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ORIGINAL PAPER

How to Induce an Error Management Climate: Experimental Evidence from Newly Formed Teams

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Abstract

An organizational climate of error management is associated with favorable organizational outcomes, including firm success, innovation, and safety. But how can an error management climate be induced? The present research used newly formed teams in a controlled setting as a model and tested the effect of two brief interventions on team climate and performance. In three-person teams, 180 participants worked on two team tasks that required communication and coordination, under 1 of 3 experimental conditions. Two of these were designed to induce an error management climate either indirectly, via the communication of social norms, or more directly, via explicit encouragement of experimentation and learning from errors. The third condition served as an error avoidant comparison group. In line with predictions, the climate induction increased processes of error management climate as perceived by teams, which in turn positively affected objectively measured team performance (mediation effect). These results strongly suggest that team error management climate can indeed affect performance and is not merely a correlate of unknown third variables that were unmeasured in previous correlational research. From a practical perspective, this research provides guidance on how principles of social influence may be leveraged to induce an error management climate.

Keywords Error management · Learning · Teams · Mindset · Team climate · Organizational climate · Team culture · Organizational culture

Introduction

Change, innovation, and crisis all bear the risk of making errors. Conversely, errors can be drivers of change and innovation in organizations, but errors can also lead to crisis. In the light of this interconnectedness, the topic of how organizations deal with errors has received an increasing interest in the past years in practitioners and researchers alike (e.g., Carroll et al., 2021; Frese & Keith, 2015; Goodman et al., 2011; Hofmann & Frese, 2011; Lei et al., 2016). The idea is that organizations fare better if they adopt procedures and practices aimed at constructively dealing with errors after they have occurred, that is, strategies of error management. Because a complete elimination of errors is not possible (Reason et al., 1990), such strategies of error management may help contain negative error consequences and support long-term learning from errors and innovation (van Dyck et al., 2005). In line with this idea, research has shown that a climate of error management[1] in organizations is related to a number of desirable outcomes such as firm profitability, safety, and entrepreneurial innovativeness (Cowley et al., 2021;

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[1] We decided to use the term *error management climate* (Frese & Keith, 2015) in favor of *error management culture* that has been introduced in the original study by van Dyck et al. (2005). The two constructs, climate and culture, are both "crucial building blocks" of organizations (Schneider et al., 2013, p. 377) and can be seen as "siblings" (Guzzo et al., 2014, p. 199) that are "essentially undifferentiated in practice" (Schneider & Barbera, 2014a, p. 4).

Fischer et al., 2018; Hofmann & Mark, 2006; van Dyck et al., 2005). On the level of individuals, incorporating principles of error management during training of work skills has been found to increase learning and transfer in trainees (e.g., Bell & Kozlowski, 2008; Heimbeck et al., 2003; Keith & Frese, 2008).

But given the benefits of error management for organizations and individuals, how can error management be effectively induced in social units, such as teams? There are practical and theoretical reasons for experimentally inducing error management climate and examining its effects. Practical reasons refer to the problem that it is not very easy to achieve change in organizations and we need to know much more on how to induce change (Stouten et al., 2018). Theoretical reasons also exist because there is little knowledge on causal effects in climate change.

Previous research primarily focused either on the micro-level of individuals or on the macro-level of organizations. Micro-level research is strong with regard to experimental evidence on performance effects of error management and psychological processes underlying this effect (e.g., Bell & Kozlowski, 2008; Dimitrova et al., 2015; Keith & Frese, 2005). However, this micro-level research focuses on *intra*personal processes (e.g., individual cognitions and affect) and is mute about potential effects on an *inter*personal level. Previous macro-level research clearly demonstrates associations of an error management climate with meaningful organizational outcomes in authentic organizational settings (e.g., Fischer et al., 2018; Hofmann & Mark, 2006; van Dyck et al., 2005). While this research shows effects on changes in objective performance, it is non-experimental and, therefore, cannot rule out alternative explanations, for example, unknown and unmeasured third variables driving the effect (e.g., aspects of leadership, modernity of organizations). Moreover, there are important methodological issues to consider. Micro-level research shows that a simple instruction, the error management instruction, can induce individuals to learn from errors well and to perform better than individuals exposed to an opposite instruction—the error prevention instruction. Would an experimental intervention of the same type on the meso-level (i.e., teams) lead to similar effects regarding performance in teams? Furthermore, macro-level research does not describe how climate can be induced. Little is known about truly causing changes in organizations and its effects (Stouten et al., 2018). Cultural research suggests that the effects of culture are due to normative pressure of common cultural practices (Gelfand & Harrington, 2015) and work via interpersonal norms. Since climate and culture are "inextricably connected, mutually reinforcing, and also reciprocally related" (Schneider & Barbera, 2014b; p. 680), would the induction of such interpersonal norms produce common practices (i.e., a climate) of error management in teams?

The present research seeks to contribute to the literature in the following ways. First, this research seeks to experimentally test performance effects of a brief team intervention that is aimed at inducing an error management climate. Second, we seek to extend previous research that focused primarily either on the macro-level of organizations or on the micro-level of individuals. Our study is set at a meso-level of analysis (i.e., teams) and tests climate induction on the level of newly formed teams in a controlled laboratory setting. By studying teams as focal unit, we also acknowledge the pivotal role of teams for organizational behavior, as teams occupy the intersection between the levels of individuals and the organization as a whole (Kozlowski & Bell, 2013). Finally, the present research seeks to complement and to contribute to previous streams of research by using two experimental interventions in a controlled laboratory setting on a unit-level of analyses (i.e., assessment of error management climate and performance in teams). One intervention is based on the influencing norms, and a second one is based on straightforward error management instructions. Can both lead to error management climate in teams?

In the following, we will present the concept of error management climate in more detail and then discuss the theoretical basis of our brief interventions for the induction of an error management climate. Our conceptual model is depicted in Fig. 1.

Theory and Hypotheses

Error Management, Error Management Climate, and Performance

Error management is a perspective towards errors that disentangles errors from their consequences (Frese et al., 1991). As a complement to strategies of error prevention, which aim at avoiding the error per se, strategies of error management seek to avoid negative consequences that may result from unmanaged errors. Prominent examples for error management are typical functions in computer software (e.g., undo function) and physical setups (e.g., the containment egg around nuclear power plants), as well as individual and interpersonal behaviors (e.g., cross-checking in cockpit crews) (Helmreich, 2000; van Dyck et al., 2005). In addition to minimizing negative error consequences, error management seeks to maximize potential positive consequences of errors, including long-term learning and innovation (Fischer et al., 2018; Frese & Keith, 2015; Homsma et al., 2009; Horvath et al., 2021; Keith et al., 2020; Sitkin, 1992). Error management should not be confused with laissez-faire approaches to errors. Laissez-faire approaches are negative approaches

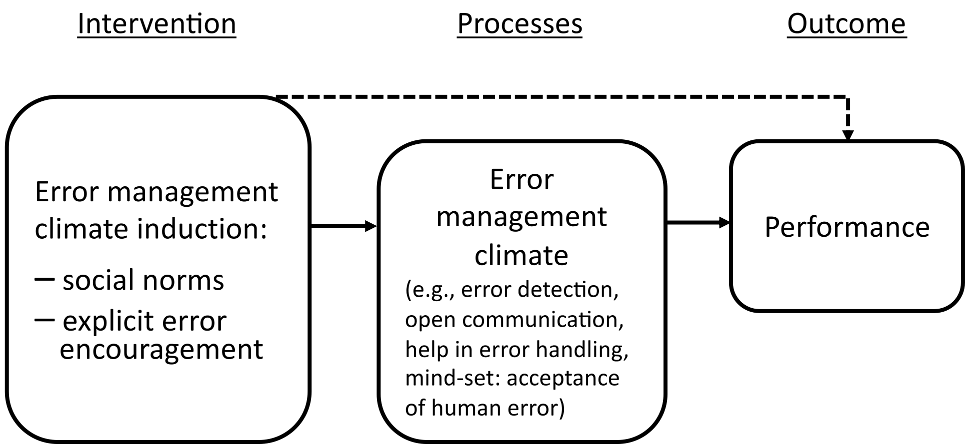

Fig. 1 Conceptual model in which the effect of climate induction on performance (dashed arrow) is mediated by processes of error management climate

to errors, which are characterized by not caring about errors or not dealing with errors at all and may result in sloppiness and poor work. In contrast, error management is an active approach towards errors that encourages dealing with errors once they happened, to avoid negative error consequences (Frese & Keith, 2015).

The concept of *error management climate* applies the principles and practices of error management to processes in organizations (as opposed to an *error avoidance climate* where principles and practices of error prevention are applied) (van Dyck et al., 2005). Errors occur at multiple levels in organizations (Goodman et al., 2011; Reason et al., 1990). Because every organization is confronted with the possibility that errors may happen, organizations implicitly or explicitly adopt some shared norms, practices, and procedures of dealing with errors (Bell & Kozlowski, 2011; Cannon & Edmondson, 2001; van Dyck et al., 2005). These shared practices and procedures constitute the organization's error climate (Denison, 1996; Reichers & Schneider, 1990; Schneider et al., 2013). One (positive) form of organizational error climate is error management climate that involves practices of quick detection and handling of errors, communication about errors, and sharing error knowledge, as well as helping in error situations (Keith & Frese, 2011; van Dyck et al., 2005). Error management climate also entails a shared mindset of acceptance of human errors (Frese & Keith, 2015). Together, these aspects of an error management climate are thought to trigger a number of processes that ultimately contribute to beneficial organizational outcomes. Immediate processes include the reduction and containment of negative error consequences, as errors are detected more quickly, as well as secondary error prevention (i.e., taking measures to avoid the same error in the future). Longer-term processes include the improvement of work procedures and quality of products and services, as organizations exhibit more learning and innovation (Fischer et al., 2018; van Dyck et al., 2005). Another aspect of error management that contributes to learning and innovation is that the climate environment encourages experimentation and exploration, without the fear of being blamed or punished if something goes wrong (Fischer et al., 2018; Wilhelm et al., 2019).

In the following, we argue for an expectation that previous organizational-level findings on the benefits of an error management climate are replicated on the team level of analysis. It is legitimate to use teams as the unit of analysis in our experimental study for two reasons. First, practically, organizational change processes are often introduced first in teams to be then rolled out in the entire organization. Second, theoretical analyses of organizational change processes are often based on team research (Stouten et al., 2018). Thus, we propose that practices of organizational error management climate—such as error communication, knowledge sharing on dealing with errors, helping in error situations, sharing mindsets of error acceptance, and reducing fear of punishment after errors (cf. Figure 1)—all involve interpersonal processes that appear in teams as well as in organizations. These processes contribute to immediate team outcomes, specifically, to better team performance, which in turn may improve organizational performance.

Hypothesis 1a: The induction of an error management climate in teams leads to higher team performance than the induction of an error avoidance climate.

Inducing an Error Management Climate

Organizational climate perceptions emerge from social interactions and observation of organizational members. Team members are influenced by the norms of social practices—"the way things are around here" (Reichers & Schneider, 1990, p. 22; Ashforth, 1985; Schneider et al., 2013). Social influence may appear because of direct communication by peers or leaders. Norms may also be established indirectly, via observation of social norms—how people in one's team behave (i.e., normative social influence; Cialdini & Goldstein, 2004). Our research attempts to influence teams with both processes, that is, the indirect and direct pathways for the emergence of an error management climate.

First, the indirect pathway of normative social influence via behavior is a key factor in the formation of organizational climate (Ashforth, 1985) that can be leveraged when introducing error management climate. *Normative social influence* can be defined as "an influence to conform with the positive expectations of another" (Deutsch & Gerard, 1955, p. 629). This type of social influence does not, or at least not necessarily, involve explicit requests to behave in a certain way. Rather, people (e.g., newcomers in an organization) behave in a certain way because others (e.g., people in the immediate work group) set the social norm of certain behaviors and practices. In social psychology, there is a long tradition of studies demonstrating the power of social influence on people's behavior in groups (e.g., Asch, 1955, 1956; Cialdini et al., 1990; Deutsch & Gerard, 1955; Milgram et al., 1969; Nolan et al., 2008; Schultz, 1999; Schultz et al., 2007; Sherif, 1935; for a review see Cialdini & Goldstein, 2004). Often norms are established by written instructions: "Communicating a descriptive norm – how most people behave in a given situation – via written information can induce conformity to the communicated behavior" (Nolan et al., 2008, p. 913; Goldstein et al., 2008; Parks et al., 2001; Schultz, 1999). For example, Goldstein and colleagues (2008) provided written messages to hotel guests about participation in a towel reuse program: "Join your fellow guests in helping to save the environment. Almost 75% of guests who are asked to participate in our new resource savings program do help by using their towels more than once. You can join your fellow guests in this program to help save the environment by reusing your towels during your stay." (p. 474). This appeal employing written descriptive norms resulted in a higher towel reuse rate. Similarly, communicating the social norm of viewing errors as a learning opportunity and openly discussing errors in the team should influence team members' behavior accordingly.

Second, direct and explicit encouragement of viewing errors as learning opportunities and of openly discussing errors may also be useful for introducing an error management climate. Such an approach is employed in so-called error management training. This is an active training approach combining active exploration by participants with explicit encouragement to allow errors to happen and to learn from them (Frese et al., 1991; Keith & Frese, 2008). The idea is that people are active learners (Bell & Kozlowski, 2008) and that learning involves the development and refinement of action-oriented mental models, which is best attained through action, thus exploration (Frese & Zapf, 1994; Hacker, 1985, 2003; Zacher & Frese, 2018). Errors in the action process function as negative but informative feedback that pinpoints where mental models are inadequate and need to be improved (Heimbeck et al., 2003). When an error occurs, exploration allows to discover the cause, potential solutions to the error, and also new ways of doing things. Thereby, learners gain an improved understanding of the system and are also prepared to master similar tasks outside the immediate training context, where errors are unavoidable (Dormann & Frese, 1994; Frese, 1995; Frese & Keith, 2015). Encouraging errors to happen and to learn from them reduces anxiety and frustration linked to errors. This forms a positive mindset towards errors. An error-tolerant attitude "maximize[s] the informational value of errors" (Ivancic & Hesketh, 1995/1996, p. 115), instigates further exploration, helps to increase motivation, and strengthens personal mastery and task interest, which may benefit learning and performance (Frese & Keith, 2015; Heimbeck et al., 2003; Keith & Frese, 2005, 2008). On the level of teams, actions and action errors are also central because (inter)action is a defining feature of teams (Kozlowski & Bell, 2013) and helps in establishing shared mental models, and shared mental models influence how to deal with errors (DeChurch & Mesmer-Magnus, 2010; Kozlowski & Bell, 2013; Mathieu et al., 2000). We propose that an explicit encouragement of exploration and errors in teams should increase error-related actions and communication in teams.

Prior research on the effectiveness of communication of social norms (Cialdini & Goldstein, 2004) and of direct instructions in error management training (Keith & Frese, 2008) suggests two variants of climate induction; we expect them to influence team members' error-related behaviors effectively, as well as perceptions of error management climate in teams, and enhance team performance. Thus, we predict (cf. Figure 1):

> *Hypothesis 1b:*The induction of an error management climate increases teams' perceived error management climate compared to the induction of an error avoidance climate.
>
> *Hypothesis 1c:* The induction of an error management climate leads to higher team performance via an increase of perceived error management climate (mediation effect) in comparison to the induction of an error avoidance climate.

Method

Sample and Procedure

Our study is based on 180 advanced undergraduate and graduate students of a German university. The students were enrolled in various majors, including psychology, law, medicine, social affairs, education, mathematics, biochemistry, information technology, or mechanical engineering. We are aware that organizational research is often skeptical about student participants because they are not in the same working environment as employees. Nevertheless, we chose to utilize access to a student population because experiments on "real work teams" are very difficult to conduct and most organizations we approached were unwilling to allow an experiment in this area because they were afraid of risks of such an experiment. Therefore, it is helpful to convince managers and scientists with empirical data from true experiments—and these are conducted more easily with students from a university. Furthermore, as we will describe in more detail below, at least one of the two experimental tasks is often used in organizational team development and team communication training. Mean age was 25.76 years ($SD = 10.12$), and 41.1% were female. Most of the participants (68.9%) worked in organizations at least part-time. Participants received either EUR 8 (approx. USD 9.50) or partial course credit as compensation, with an additional incentive for the best performing team to win a voucher for an online retailer (worth approx. USD 36). The participants were grouped into 60 teams of three and were invited to individual laboratory sessions. Upon arrival at the laboratory, they first completed questionnaires including demographics and individual difference variables that we assessed to exclude pre-experimental differences.[2] The teams then received written instructions according to the experimental condition they were randomly assigned to: (1) error management climate induction based on principles of social influence (20 teams), (2) error management climate induction based on action instructions, similar to the error management instructions provided in error management training (20 teams), or (3) a control condition that de-emphasized error management in favor of an error avoidant approach (20 teams). Subsequently, the teams worked on two team tasks and filled in questionnaires on how they perceived their team's error management climate. Finally, participants were thanked, debriefed, and compensated.

Experimental Tasks

Choosing adequate team tasks for laboratory research is not trivial, as the task itself and the performance measures derived from it need to meet several criteria concerning reliability, validity, and practicality. The task also needs to meaningfully reflect the research question at hand. To increase reliability, statistical power, and breadth of the performance measure (as one aspect of validity), we used two tasks rather than a single task (i.e., the teams worked on two different team tasks consecutively) (Goulet & Cousineau, 2019). With regard to practicality and psychological realism (as another aspect of validity), we identified the following criteria that should be met by the tasks: (1) The tasks need to involve a clear goal that can be pursued within a reasonable time during the lab session. (2) The measurement of task performance should be meaningful and preferably objective. (3) The tasks need to be psychologically engaging for participants. (4) They should not be too dependent on team members' abilities or previous task experience. (5) They should elicit errors, and these errors should be detectable as well as correctable for team members without external feedback. (6) They should entail certain degrees of freedom with regard to how to arrive at a solution (i.e., a task that involves one single-best way would not be suitable). (7) They should require a minimum of coordination and communication among team members (i.e., a team task that can be completely subdivided and worked on individually without further team coordination would not be suitable; Kozlowski & Bell, 2013). Based on these considerations and on intensive pilot testing, the so-called Marshmallow Challenge and a marble-run task emerged as suitable for our research purposes.

The *Marshmallow Challenge* has occasionally been used in experimental settings (e.g., Cook & Olson, 2006; Steele et al., 2021) but is probably better known for its common use in team development training (Wujec, 2010). The name of the task is derived from the goal of the task, namely, to build a structure as high as possible using dry spaghetti and to place a marshmallow on its top. This structure needs to be stable (i.e., must not collapse) for at least 30 s. After explaining the task and its goal, we provided all teams with the same amount of material (spaghetti, marshmallow, and tape) and informed them that they can ask for more material should this be required during the task (for example, in case of broken spaghetti or tape sticking together). The *marble-run task* has been used in previous research on team coordination (Tschan, 1995, 2002). It basically involves building a ball track system that is a "roller coaster structure for marbles" (Tschan, 1995, p. 376), using plastic or wooden pieces that are widely available in toy stores (we purchased a set of plastic pieces). The goal is to build a system in which the marble travels as long as possible without falling off the track. Based on pilot testing, we set the time on task at 10 min for both tasks. The tasks were presented to the teams in the same order.

Experimental Manipulations

We used two variants of an error management climate induction. Both aimed at inducing a mindset of errors as a learning opportunity, an increased active exploration, and error

[2] We assessed error orientation prior to the intervention as an attitude (Rybowiak et al., 1999), task familiarity, familiarity with other team members, and goal commitment (Hollenbeck et al., 1989) and found no differences between experimental conditions.

communication in teams, but the variants used slightly different means for the induction, namely, a more direct and explicit versus a more indirect approach through the communication of social norms of error management. A third experimental condition—the error avoidance condition—served as a comparison group.

The direct approach of error management climate induction was similar to error management conditions in earlier training research (e.g., Bell & Kozlowski, 2008; Heimbeck et al., 2003; Keith & Frese, 2005), in that participants were explicitly encouraged to explore, make errors, and learn from these errors as a team. For example, referring to the marshmallow task, the instructions read: "Test again and again whether the structure is already stable enough (…). If the structure collapses – be happy because you made an error; you can learn from your errors! Discuss in your team what went wrong. Be open about dealing with errors. (…) The more errors you make, the better you can get!" (for complete manipulations see supplementary material in the JBP open science repository).

The indirect approach of error management climate induction was similar to earlier techniques to communicate social norms (Goldstein et al., 2008), in that participants were told about how other teams in their situation had behaved and succeeded. In particular, we told participants that the most successful teams on this task were those who engaged in "the most trials and also made the most errors! Ninety percent of the most successful teams openly discussed errors. That way it was possible to learn from the errors as a team and to improve further. (…) Studies have shown that companies that see errors as a learning opportunity are much more successful." Thus, this instruction was supposed to influence norms of common error management practices in keeping with our definition of climate as common practices.

The comparison group was similar to the comparison groups used in many individual training studies, in that making errors was deemphasized in favor of error avoidance (e.g., Heimbeck et al., 2003). In particular, we told participants that they should work carefully and avoid making errors during the task because dealing with errors costs time and energy and because errors produce stress that could have been avoided.

To increase the impact of climate inductions, before starting the team tasks, we asked participants to discuss in the team what they had just learned about errors, to formulate action principles on how to deal with errors, and to write them down on a flipchart. Action principles are action-oriented rules of thumbs that represent the essence of some information (e.g., "Make errors and discuss them in the team to learn from them"). The idea is that the teams internalize essential information as they discuss and develop the action principles (Frese et al., 2016). As a reminder, we left the flipchart in the room during the team tasks. We also later used the action principles as manipulation checks.

Measures

Manipulation Checks

Two raters independently rated the team-generated action principles as either reflecting error management, error avoidance, or as non-classifiable. Ratings were in line with experimental manipulations, with an "Almost Perfect" (Landis & Koch, 1977, p. 165) inter-rater agreement (Cohen's kappa = .96). These results suggest that our brief interventions had worked as intended.

Dependent Variable (Team Performance)

Team performance was an aggregate measure that we directly derived from objective measures that represented the goal of the team tasks. Because the goal of the marshmallow task was to build as high a structure as possible, we used height of the structure (in centimeters) as the performance measure. Because the goal of the marble-run task was to build a track with as long the marble's running time as possible, we used running time (in seconds) as the performance measure. We standardized and aggregated the measures and linearly transformed the score to obtain a scale with positive values. We used aggregation to increase reliability and statistical power of the performance measure (Goulet & Cousineau, 2019), as well as to cover a broader criterion space.

Mediator Variable (Error Management Climate)

Error management climate was a team measure that aggregated team members' individual responses to the Error Management Climate Questionnaire by van Dyck et al. (2005) (17 items, to be answered on a 5-point Likert scale). We modified item wordings to explicitly refer to the team level. For example, the original item "After making a mistake, people try to analyze what caused it" was modified to "After making a mistake, people in this team tried to analyze what caused it." Individual-level internal consistencies were good (Cronbach's alpha = .89 and .87 for the two tasks). Before aggregating to the team level, we computed with the R (Version 4.2.1) package "multilevel" (Version 2.7; Bliese, 2022) within-team agreement for each team using $r_{wg(j)}$ (James et al., 1984, 1993) and reliability of responses among team members with intraclass correlation coefficients (ICC; Bliese, 2000). The mean values of $r_{wg(j)} = .95$, ICC(1) = .19, and ICC(2) = .41 ($F(59,120) = 1.71$, $p < .01$) suggested appropriate levels of within-team agreement and reliability[3] (LeBreton & Senter, 2008), justifying aggregation.

[3] These values pertain to the aggregated measure across tasks. Separate values were $r_{wg(j)} = .83$, ICC(1) = .27, and ICC(2) = .52 ($F(59,120) = 2.11$, $p < .001$) for Task 1 and $r_{wg(j)} = .92$, ICC(1) = .18, and ICC(2) = .39 ($F(59,120) = 1.65$, $p < .05$) for Task 2.

Table 1 Means, standard deviations, and intercorrelations of study variables

	M	*SD*	*1*	*2*	*3*
1. Contrast 1 (effect of EM conditions)[a]	0.00	0.48	-		
2. Contrast 2 (comparison of EM conditions)[b]	0.00	0.41	.00	-	
3. Error management climate	3.86	0.37	.36**	.17	-
4. Team performance	2.05	1.51	.29*	.05	.46**

60 teams in 3 conditions

[a]Contrast code 1 represents the comparison of the two error management (EM) conditions with the comparison condition (i.e., error avoidance condition)

[b]Contrast code 2 represents the comparison among the EM conditions

*$p < .05$

**$p < .01$

Table 2 Means and standard deviations of study variables by experimental conditions

Experimental condition	Direct approach of error management climate induction ($n = 20$ teams)		Indirect approach of error management climate induction ($n = 20$ teams)		Error avoidance climate induction ($n = 20$ teams)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Error management climate	4.03	0.39	3.88	0.38	3.67	0.26
Team performance	2.44	1.14	2.27	2.04	1.43	1.03

Independent Variable (Climate Induction)

To represent the three experimental conditions, we used Helmert (contrast) coding such that the first code (Contrast 1) compared the two error management climate groups (.333; .333) with the comparison group (error avoidance climate groups; – .667) and the second code (Contrast 2) compared the two error management climate groups (.500; – .500) (see West et al., 1996). Thus, Contrast 1 directly reflects our hypotheses concerning the effects of the error management climate induction (as compared to the comparison group) on perceived error management climate and team performance. We still included Contrast 2 in all analyses for the sake of completeness even though we did not have any hypotheses related to Contrast 2.

Results

Means, standard deviations, and intercorrelations of study variables are depicted in Tables 1 and 2. As depicted in Table 1, the predictor (i.e., the Contrast variable 1, representing the comparison between the error management climate induction and comparison group), mediator (i.e., error management climate), and dependent variable (i.e., team performance) shared positive correlations. This correlational pattern lends preliminary support to our hypotheses, which we tested using regression analytic and bootstrapping techniques with IBM SPSS Statistics (Version 28) and the PROCESS macro for SPSS (Version 4.1; Hayes, 2022).

Test of Hypotheses

Our hypotheses predicted that our error management climate induction leads to a stronger error management climate perceived in teams (Hypothesis 1b) as well as to higher team performance (Hypothesis 1a) than the error avoidance climate induction and that these performance effects of the error management climate induction are mediated by perceived error management climate (Hypothesis 1c). In principle, these hypotheses can be tested simultaneously via the overarching hypothesis of mediation (Hypothesis 1c), which we did using bootstrapping techniques. For illustrative purposes, however, we first report the results of separate regression analyses along the lines of the more traditional so-called causal steps approach by Baron and Kenny (1986).

As shown in Table 3, with regard to the effect of the two error management conditions in comparison with the error avoidance group (represented by Contrast variable 1), all conditions for a mediation in terms of Baron and Kenny (1986) were met: Experimental condition (i.e., Contrast 1) predicted mediator error management climate (Model 1; $\beta = .36$, $p < .01$), and this mediator predicted criterion team performance[4] (Model

[4] The original work by Baron and Kenny (1986) suggests to evaluate the effect of the mediator in a regression model that includes the predictor as well, as we did in Model 4.

Table 3 Results of ordinary least squares regression analyses (Models 1 to 4) and of simple mediation bootstrapping analyses (Model 5), involving experimental conditions as predictors (*X*), error management climate as mediator (*M*), and team performance as criterion (*Y*)

	Coefficient (*SE*)	95% CI [*LL*, *UL*]	*t*	*p*	*β*	R^2
Model 1: $X \rightarrow M$						.16
Contrast 1 (effect of EM conditions)[a]	0.28 (0.10)	[0.09, 0.47]	2.96	.004	.36**	
Contrast 2 (comparison of EM conditions)[b]	0.15 (0.11)	[−0.07, 0.37]	1.37	.178	.17	
Constant	3.86 (0.05)	[3.77, 3.95]	85.78	< .001		
Model 2: $M \rightarrow Y$						.21
Error management climate	1.86 (0.47)	[0.92, 2.81]	3.95	< .001	.46**	
Constant	−5.15 (1.83)	[−8.82, −1.48]	−2.81	.007		
Model 3: $X \rightarrow Y$						.09
Contrast 1[a]	0.93 (0.40)	[0.12, 1.73]	2.30	.025	.29*	
Contrast 2[b]	0.16 (0.47)	[−0.77, 1.10]	0.35	.726	.05	
Constant	2.05 (0.19)	[1.67, 2.43]	10.77	< .001		
Model 4: $X, M \rightarrow Y$						.23
Contrast 1[a]	0.45 (0.40)	[−0.35, 1.26]	1.13	.265	.14	
Contrast 2[b]	−0.09 (0.44)	[−0.97, 0.79]	−0.20	.842	−.02	
Error management climate	1.67 (0.52)	[0.64, 2.71]	3.23	.002	.42**	
Constant	−4.42 (2.01)	[−8.34, −0.40]	−2.20	.032		
Model 5: $X \rightarrow M \rightarrow Y$						.23
Indirect effect (bootstrap analyses[c])	0.47 (0.21)	[0.13, 0.95]				

60 teams in 3 conditions

[a]Contrast code 1 represents the comparison of the two error management (EM) conditions with the comparison condition

[b]Contrast code 2 represents the comparison among the EM conditions

[c]Number of bootstrap samples = 5000

*$p < .05$

**$p < .01$

2; $\beta = .46$, $p < .01$). Experimental condition (i.e., Contrast 1) also predicted team performance (Model 3; $\beta = .29$, $p < .05$). Finally, in a model including both the predictor and the mediator (Model 4), the effect of the mediator remained stable ($\beta = .42$, $p < .01$), whereas the effect of the predictor did not ($\beta = .14$, *ns*), suggesting full mediation in terms of Baron and Kenny's (1986) criteria. No effects emerged for Contrast variable 2 (comparison among the two error management conditions), indicating that the two different strategies of induction of error management climate did not lead to differences in team perceptions of error management climate (Model 1; $\beta = .17$, *ns*) nor to a difference in team performance (Models 3 and 4; $b = .05$, *ns*, and −.02, *ns*, respectively).

To formally test the hypothesized indirect effect of error management climate induction (Contrast 1, representing the comparison of the two error management groups with the comparison group) via error management climate on team performance, we used bootstrap methods for the calculation of confidence intervals around the estimated effect (Hayes & Preacher, 2014; Preacher & Hayes, 2004). We used 5,000 bootstrap samples and estimated 95% bootstrap confidence intervals (CI) (for completeness, we included the comparison among the two error management conditions, Contrast 2, as a covariate in the model). If the confidence interval does not include zero, the indirect effect is significant, and mediation is present. As shown in Table 3 (Model 5), this was the case, in that the lower and the upper limit of the confidence interval were positive. In sum, both the more traditional approach of Baron and Kenny (1986) and the bootstrapping approach to mediation analyses supported our overarching mediational hypothesis, namely, that our error management climate inductions were successful in increasing error management climate in teams and that this increase, in turn, accounts for team performance.

Discussion

Our research focused on the meso-level of analysis (i.e., teams) and tested whether and how a climate of error management can be induced. We used two variants of climate induction, deduced from two different streams of literature: An indirect induction via communication of social norms, based on research on normative social influence, and a direct induction based on active learning and related research on error management during training. In line with what we expected, the interventions successfully induced error management climate and improved performance in teams, as compared with the error-avoidant comparison condition. In turn, error management climate explained performance differences between experimental conditions (i.e., mediation effect).

Theoretical and Practical Contributions

The results of our study suggest that an induction of team error management climate is indeed possible. Our study contributes to the scarce body of experimental research concerning the induction of an error management climate and its casual effects on performance. Prior studies have shown the importance of training error management climate in teams for safety performance (Helmreich, 2000; Salas et al., 1999, 2006); however, they did not usually use a randomized controlled trial approach.

Our original interest in conducting this experimental study was to contribute to the burgeoning literature on organizational climate in organizations. Our results are in line with previous organizational-level findings that demonstrated relationships of an error management climate with positive organizational performance outcomes. They are also in line with previous individual-level findings that demonstrated the effectiveness of error management as a result of training. Our research extends these findings by demonstrating experimental effects that were previously found in correlational studies (i.e., in organizational field studies) or in individuals' training.

This extension is important because it strongly suggests that it is indeed the aspects of error management climate (and not some unknown third variables) that is underlying the previously established relationships between error management climate and organizational outcomes—aspects such as increased error communication and knowledge sharing and shared mindsets of error acceptance, as well as an absence of fear of punishment after errors. Such processes have been suggested in earlier correlational research on error management climate and related concepts (e.g., psychological safety; Edmondson, 1999). A controlled laboratory study provides strong evidence from a methodological viewpoint.

From a practical perspective, the results are noteworthy as well; they highlight the importance of changing error management climate in organizational development programs. Making use of our results, the topic of errors and error management could be included in leadership and employee development programs. Our results also provide some guidance on how leaders can promote an error management climate, namely, by using direct encouragement of exploration, experimentation, and learning from error as well as, more indirectly, by communicating throughout the organization how others (e.g., other teams in the organization) have succeeded with adopting an error management approach. Clearly, organizational leaders have an important role in transmitting and shaping organizational climates (Schneider et al., 2013). They can set social norms either by communicating them or by acting as role models.

Strengths, Limitations, and Avenues for Future Research

This study used a controlled laboratory setting which allowed us to systematically vary error management climate while keeping other potentially influential factors constant. We also used two (rather than only one) team tasks that we carefully selected based on theoretical and practical considerations as well as on intensive pilot testing. Finally, we measured performance objectively. This study design lends high confidence regarding internal validity of the focal effect while raising questions about external validity or generalizability of our findings to real-world settings.

We hasten to add that our study belongs to the category of low fidelity simulations (Mathieu et al., 2000). Our study neither used actual work tasks nor participants in their organizational environment. From this perspective, generalizability to real-world settings may appear to be limited. Yet, conceptual and empirical arguments suggest otherwise. Conceptually, we derived our interventions from theory and existing research on error management, and we chose tasks that can be expected to induce psychological processes similar to those that occur in organizational teams—after all, one of our tasks (i.e., the so-called Marshmallow Challenge) is a task that is often used in team development training (Wujec, 2010), precisely because it is believed to be a useful vehicle for demonstrating critical interpersonal processes in teams. Empirically, this study should not be viewed in isolation but in the context of other research on error management climate that was conducted in real-world contexts and with meaningful organizational outcomes (e.g., firm success, safety, innovation). Thus, we believe that the psychological and interpersonal processes induced in this study are not that dissimilar to those in real-world organizational settings.

Obviously, an impact on a team of students cannot be taken as proof that the same treatment would work in an organization. Our theoretical approach hinges on the assumption of multilevel homology. As discussed by Kozlowski's multilevel theory (2012), there are contextual top-down effects from the organization to the team, emergent bottom-up effects from the team to the organization and multilevel homology, where parallel processes exist between organizations and teams. This is an assumption that we have not tested and which is unlikely to be tested experimentally. However, available evidence shows that the assumption of homology holds for the non-experimental relationships between error management climate and performance in organizations (van Dyck et al., 2005) and it also holds for team interventions and performance including crew resource training (Klein et al., 2006).

Of course, we need to acknowledge that changing an established organizational or team climate is likely much more difficult than with newly formed teams as in the present study (Kozlowski & Ilgen, 2006). Also, our newly formed teams consisted only of three participants: larger teams may need more time to develop shared perceptions in group activity. Thus, we would expect the path from the induction to climate (left arrow in Fig. 1) to be weaker in applied settings, as interventions may not be strong enough to overrule already established norms and practices of dealing with errors. However, the path from error management climate to performance (right arrow in Fig. 1) is likely comparable or even stronger in real-world settings, as there are more opportunities for favorable error management processes to develop than in the present short-term experiment.

In organizations, relevant climates have possibly evolved over time and are presumably engrained and internalized by the members of the organization, whereas in our study of newly formed teams, climate obviously emerged within a very short time. The newly formed teams in this research could not have shared perceptions of error management prior to the experimental task and interacted only briefly. Given the short time period of our study, it is striking that our induction of an error management climate *did* affect participants' common perception of the groups' error climate and even improved team performance. It is plausible to assume that a stable and engrained error management climate in an organization may contribute to stronger effects leading to higher long-term performance consequences (Bell & Kozlowski, 2011; van Dyck et al., 2005).

One critical question is whether the effect of our error management climate manipulations on perceived error management climate is an indicator of a superficial compliance with the instructions rather than an indicator of actual change in attitudes towards errors or climate. As the effect of the instructions were not only reflected in the perception of error management climate (assessed via self-reports) but also in actual behavior concerning performance, we think that an actual change in attitudes towards errors took place. However, we cannot be certain whether this is the case and whether such change would be enduring and ingrained as would be expected of team climate in actual organizations.

One might argue that not the error management instructions resulted in differences on the climate measurement, but the error avoidant instruction led teams to act in ways they normally would not have. However, in general, people have a negative mindset towards errors and try to prevent them, even unconsciously (Frese & Keith, 2015; van Dyck et al., 2005). Thus, error prevention seems to be used as a default strategy when dealing with errors, while error management requires a more explicit effort (Frese & Keith, 2015; van Dyck et al., 2005). Nonetheless, future studies should incorporate neutral control groups with instructions where errors are not mentioned.

As stated in the method section, in addition to the compensation for participation in our study, the best performing team had the chance to win a voucher for an online retailer. In organizational settings, performance incentives are also common. However, one might wonder whether the element of competition between teams could have affected our findings. For example, a temptation to trade off errors and experimentation (which are time-consuming) for faster performance could reduce error management climate. Future studies should account for this possibility.

Also, in the tasks used in our study, participants received immediate and clear feedback when they made an error—such as when the structure they constructed collapsed. In organizations, there may be tasks on which such immediate feedback is not provided. The generalizability of our results may be limited to work tasks where error feedback can be clearly interpreted. Future studies may investigate if making an error and receiving feedback about it is necessary for error management climate to unfold its beneficial effects on performance. Possibly, it may even be enough to have an environment where errors are considered as chances to learn rather than as threats (e.g., an error management climate) to improve performance. To increase generalization, future studies may also incorporate other tasks and counterbalance the order of task presentation.

Furthermore, laypeople commonly do not distinguish errors (i.e., unintentional deviations from goals, rules, and standards; Frese & Zapf, 1994; Hofmann & Frese, 2011; Reason et al., 1990) from violations (i.e., intentional deviations) (Frese & Keith, 2015; Hofmann & Mark, 2006; Reason, 1997). However, management and prevention of errors and violations differ both theoretically and practically (Frese & Keith, 2015). Future studies should therefore investigate how the encouragement of errors may affect the occurrence of violations.

Obviously, this research would benefit from field interventions in which teams or leaders of teams are trained in adopting an error management climate and in which real-world outcome variables are assessed after the intervention. We hope that our study can contribute to persuade managers to allow experiments to be done in their organizations. Ideally, such research would encompass the observation of behavioral changes of team members (e.g., increased or intensified communication and coordination). Finally, future research may explore the interplay between climate influences in teams and other team processes that have been found to benefit team outcomes. For example, team reflexivity, that is, "the extent to which teams collectively reflect upon and adapt their working methods and functioning" (Schippers et al., 2015, p. 769), has been found to be associated with favorable team outcomes such as innovation. We would expect error management climate to support team reflexivity either by making reflective processes in teams more likely (predictor) or by contributing to better outcomes of reflection (moderator). Error management climate may also contribute to psychological safety in teams (Edmondson, 1999), as team members feel safe to speak up in teams. Future research may further explore such relationships.

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Data Availability The dataset of the current study is available from the authors on reasonable request.

Declarations

Ethics Approval Approval was obtained from the ethics committee of Leuphana University Lüneburg.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare no competing interests.

References

Asch, S. E. (1955). Opinions and social pressure. *Scientific American, 193*(5), 31–35. https://doi.org/10.1038/scientificamerican1155-31

Asch, S. E. (1956). Studies of independence and conformity: A minority of one against a unanimous majority. *Psychological Monographs: General and Applied, 70*(9), 1–70. https://doi.org/10.1037/h0093718

Ashforth, B. E. (1985). Climate formation: Issues and extensions. *The Academy of Management Review, 10*(4), 837–847. https://doi.org/10.2307/258051

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Bell, B., & Kozlowski, S. W. J. (2008). Active learning: Effects of core training design elements on self-regulatory processes, learning, and adaptability. *Journal of Applied Psychology, 93*(2), 296–316. https://doi.org/10.1037/0021-9010.93.2.296

Bell, B. S., & Kozlowski, S. W. J. (2011). Collective failure: The emergence, consequences, and management of errors in teams. In D. A. Hofmann & M. Frese (Eds.), *Errors in organizations* (pp. 113–142). Routledge/Taylor and Francis Group.

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research and methods in organizations: Foundations, extensions, and new directions* (pp. 349–381). Jossey-Bass.

Bliese, P. D. (2022). *multilevel: Multilevel functions* (R package version 2.7) [Computer software]. The Comprehensive R Archive Network. https://CRAN.R-project.org/package=multilevel

Cannon, M. D., & Edmondson, A. C. (2001). Confronting failure: Antecedents and consequences of shared beliefs about failure in organizational work groups. *Journal of Organizational Behavior, 22*(2), 161–177. https://doi.org/10.1002/job.85

Carroll, J. S., Christianson, M., Frese, M., Lei, Z., Naveh, E., & Vogus, T. J. (2021). Errors in organizations: New frontiers in research and practice. *Academy of Management Discoveries, 7*(4), 451–460. https://doi.org/10.5465/amd.2021.0217

Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and conformity. *Annual Review of Psychology, 55*, 591–621. https://doi.org/10.1146/annurev.psych.55.090902.142015

Cialdini, R., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology, 58*(6), 1015–1026. https://doi.org/10.1037/0022-3514.58.6.1015

Cook, L. S., & Olson, J. R. (2006). The sky's the limit: An activity for teaching project management. *Journal of Management Education, 30*(3), 404–420. https://doi.org/10.1177/2F1052562905279220

Cowley, C., Denyer, D., Kutsch, E., & James, K. T. (2021). Constructing safety: Reconciling error prevention and error management in oil & gas and petrochemicals operations. *Academy of Management Discoveries, 7*(4), 554–580. https://doi.org/10.5465/amd.2019.0190

DeChurch, L. A., & Mesmer-Magnus, J. R. (2010). The cognitive underpinnings of effective teamwork: A meta-analysis. *Journal of Applied Psychology, 95*(1), 32–53. https://doi.org/10.1037/a0017328

Denison, R. D. (1996). What is the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. *The Academy of Management Review, 21*(3), 619–654. https://doi.org/10.2307/258997

Deutsch, M., & Gerard, H. B. (1955). A study of normative and informational social influences upon individual judgment. *The Journal of Abnormal and Social Psychology, 51*(3), 629–636. https://doi.org/10.1037/h0046408

Dimitrova, N. G., van Dyck, C., van Hooft, E. A. J., & Groenewegen, P. (2015). Don't fuss, focus: On-task thoughts as a mediator of the effect of error approach instructions on performance. *Applied Psychology: An International Review, 64*(3), 599–624. https://doi.org/10.1111/apps.12029

Dormann, T., & Frese, M. (1994). Error training: Replication and the function of exploratory behaviour. *International Journal of Human-Computer Interaction, 6*(4), 365–372. https://doi.org/10.1080/10447319409526101

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly, 44*(2), 350–383. https://doi.org/10.2307/2666999

Fischer, S., Frese, M., Mertins, J. C., & Hardt-Gawron, J. V. (2018). The role of error management culture for firm and individual innovativeness. *Applied Psychology: An International Review, 67*(3), 428–453. https://doi.org/10.1111/apps.12129

Frese, M., & Keith, N. (2015). Action errors, error management, and learning in organizations. *Annual Review of Psychology, 66*, 661–687. https://doi.org/10.1146/annurev-psych-010814-015205

Frese, M., Brodbeck, F. C., Heinbokel, T., Mooser, C., Schleiffenbaum, E., & Thiemann, P. (1991). Errors in training computer skills: On the positive function of errors. *Human-Computer Interaction, 6*(1), 77–93. https://doi.org/10.1207/s15327051hci0601_3

Frese, M., Gielnik, M. M., & Mensmann, M. (2016). Psychological training for entrepreneurs to take action: Contributing to poverty reduction in developing countries. *Current Directions in Psychological Science, 25*(3), 196–202. https://doi.org/10.1177/0963721416636957

Frese, M., & Zapf, D. (1994). Action as the core of work psychology: A German approach. In H. C. Triandis, M. D. Dunette, & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology* (Vol. 4, pp. 271–340). Consulting Psychologists Press.

Frese, M. (1995). Error management in training: Conceptual and empirical results. In C. Zucchermaglio, S. Bagnara, & S. U. Stucky (Eds.), *Organizational learning and technological change* (NATO ASI Series F, Vol. 141, pp. 112–124). Springer. https://doi.org/10.1007/978-3-642-79550-3_7

Gelfand, M. J., & Harrington, J. R. (2015). The motivational force of descriptive norms: For whom and when are descriptive norms most predictive of behavior? *Journal of Cross-Cultural Psychology, 46*(10), 1273–1278. https://doi.org/10.1177/2F0022022115600796

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A room with a viewpoint: Using social norms to motivate environmental conservation in hotels. *Journal of Consumer Research, 35*(3), 472–482. https://doi.org/10.1086/586910

Goodman, P. S., Ramanujam, R., Carroll, J. S., Edmondson, A. C., Hofmann, D. A., & Sutcliffe, K. M. (2011). Organizational errors: Directions for future research. *Research in Organizational Behavior, 31*, 151–176. https://doi.org/10.1016/j.riob.2011.09.003

Goulet, M.-A., & Cousineau, D. (2019). The power of replicated measures to increase statistical power. *Advances in Methods and Practices in Psychological Science, 2*(3), 199–213. https://doi.org/10.1177/2515245919849434

Guzzo, R. A., Nalbantian, H. R., & Parra, L. F. (2014). A big data, say-do approach to climate and culture: A consulting perspective. In B. Schneider & K. M. Barbera (Eds.), *The Oxford handbook of organizational climate and culture* (pp. 197–211). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199860715.013.0011

Hacker, W. (1985). Activity: A fruitful concept in industrial psychology. In M. Frese & J. Sabini (Eds.), *Goal directed behavior: The concept of action in psychology* (pp. 262–284). Erlbaum.

Hacker, W. (2003). Action regulation theory: A practical tool for the design of modern work processes? *European Journal of Work and Organizational Psychology, 12*(2), 105–130. https://doi.org/10.1080/13594320344000075

Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology, 67*(3), 451–470. https://doi.org/10.1111/bmsp.12028

Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (3rd ed.). Guilford Press.

Heimbeck, D., Frese, M., Sonnentag, S., & Keith, N. (2003). Integrating errors into the training process: The function of error management instructions and the role of goal orientation. *Personnel Psychology, 56*(2), 333–361. https://doi.org/10.1111/j.1744-6570.2003.tb00153.x

Helmreich, R. L. (2000). On error management: Lessons from aviation. *British Medical Journal, 320*(7237), 781–785. https://doi.org/10.1136/bmj.320.7237.781

Hofmann, D. A., & Frese, M. (2011). Errors, error taxonomies, error prevention, and error management: Laying the groundwork for discussing errors in organizations. In D. A. Hofmann & M. Frese (Eds.), *Errors in organizations* (pp. 1–44). Taylor & Francis.

Hofmann, D. A., & Mark, B. A. (2006). An investigation of the relationship between safety climate and medication errors as well as other nurse and patient outcomes. *Personnel Psychology, 59*(4), 847–869. https://doi.org/10.1111/j.1744-6570.2006.00056.x

Hollenbeck, J. R., Williams, C. R., & Klein, H. J. (1989). An empirical examination of the antecedents of commitment to difficult goals. *Journal of Applied Psychology, 74*(1), 18–23. https://doi.org/10.1037/0021-9010.74.1.18

Homsma, G. J., van Dyck, C., De Gilder, D., Koopman, P. L., & Elfring, T. (2009). Learning from error: The influence of error incident characteristics. *Journal of Business Research, 62*(1), 115–122. https://doi.org/10.1016/j.jbusres.2007.12.003

Horvath, D., Klamar, A., Keith, N., & Frese, M. (2021). Are all errors created equal? Testing the effect of error characteristics on learning from errors in three countries. *European Journal of Work and Organizational Psychology, 30*(1), 110–124. https://doi.org/10.1080/1359432X.2020.1839420

Ivancic, K., & Hesketh, B. (1995/1996). Making the best of errors during training. *Training Research Journal, 1*, 103–125

James, L. R., Demaree, R. J., & Wolf, G. (1984). Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology, 69*(1), 85–98. https://doi.org/10.1037/0021-9010.69.1.85

James, L. R., Demaree, R. J., & Wolf, G. (1993). r_{wg}: An assessment of within-group interrater agreement. *Journal of Applied Psychology, 78*(2), 306–309. https://doi.org/10.1037/0021-9010.78.2.306

Keith, N., & Frese, M. (2005). Self-regulation in error management training: Emotion control and metacognition as mediators of performance effects. *Journal of Applied Psychology, 90*(4), 677–691. https://doi.org/10.1037/0021-9010.90.4.677

Keith, N., & Frese, M. (2008). Effectiveness of error management training: A meta-analysis. *Journal of Applied Psychology, 93*(1), 59–69. https://doi.org/10.1037/0021-9010.93.1.59

Keith, N., Horvath, D., & Klamar, A. (2020). The more severe the merrier: Severity of error consequences stimulates learning from error. *Journal of Occupational and Organizational Psychology, 93*(3), 712–737. https://doi.org/10.1111/joop.12312

Keith, N., & Frese, M. (2011). Enhancing firm performance and innovativeness through error management culture. In N. M. Ashkanasy, C. P. M. Wilderom, & M. F. Peterson (Eds.), *Handbook of organizational culture and climate* (2nd ed., pp. 137–157). Sage.

Klein, C., Salas, E., Burke, C. S., Goodwin, G. F., Halpin, S. M., Diazgranados, D., & Badum, A. (2006). Does team training enhance team processes, performance, and team member affective outcomes? *A Meta-Analysis. Academy of Management Proceedings, 2006*(1), 1–6. https://doi.org/10.5465/ambpp.2006.27162005

Kozlowski, S. W. J. (2012). Groups and teams in organizations: Studying the multilevel dynamics of emergence. In A. B. Hollingshead & M. S. Poole (Eds.), *Research methods for studying groups and teams: A guide to approaches, tools, and technologies* (pp. 260–284). Routledge.

Kozlowski, S. W. J., & Bell, B. S. (2013). Work groups and teams in organizations. In N. W. Schmitt, S. Highhouse, & I. B. Weiner (Eds.), *Handbook of psychology: Industrial and organizational psychology* (pp. 412–469). John Wiley & Sons Inc.

Kozlowski, S. W. J., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. *Psychological Science in the Public Interest, 7*(3), 77–124. https://doi.org/10.1111/2Fj.1529-1006.2006.00030.x
Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159–174. https://doi.org/10.2307/2529310
LeBreton, J. M., & Senter, J. L. (2008). Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods, 11*(4), 815–852. https://doi.org/10.1177/2F1094428106296642
Lei, Z., Naveh, E., & Novikov, Z. (2016). Errors in organizations: An integrative review via level of analysis, temporal dynamism, and priority lenses. *Journal of Management, 42*(5), 1315–1343. https://doi.org/10.1177/0149206316633745
Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., & Cannon-Bowers, J. A. (2000). The influence of shared mental models on team process and performance. *Journal of Applied Psychology, 85*(2), 273–283. https://doi.org/10.1037/0021-9010.85.2.273
Milgram, S., Bickman, L., & Berkowitz, L. (1969). Note on the drawing power of crowds of different size. *Journal of Personality and Social Psychology, 13*(2), 79–82. https://doi.org/10.1037/h0028070
Nolan, J., Schultz, P., Cialdini, R., Goldstein, N., & Griskevicius, V. (2008). Normative social influence is underdetected. *Personality and Social Psychology Bulletin, 34*(7), 913–923. https://doi.org/10.1177/2F0146167208316691
Parks, C. D., Sanna, L. J., & Berel, S. R. (2001). Actions of similar others as inducements to cooperate in social dilemmas. *Personality and Social Psychology Bulletin, 27*(3), 345–354. https://doi.org/10.1177/2F0146167201273008
Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*(4), 717–731. https://doi.org/10.3758/BF03206553
Reason, J. (1997). *Managing the risks of organizational accidents*. Ashgate.
Reason, J., Manstead, A., Stradling, S., Baxter, J., & Campbell, K. (1990). Errors and violations on the roads: A real distinction? *Ergonomics, 33*(10–11), 1315–1332. https://doi.org/10.1080/00140139008925335
Reichers, A. E., & Schneider, B. (1990). Climate and culture: An evolution of constructs. In B. Schneider (Ed.), *Organizational climate and culture* (pp. 5–39). Jossey-Bass.
Rybowiak, V., Garst, H., Frese, M., & Batinic, B. (1999). Error orientation questionnaire (EOQ): Reliability, validity, and different language equivalence. *Journal of Organizational Behavior, 20*(4), 527–547. https://doi.org/10.1002/(SICI)1099-1379(199907)20:4%3C527::AID-JOB886/3E3.0.CO;2-G
Salas, E., Fowlkes, J. E., Stout, R. J., Milanovich, D. M., & Prince, C. (1999). Does CRM training improve teamwork skills in the cockpit? *Two evaluation studies. Human Factors, 41*(2), 326–343. https://doi.org/10.1518/2F001872099779591169
Salas, E., Wilson, K. A., Burke, C. S., & Wightman, D. C. (2006). Does crew resource management training work? An update, an extension, and some critical needs. *Human Factors, 48*(2), 392–412. https://doi.org/10.1518/2F001872006777724444
Schippers, M. C., West, M. A., & Dawson, J. F. (2015). Team reflexivity and innovation: The moderating role of team context. *Journal of Management, 41*(3), 769–788. https://doi.org/10.1177/0149206312441210
Schneider, B., Ehrhart, M. G., & Macey, W. H. (2013). Organizational climate and culture. *Annual Review of Psychology, 64*, 361–388. https://doi.org/10.1146/annurev-psych-113011-143809
Schneider, B., & Barbera, K., M. (2014a). Introduction: The Oxford handbook of organizational climate. In B. Schneider & K. M. Barbera (Eds.), *The Oxford handbook of organizational climate* (pp. 3–20). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199860715.001.0001
Schneider, B., & Barbera, K., M. (2014b). Summary and conclusion. In B. Schneider & K. M. Barbera (Eds.), *The Oxford handbook of organizational climate* (pp. 679–688). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199860715.001.0001
Schultz, P. W. (1999). Changing behavior with normative feedback interventions: A field experiment on curbside recycling. *Basic and Applied Social Psychology, 21*(1), 25–36. https://doi.org/10.1207/s15324834basp2101_3
Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological Science, 18*(5), 429–433. https://doi.org/10.1177/1745691617693325
Sherif, M. (1935). A study of some social factors in perception. *Archives of Psychology, 27*(187), 1–60.
Sitkin, S. B. (1992). Learning through failure: The strategy of small losses. *Research in Organizational Behavior, 14*, 231–266.
Steele, L. M., Hardy, J. H., III., Day, E. A., Watts, L. L., & Mumford, M. D. (2021). Navigating creative paradoxes: Exploration and exploitation effort drive novelty and usefulness. *Psychology of Aesthetics, Creativity, and the Arts, 15*(1), 149–164. https://doi.org/10.1037/aca0000236
Stouten, J., Rousseau, D. M., & De Cremer, D. (2018). Successful organizational change: Integrating the management practice and scholarly literatures. *Academy of Management Annals, 12*(2), 752–788. https://doi.org/10.5465/annals.2016.0095
Tschan, F. (1995). Communication enhances small group performance if it conforms to task requirements: The concept of ideal communication cycles. *Basic and Applied Social Psychology, 17*(3), 371–393. https://doi.org/10.1207/s15324834basp1703_6
Tschan, F. (2002). Ideal cycles of communication (or cognitions) in triads, dyads, and individuals. *Small Group Research, 33*(6), 615–643. https://doi.org/10.1177/2F1046496402238618
van Dyck, C., Frese, M., Baer, M., & Sonnentag, S. (2005). Organizational error management culture and its impact on performance: A two-study replication. *Journal of Applied Psychology, 90*(6), 1228–1240. https://doi.org/10.1037/0021-9010.90.6.1228
West, S. G., Aiken, L. S., & Krull, J. L. (1996). Experimental personality designs: Analyzing categorical by continuous variable interactions. *Journal of Personality, 64*(1), 1–48. https://doi.org/10.1111/j.1467-6494.1996.tb00813.x
Wilhelm, H., Richter, A. W., & Semrau, T. (2019). Employee learning from failure: A team-as-resource perspective. *Organization Science, 30*(4), 694–714. https://doi.org/10.1287/orsc.2018.1255
Wujec, T. (2010, February). *Tom Wujec: Build a tower, build a team* [Video]. Ted Conferences. https://www.ted.com/talks/tom_wujec_build_a_tower_build_a_team/transcript?langlang=en
Zacher, H., & Frese, M. (2018). Action regulation theory: Foundations, current knowledge and future directions. In D. S. Ones, N. Anderson, C. Viswesvaran, & H. K. Sinangil (Eds.), *The sage handbook of industrial, work & organizational psychology* (2nd ed., Vol. 2, pp. 122–143). SAGE Publications Ltd.

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