ford, & Salas, 1993) and may include cognitive, affective, and behavioural outcomes (Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997; Kirkpatrick, 1976; Kraiger *et al.*, 1993). In the present research, in keeping with this multidimensionality perspective, we use one affective (Studies 1 and 2) and one cognitive measure of learning (Study 2 only). (We concede that additionally including a behavioural outcome measure would be desirable; in the discussion section, we will discuss in more detail issues concerning the measurement of learning from error.)

In organizational training research, various outcomes are subsumed under the heading of affective learning, including affective-emotional, attitudinal, and motivational reactions to training (Bell *et al.*, 2017; Kraiger *et al.*, 1993). A common distinction within trainee reaction measures is between affective reactions in the narrower sense (i.e. liking of the training) and judgements of training utility, with the latter being more predictive of training transfer than the former (Alliger *et al.*, 1997). Also, conceptually, perceived utility of a task or training is assumed to be important because it affects to what extent learners are willing to invest effort into learning (Kanfer & Ackerman, 1989). We, therefore, assessed *affective learning* as perceived utility of the error in the present research.

We used three items of the subscale 'Learning from errors' of the Error Orientation Questionnaire (EOQ; Rybowiak, Garst, Frese & Batinic, 1999; German version as used by Keith & Frese, 2005). The EOQ measures attitudes towards and responses to errors at work, with subscale 'Learning from errors' focusing on long-term learning and optimization of work plans. For the vignettes used in the present study, we slightly modified item wordings. For example, the original item 'My mistakes help me to improve my work' was changed to 'This mistake helps me to improve my work'. Another item was 'I learn a lot from this error'. Participants responded on a 5-point Likert scale, as in the original EOQ measure. The items have also been used in training studies (e.g. Keith & Frese, 2005) and adapted for the measurement of error management culture in organizations (van Dyck *et al.*, 2005). In the present study, median Cronbach's alpha was .76 across experimental conditions. Construct validity statistics from factor analyses (Table 1) were satisfactory (Kaiser, 1970, 1974).

Manipulation checks

After reading the vignettes and before the dependent variable was assessed, participants responded to manipulation checks that probed whether participants perceived the severity of the error consequences in the intended way. We asked participants two questions (e.g. 'How negative do you evaluate the described situation?'). In keeping with the scaling of the dependent variable, we used a 5-point Likert scale for these questions. In addition, we asked participants to indicate on a 7-point Kunin face scale (original scaling) how they would feel in the described situation (Kunin, 1955). As expected, we found large effects both for the two questions: $F(2, 206) = 265.43$, $p < .001$, $\eta_p^2 = .72$, and for the Kunin item: $F(2, 200) = 272.61$, $p < .001$, $\eta_p^2 = .73$, indicating that our manipulations had worked well.

Table 1. Construct validity statistics from principal component analyses (one-factor solution) of items assessing the dependent variable affective learning from error

Study no. and experimental condition (severity of error consequences)	KMO	TVE	Bartlett test		Factor loadings		
			$\chi^2(df)$	*p* value	Item 1	Item 2	Item 3
Study 1							
Mild	.66	63.87%	126.49 (3)	<.001	.79	.76	.84
Moderate	.66	68.34%	177.90 (3)	<.001	.81	.79	.88
Severe	.67	69.99%	202.88 (3)	<.001	.87	.76	.88
Study 2							
Mild	.77	88.13%	293.52 (3)	<.001	.93	.94	.94
Severe	.75	85.72%	258.82 (3)	<.001	.92	.91	.94

Note. $N = 215$ in Study 1, $N = 121$ in Study 2.
KMO = Kaiser–Meyer–Olkin criterion; TVE = total variance explained.

Moderator variable

We assessed trait *negative affectivity* with five items (e.g. scared, afraid) of the dispositional version of the negative-affect subscale of the Positive and Negative Affect Schedule (PANAS; Watson *et al.*, 1988; German version by Krohne, Egloff, Kohlmann, & Tausch, 1996). Participants responded on a 7-point Likert scale (the original measure uses a 5-point Likert scale; additional analyses with a measure that we transformed to a 5-point scale yielded highly similar results). Cronbach's alpha was .80.

Statistical analyses

The hypothesized effects were tested in a repeated-measures ANCOVA in which the material version (i.e. vignette-factor combination) was included as a between-subjects control factor (Judd, Kenny, & McClelland, 2001). Trait negative affectivity was centred and included as a between-subjects covariate (Cohen, Cohen, West, & Aiken, 2003).

Results and discussion

Means, standard deviations, and correlations of study variables are depicted in Table 2.

Hypothesis 1 predicted a main effect of severity of error consequences on learning from error in that learning is higher for errors with severe consequences. In support of this prediction, severity of error consequences had an effect on affective learning from error in terms of perceived utility of the error, $F(2, 204) = 7.26$, $p < .01$, $\eta_p^2 = .07$ (see Figure 1, panel a). Hypothesis 2 predicted trait negative affectivity and severity of error consequences to interact such that trait negative affectivity negatively relates to learning from error when error consequences are severe. In support of this prediction, negative affectivity interacted with severity of error consequences, $F(2, 204) = 6.40$, $p < .01$, $\eta_p^2 = .06$. As depicted in Figure 2 (panel a) and as indicated by simple-slopes analyses, negative affectivity was negatively related to affective learning from error when error consequences were severe ($\beta = -.19$, $p < .01$) but unrelated with learning when error consequences were moderate ($\beta = -.07$, $p = .29$) or mild ($\beta = .12$, $p = .09$).

We found no main effect of material version, $F(8, 205) = 1.22$, $p = .29$, $\eta_p^2 = .05$, but an interaction effect of material version with severity of error consequences $F(16,$

Table 2. Means, standard deviations, and intercorrelations of study variables in Study 1

Variable	*M*	*SD*	1	2	3	4	5	6	7
Person characteristics									
1. Age	23.57	3.54	–						
2. Gender	–	–	−.17*	–					
3. Negative affectivity	1.88	1.01	−.16*	.15*	(.80)				
Dependent variable affective learning from error (overall and by levels of severity of error consequences)									
4. Overall (aggregated across levels)	2.57	0.61	.01	.17*	−.08	–			
5. Mild error consequences	2.42	0.92	.01	.10	.10	.70**	(.71)		
6. Moderate error consequences	2.57	0.86	.05	.19**	−.09	.70**	.21**	(.76)	
7. Severe error consequences	2.71	0.85	−.03	.07	−.19**	.70**	.22**	.27**	(.78)

Note. $N = 216$ ($N = 215$ for person characteristics). Cronbach's alpha coefficients are shown in parentheses along the diagonal. Gender was coded 1 for male and 2 for female.
*$p < .05$; **$p < .01$.

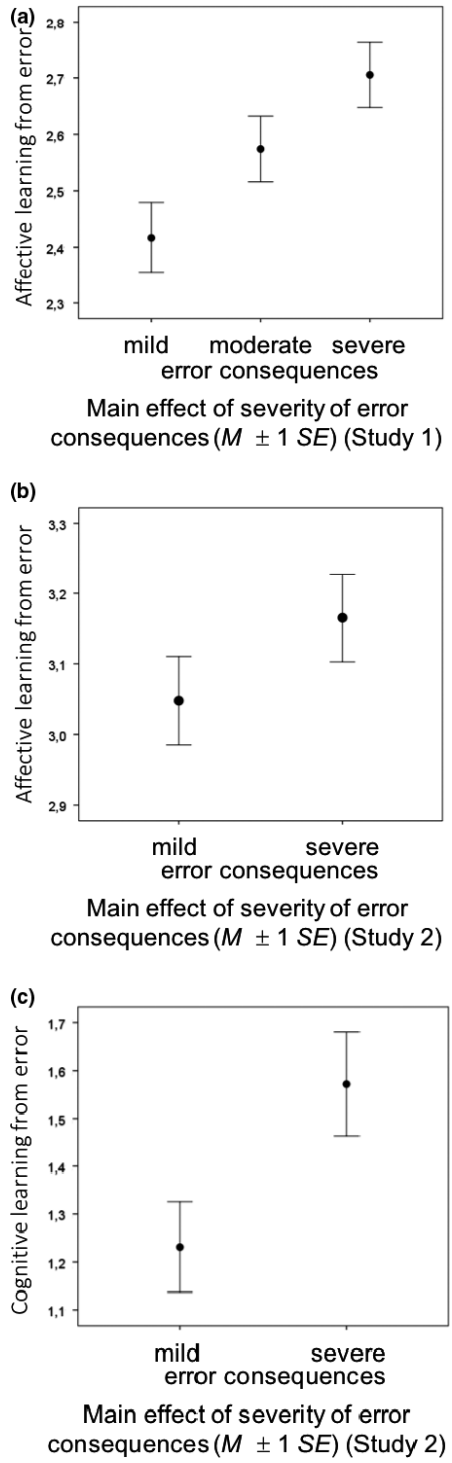

Figure 1. Main effect of severity of error consequences on affective learning from error in Studies 1 and 2 (panels a and b) and cognitive learning in Study 2 (panel c).

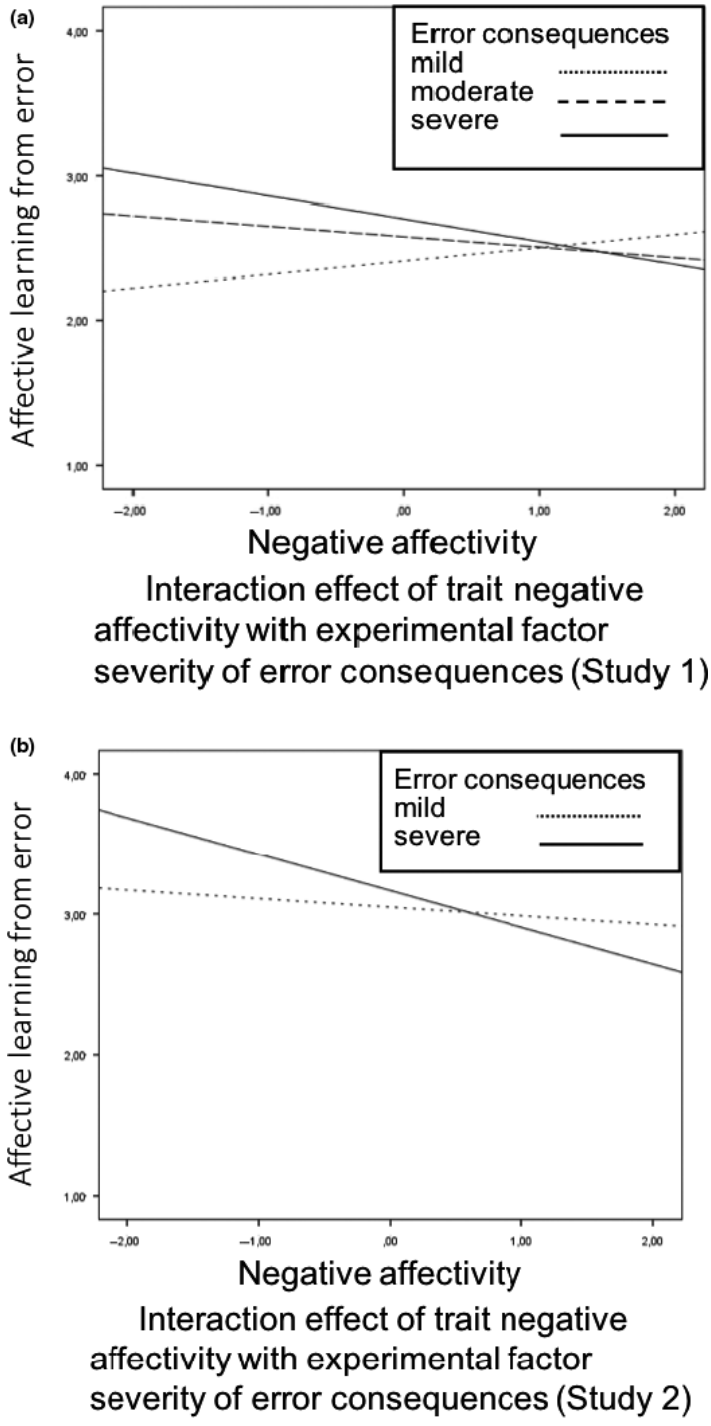

Figure 2. Interaction of severity of error consequences with trait negative affectivity on affective learning from error in Study 1 (panel a) and Study 2 (panel b).

408) = 2.58, $p < .01$, $\eta_p^2 = .09$, indicating that the hypothesized effect of the independent variable was present on average but differed in magnitude across material versions. Such interaction effects are common in experiments that include multiple naturalistic materials and they underscore the appropriateness of systematically varying and statistically controlling for experimental material.

In sum, the results of Study 1 are in line with our propositions concerning the role of severity of error consequences and trait negative affectivity for learning from error. With Study 2, we sought to replicate our findings in a sample of employees and with error scenarios that are more typical for work situations. We also included a cognitive learning measure in addition to the affective, self-report learning measure of Study 1.

STUDY 2

Method

Sample

Participants of Study 2 were 121 adults with previous or current work experience (M = 15.67 years of work experience, SD = 13.87).[1] The majority (81.8%) were currently employed (full-time or part-time) at various organizations, with some of them (19%) holding a leadership position; 7.4% were full-time students with work experience; the remaining participants were currently on parental leave, job seeking, or retired (10.8%). Mean age was 36.92 years (SD = 15.09) and 61.2% were female. Participants were recruited via social media and social networks as well as on campus of a mid-sized German university. Participation was compensated with 8 Euros (approx. 9.5 US$) or partial course credit.

Experimental design and procedure

Design and procedure of Study 2 were similar to those of Study 1, with the following differences. First, Study 2 was an online (not a paper–pencil) experiment. Second, to increase reliability and statistical power, Study 2 used only two levels of the experimental factor severity of error consequences (mild vs. severe), implemented by three vignettes per level (i.e. 6 vignettes overall; 3 with mild and 3 with severe error consequences). Third, in addition to participants' responses assessed immediately following the presentation of vignettes (identical procedure as in Study 1), Study 2 included participants' recall of error scenarios as a second, cognitive learning measure.[2] The recall test was administered after participants had worked on a filler task which lasted about 30 min. Thus, experimental sessions were substantially longer in Study 2 than in Study 1.

Experimental material

The scenarios in Study 2 described typical errors at work. They were developed based on actual errors as reported by managers in interviews that were unrelated to the present studies (these interviews were about errors and error management in organizations). For

[1] *Of the 122 participants originally recruited, 1 did not complete the experiment in one session but dispersed completion over several days. We excluded this participant's data from further analyses.*

[2] *Originally, we had planned to additionally include multiple-choice test items but the items were too easy (75–90% correct answers across conditions) and produced ceiling effects.*

example, one scenario described an employee having placed a wrong order of materials based on an outdated project plan. Another scenario described a planning mistake in a project calculation. As for Study 1, all scenarios, including the associated mild and severe error consequences, were selected and pilot tested for degree of realism.

Measures

Manipulation checks

We used the same manipulation checks as in Study 1. Again, we found large effects both for the two questions, $F(1, 120) = 291.33, p < .001, \eta_p^2 = .71$, and for the Kunin item, $F(1, 120) = 190.01, p < .001, \eta_p^2 = .61$, indicating that participants perceived the severity of error consequences in the intended way.

Dependent variables

In Study 2, we used two dependent variables as indicators of learning from error. The first variable was identical to the one used in Study 1 (i.e. three items of EOQ subscale Learning from error to assess affective learning as perceived utility of the error; median Cronbach's alpha was .88 in Study 2). Construct validity statistics from factor analyses were satisfactory (Table 1).

The second variable was a cognitive learning measure based on the recall task that participants worked on after the filler task. The recall task asked participants to recall as many of the previously presented error scenarios in as much detail as they could. As guiding questions, we asked for the error and the situational context in which it occurred as well as the error consequences. For both aspects (i.e. the error situation and the error consequences), two raters independently assigned the values 0 (incorrect), 1 (partially correct), or 2 (fully correct), resulting in a maximum score of 4 for this dependent variable. Inter-rater agreement was high, with a median ICC(3, 2) of .99 (range .96–.99) across the scenarios.

Moderator variable

We assessed trait negative affectivity with ten items of the dispositional version of the negative-affect subscale of the PANAS (Watson *et al.*, 1988; German version by Krohne *et al.*, 1996). Participants responded on a 5-point Likert scale (original scaling). Cronbach's alpha was .86.

Filler task (cognitive ability test)

As filler task (after presentation of error scenarios and before recall of error scenarios), we used a freely available German cognitive ability test (Satow, 2017) that measures numerical skills (22 items; Cronbach's alpha = .70) and spatial-visual skills (12 items; Cronbach's alpha =.38) (overall Cronbach's alpha = .67). Our primary goal was to use this test as a filler task, as it is common to use unrelated filler tasks in experiments that use recall tests. Our second goal was to use it as a potential control variable for the recall task because we suspected that performance on this cognitive measure may be influenced by participants' cognitive ability.[3]

[3] *We reran all analyses with cognitive ability included as a covariate but the pattern and magnitude of effects were unaltered.*

Results and discussion

Means, standard deviations, and correlations of study variables are depicted in Table 3.

Main effect of severity of error consequences

Hypothesis 1 predicted a main effect of severity of error consequences on learning from error in that learning is higher for errors with severe consequences. We first tested this hypothesis simultaneously for both the affective and cognitive dependent variables (i.e. perceived utility of the error and recall of error situations), using multivariate analyses. In support of Hypothesis 1, severity of error consequences had a main effect on learning from error in that more learning occurred from errors with severe than with mild consequences, $F(2, 117) = 7.96$, $p < .01$, $\eta_p^2 = .12$. As indicated by additional post hoc univariate analyses, this effect held for both dependent variables, $F(1, 118) = 5.59$, $p < .05$, $\eta_p^2 = .05$, and $F(1, 118) = 10.32$, $p < .01$, $\eta_p^2 = .08$ for affective and cognitive learning from error, respectively (see Figure 1, panels b and c).[4]

Moderating effect of negative affectivity

Hypothesis 2 predicted trait negative affectivity and severity of error consequences to interact such that trait negative affectivity negatively relates to learning from error when error consequences are severe. We first tested this hypothesis simultaneously for both dependent variables in multivariate analyses. In support of Hypothesis 2, trait negative affectivity and severity of error consequences interacted, $F(2, 117) = 3.49$, $p < .05$, $\eta_p^2 = .06$. As indicated by additional post hoc univariate analyses, however, this effect held only for affective learning (i.e. perceived utility), $F(1, 118) = 6.54$, $p < .05$, $\eta_p^2 = .05$. For the cognitive learning measure (i.e. correct recall of error situations), we did not find the expected interaction effect between severity of error consequences and trait negative affectivity, $F(1, 118) = 0.46$, $p = .50$, $\eta_p^2 = .00$. Thus, Study 2 replicated the interaction found in Study 1 for the same dependent variable but not for the different dependent variable. As depicted in Figure 2 (panel b) and as indicated by simple-slopes analyses, the pattern was the same as in Study 1: Negative affectivity was negatively related to affective learning when error consequences were severe ($\beta = -.23$, $p < .05$) but unrelated with learning when error consequences were mild ($\beta = -.05$, $p = .61$).

In sum, Study 2 replicated and extended the results of Study 1 with regard to the main effect of severity of error consequences on learning. Not only did participants report more learning after errors with severe consequences (affective learning measure); they also recalled error scenarios with severe consequences better than error scenarios with mild consequences (cognitive learning measure). With regard to the expected interaction effect with negative affectivity, results were mixed in that Study 2 found the same effect as Study 1 for the affective learning measure but not for the cognitive learning measure, although results of multivariate analyses were statistically significant.

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[4] *The other effects in the ANCOVAs (not pertinent to the hypothesis) were as follows. For the affective learning measure (perceived utility): no main effect of material version,* $F(1, 118) = 0.02$, $p = .89$, $\eta_p^2 = .00$, *no interaction effect of material version with severity of error consequences,* $F(1, 118) = 3.04$, $p = .08$, $\eta_p^2 = .03$. *For the cognitive learning measure (recall of error situations): no main effect of material version,* $F(1, 118) = 1.56$, $p = .21$, $\eta_p^2 = .01$, *interaction effect of material version with severity of error consequences,* $F(1, 118) = 9.65$, $p < .01$, $\eta_p^2 = .08$.

Table 3. Means, standard deviations, and intercorrelations of study variables in Study 2

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
Person characteristics												
1. Age	36.92	15.09	–									
2. Gender	–	–	−.12	–								
3. Negative affectivity	0.78	0.61	−.23*	−.03	(.86)							
4. Cognitive ability (filler task)	25.43	6.13	−.12	−.05	−.06	(.67)						
Dependent variable affective learning from error (overall and by levels of severity of error consequences)												
5. Overall (aggregated across levels)	3.11	0.63	.24**	.17	−.16	.04	(.93)					
6. Mild error consequences	3.05	0.69	.21*	.17	−.05	.05	.91**	(.92)				
7. Severe error consequences	3.17	0.69	.23*	.14	−.23*	.03	.91**	.66**	(.91)			
Dependent variable cognitive learning from error (overall and by levels of severity of error consequences)												
8. Overall (aggregated across levels)	1.40	0.94	−.14	.01	−.02	.37**	−.16	−.14	−.14	–		
9. Mild error consequences	1.23	1.04	−.14	.06	.00	.30**	−.13	−.11	−.13	.82**	–	
10. Severe error consequences	1.57	1.19	−.09	−.04	−.04	.33**	−.13	−.13	−.11	.86**	.42**	–

Note. $N = 121$. Cronbach's alpha coefficients are shown in parentheses along the diagonal. Gender was coded 1 for male and 2 for female.
*$p < .05$; **$p < .01$

GENERAL DISCUSSION

Errors at work can be a rich source of learning, but not all errors automatically lead to learning, nor do all individuals effectively learn from error. The present research explored effects of one error attribute (i.e. severity of error consequences) and of one person attribute (i.e. trait negative affectivity) on learning from error. We found that what is crucial for learning is not the error per se but its consequences or, more precisely, whether otherwise identical errors develop more or less severe consequences. This pattern emerged across two participant samples and across two measures of learning, namely, affective learning in terms of perceived utility of the error, and cognitive learning in terms of correct recall of error scenarios. We further found that trait negative affectivity was negatively related to learning when error consequences were severe. This pattern emerged in both studies for affective learning, but not for cognitive learning.

Theoretical contributions

Our finding that severity of error consequences affects learning is consistent with the attentional assumption that has been proposed – but rarely directly tested – in earlier work (e.g. Tucker & Edmondson, 2003). This assumption states that to attract attention and to create an urgency for action, errors must have visibly severe consequences; otherwise, errors can be easily ignored or discarded as irrelevant. The present findings offer considerable support for this attentional interpretation, because attention during the learning phase is known to be essential for encoding and later retrieval of information (Anderson, Craik, & Naveh-Benjamin, 1998; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996) and because we found the effect for two different operationalizations of learning from error. The present findings do not support the competing hypothesis of small losses, stating that while error consequences should be severe enough to attract attention, they should not be as severe as to induce too much threat that may, in turn, trigger maladaptive responses (e.g. Sitkin, 1992).

The effect of severity on learning is also consistent with previous research indicating that severity of past incidents predicts learning behaviours in organizations (Homsma *et al.*, 2009) and that organizations learn more effectively from failure than from success (Madsen & Desai, 2010). In this respect, the present research experimentally replicates what has been found in previous correlational field research. We consider our experiments to be a significant complement to previous correlational research, because errors occurring in natural settings may have several confounded attributes (e.g. errors with severe consequences may occur in more complex systems), which leaves the question of causality unanswered (Shadish, Cook, & Campbell, 2002). Also, our research indicates that not all errors attract attention, which raises concerns about accuracy of self-reports of errors at work. It stands to reason that those errors that are reported in organizations represent a selective sample of errors that for some reason raised attention, for example, because the error consequences were highly visible. Due to the high degree of standardization in our studies, these potential concerns should be alleviated.

Our results concerning the interaction of trait negative affectivity with severity of error consequences on learning from error underscores the importance of simultaneously considering error attributes and person attributes when investigating response to error. This has been done in some previous research on error management training (e.g. Carter & Beier, 2010; Keith *et al.*, 2010; Loh et al., 2013) but, to our knowledge, not in the context of naturalistic errors that occur as part of one's work. It seems intuitive that not all

individuals respond to errors and their consequences in the same way (Rybowiak *et al.*, 1999). Our findings suggest that trait negative affectivity influences the extent to which people react adaptively in the face of errors, at least when error consequences are severe. Yet, trait negative affectivity was unrelated with our cognitive learning measure (i.e. correct recall of error situations), irrespective of severity of error consequences (neither main effect nor interaction effect). This may be due to the recall measure being more 'cognitively loaded' (Sackett, Shewach, & Keiser, 2017, p. 1435) than our affective learning measure, as witnessed by its considerable correlation with cognitive ability ($r = .37$, $p < .01$, across experimental conditions; Table 3). In this context, it is noteworthy that the recall measure was affected by our experimental manipulation *despite* it being considerably related to dispositional cognitive ability and despite the experimental manipulation being relatively minimal.

Practical implications

Our results suggest that otherwise identical errors receive unequal attention, depending on how severely the consequences develop. For management and organizations, this implies that the learning potential of many errors remains unexploited – which is unfortunate, given the valuable lessons that can be drawn from errors and failure (e.g. Ellis, Carette, Anseel, & Lievens, 2014; Frese & Keith, 2015; Joung, Hesketh, & Neal, 2006). Furthermore, severe error consequences and failure often develop from combinations of errors, violations, and unfavourable situational circumstances (Hofmann & Frese, 2011; Reason, 1990), implying that whether or not adverse consequences develop may be simply due to chance (Zakay *et al.*, 2004). To fully exploit learning opportunities, organizations are well advised to take all errors seriously, irrespective of severity of error consequences. Otherwise, similar errors could occur in the future under less favourable circumstances that ultimately lead to adverse outcomes (Tucker & Edmondson, 2003). For managers, this may imply that a culture should be established which encourages open communication about errors, irrespective of severity of immediate consequences (cf. van Dyck *et al.*, 2005). This may entail that managers openly admit to their own mistakes and that they respond to their subordinates' mistakes in a constructive and supportive manner as well as avoid unproductive blaming. This is not to imply a laissez-faire leadership style or a non-chalant attitude towards errors; errors, along with their potential causes and their elimination for the future, should still be taken seriously, but in a constructive way (cf. Frese & Keith, 2015). A constructive error management also includes that managers do not artificially raise the threat of errors to increase attention and learning, for example, by harsh punishment of minor mistakes made by employees. Increasing threat would probably only lead to more covering up of errors rather than openness and willingness to change (van Dyck *et al.*, 2005; Edmondson, 1996, 1999; Frese & Keith, 2015; Rybowiak *et al.*, 1999; Zhao & Olivera, 2006). Instead, routines of error communication may be established. For example, managers may encourage regular disclosure and discussions of errors in meetings in a non-threatening atmosphere. This may help to turn attention to errors that managers and employees would otherwise not have attended to if the consequences had not been severe and visible enough. A non-threatening atmosphere may be particularly important for individuals who are prone to feel threatened by errors, as our results concerning the interaction with trait negative affectivity indicate. Managers may keep in mind that some employees may more easily disclose and discuss their errors, while others may respond more defensively.

If employees are too reluctant to openly discuss errors, particularly in the presence of supervisors and managers, managers may at least encourage error discussions in smaller groups and outside the formal chain of command. For example, managers may explicitly encourage that employees discuss errors among colleagues of the same level of hierarchy or as part of one-to-one formal or informal mentoring relationships with mentors outside the chain of command.

Limitations and directions for future research

An obvious limitation of this research is that we did not include a behavioural measure of learning from error. For example, a behavioural measure of learning may be to observe whether participants commit the same errors that were described in the vignettes or whether they learned to avoid the same error (i.e. secondary error prevention). However, measuring learning from error in terms of behaviour is difficult for at least two reasons. First, because errors at work are unplanned, learning from errors at work is unplanned as well. Learning from error occurs informally (i.e. outside formal, planned training settings; Tannenbaum, Beard, McNall, & Salas, 2010). As a consequence, there are no formal learning goals that could be the basis for the development of specific behavioural learning criteria that could be assessed in a standardized and objective way. Second, learning from error may take several forms and goes beyond merely learning to avoid specific errors in the future (i.e. secondary error prevention); rather, it may entail learning a general approach of how to manage errors effectively or learning about new parts of a system or task that would not have been explored without the error (Frese & Keith, 2015). Such broader forms of learning are inherently more difficult to operationalize. Nevertheless, we encourage future research to develop more behaviourally based learning criteria or to identify and measure particular dimensions of job performance that may be influenced by learning from error.

Another limitation may reside in our decision to use experimental vignette methodology to test the effect of severity of error consequences on learning from error. The advantage of experimental vignette methodology is that it allowed us to systematically manipulate error consequences and, therefore, provides confidence that our effects are actually due to error consequences rather than due to some confounding factors, which may be present in naturally occurring error situations. We concede that this high degree of internal validity comes at the expense of immediacy of error situations in that we did not study errors that were actually made by participants, but merely errors which we asked participants to imagine having made. Related to this issue, it may be argued that we addressed vicarious learning rather than actual learning from errors, that is, the question may be raised whether individuals learn more from their own mistakes or those of others. This would be particularly problematic if participants would have responded differently to actual errors than to the vicariously presented errors, which would raise concerns of external validity of our findings. We cannot exclude this possibility, but we are confident that this is not the case for the following reasons. First, we developed the experimental material based on actual errors reported by interview partners and we thoroughly pretested the error scenarios. Second, we believe that the fact that we found effects of our experimental manipulation, particularly with regard to our recall measure, indicates that the described error situations had some psychological and experimental realism for participants (Wilson, Aronson, & Carlsmith, 2010). Third, our experimental findings converge with those that were obtained in research that used completely different study designs (i.e. a survey-based field study and a study using a large archival data set; Homsma

et al., 2009; Madsen & Desai, 2010). We do concede, of course, that cross-validation with real errors in natural settings would be desirable.

Another limitation that arises from our use of experimental vignette methodology involves the de-contextualization and potential simplification of errors that we used. For example, in our vignettes, the person responsible for the error is always clearly identified, whereas in the real-life context of organizations, responsibilities and causes of errors may be not as clear. There may also be political processes involved in identifying error causes in organizations, with individuals seeking to protect their reputations or blame others (cf. Zhao & Olivera, 2006). However, as described above, we have developed and pretested the error scenarios based on interviews with managers (Study 2) who reported actual errors that they were confronted with at work or, for the student sample, on typical student errors (Study 1), with the goal to arrive at realistic scenarios. Also, we are not claiming that our experimental vignette approach was the single best way to study learning from error at work. We believe that the use of multiple methods and triangulation is most appropriate here and we think that our vignette approach is useful in complementing more contextualized studies with other strengths and weaknesses.

We would also like to point out that, despite the high experimental control, we cannot rule out the possibility that error attributes other than the one we sought to manipulate were present and effective in our manipulation. Still other error attributes may affect learning but were not included in our research. For example, people may react differently to errors depending on whether the error's impact is primarily social or material. As another example, the visibility of errors may play a role (and this error attribute may be interlinked with severity of consequences, in that errors with more severe consequences tend to be more visible and less easy to cover up). Although our manipulation checks clearly indicate that participants perceived severity as intended, such other factors, which we did not focus on during the development of our vignettes, might also have played a role. We encourage future research to systematically scrutinize this possibility and to test for effects of additional error attributes that may be involved in learning from error.

The present research tested effects of severity of error consequences and focused on a more motivational pathway (i.e. severe error consequences raise attention and increase motivation to learn). Yet, errors may also differ with regard to informational richness inherent in errors. For example, errors that occur on complex tasks are probably more informative (in terms of improvement of mental models of the task) than are errors that occur on simpler tasks or on a lower level of action regulation (e.g. movement errors; for an overview of error taxonomies, see Hofmann & Frese, 2011). Another possibility is that types of errors differ with regard to the kind of lesson to be learned (e.g. learning of specific errors vs. development of a broader understanding of the task or system). Future research may also explore additional processes that may explain effects of severity of error consequences of learning other than mere attention. For example, errors with severe consequences may induce more counterfactual thinking (Roese, 1994), which may underlie increased cognitive processing of the error and of potential lessons to be drawn from this error.

Similarly, future research may explore additional person attributes. The present research was primarily concerned with trait negative affectivity as a person attribute (we also assessed cognitive abilities as a control variable in one of the two studies). However, a number of other person attributes are conceivable as potentially effective in the process of learning from error. For example, highly conscientious individuals may be more eager to learn from error and, therefore, may be less susceptible to severity of error consequences (i.e. may be willing to learn from any error, irrespective of the associated error

consequences). Similarly, individuals high in dispositional prevention focus (which describes a focus on averting losses, as opposed to promotion focus, which describes a focus on seeking gains; Higgins, 1997) may be highly motivated to avoid errors in the first place, but once an error has occurred, they may be highly motivated to learn in order to avoid the same error in the future. Finally, multiple personal characteristics may simultaneously be effective and interact such that they mutually intensify or weaken their influence. Future research may explore this possibility.

Future research could also systematically explore cross-cultural influences on learning from error. Gelfand, Frese, and Salmon (2011) proposed a number of cultural dimensions that might affect responses to errors and error management in organizations. For example, a low degree of uncertainty avoidance in a culture may lead to less intensive negative emotional reactions to errors. Future research may probe for this possibility and also test for generalizability of our findings to other cultures.

Future research may also explore the role of negative affect for learning from error in more detail. Interestingly, together our results paint a mixed picture concerning this role. Negative affect is usually ascribed a detrimental, maladaptive role for learning because preoccupation with negative emotions drains attentional capacities that could otherwise be devoted to the task at hand (Kanfer & Ackerman, 1989; Keith & Frese, 2005; Kluger & DeNisi, 1996; Zhao, 2011). Errors, almost by definition, are negative and aversive events that evoke negative affective reactions including anger and anxiety (Carmeli & Gittell, 2009; Edmondson, 1999; Hajcak & Foti, 2008; Ivancic & Hesketh 1995/1996; Keith & Frese, 2005, 2008; Metcalfe, 2017; Zhao, 2011). In the present studies, too, errors with severe consequences induced negative affect, as witnessed in our manipulation checks. Yet, this increased negative affect was associated with more, rather than with less, learning from error in our studies. This adaptive effect of negative affect is consistent with recent findings indicating that focusing on negative emotions upon failure on one task may increase motivation on a second similar task (Nelson *et al.*, 2018). On the other hand, the moderation effect of trait negative affectivity that we found is consistent with the traditional view that negative affect during learning is maladaptive. Future research may scrutinize the conditions under which negative affect plays an adaptive versus a maladaptive role in learning from error.

On a final and more speculative note, we would like to suggest that future research may pursue the following idea. Some research suggests that errors are not rare events but occur more frequently than commonly assumed (e.g. Prümper *et al.*, 1992; Zapf, Brodbeck, Frese, Peters, & Prümper, 1992), with some estimations ranging up to 2–4 errors per hour (Frese & Keith, 2015). The present results are consistent with the idea that not errors per se are infrequent but that it is only the severe negative consequences of errors that – fortunately – materialize infrequently, for example, because the error is noticed and corrected quickly or because favourable circumstances prevent the development of widely visible adverse outcomes. As a result, people readily dismiss or forget error situations with minor consequences, fail to draw lessons from the error, and even erroneously believe that they err less frequently than they in fact do. Underestimating error occurrence, however, might lead to overconfidence and decreased error detection which, in turn, could impair effective management of errors as well as long-term performance (Audia, Locke, & Smith, 2000; Frese & Keith, 2015; Gelfand *et al.*, 2011). Future research may seek to test more directly these potential dynamics among error occurrence, error detection, (over-)confidence, and long-term consequences in individuals and organizations.

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Conflicts of interest

All authors declare no conflict of interest.

Author contributions

Nina Keith (Conceptualization; Data curation; Formal analysis; Funding acquisition; Methodology; Supervision; Writing – original draft; Writing – review & editing) Dorothee Horvath (Conceptualization; Data curation; Formal analysis; Writing – review & editing) Alexander Klamar (Conceptualization; Data curation; Formal analysis; Writing – review & editing).

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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