The Perception of Error in Production Plants of a Chemical Organisation

Jürgen Seifried · Eva Höpfer

Abstract There is considerable current interest in error-friendly corporate culture, one particular research question being how and under what conditions errors are learnt from in the workplace. This paper starts from the assumption that errors are inevitable and considers key factors which affect learning from errors in high responsibility organisations, focusing specifically on production plants in a chemical company. An attempt is made to conceptualize potential links between individual, collective and organisational levels of analysis on the one hand, and factors relevant to an error management culture on the other hand. This is followed by an empirical validation of the factors proposed by means of interviews with ten safety representatives and executives from production plants in a chemical company. A problem-centred interview technique was chosen focussing questions on a realistic near-miss event. The content analysis identified two relevant factors for constructive error handling in chemical production plants: a) the perception of an error as a learning opportunity, and b) psychological safety within work groups. On the basis of these findings, strategies are discussed for fostering an error management culture which allows learning from errors and provides suggestions for the handling of errors.

Keywords Error management culture · Learning from Errors · Workplace learning · Learning organisation · Near-miss

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Introduction

Whether in a surgery, the cockpit of an airplane or in a chemical production plant, both the handling of errors and learning from them are of fundamental importance for organisations in which errors can have extensive and significant consequences. Such a "High Reliability Organisation" (HRO: La Porte 1996; Roberts 1990; Weick et al. 1999) demands a reflective, variable and context-specific handling of errors. Since the chemical spills in Seveso, Italy (1976) and Bhopal, India (1984), the chemical sector has been particularly focused on the subject of HROs (Reason 2000; Weick 1987). This line of research has been particularly influenced by theories of error learning, which is at variance with the conventional observation that continuous developments in technology are making humans increasingly redundant when it comes to the control of complex systems. While technical systems remove the human factor, thus theoretically reducing the probability of human error, questions arise as to what happens if and when technical error analysis tools reach their limits. What set of circumstances needs to be present for the successful management of errors in HROs if one wishes to go beyond excluding the human factor?

To gain a deeper understanding of the complex and multilayered learning processes in HROs, empirical research needs to be carried out on error culture[1] in the different levels of the field: the individual, collective and organisational level (Bauer 2008; Billett 2012; Schilling and Kluge 2009; for differentiation between organisational culture and organisational climate see Schneider et al. 2011a, b; for a brief overview of research approaches in this area see Yammarino and Dansereau 2011). In this paper we investigate error management culture at individual and collective (team) levels. The main aim is to identify factors which could foster individual and team learning from errors in an HRO. Analysing these factors can be benefcal for both error communication in organisations and for organisational learning processes (Barach and Small 2000; Harteis et al. 2008, 2007; Hetzner et al. 2011; Keith and Frese 2011; Reason 2000; Wuttke and Seifried 2012; Zhao and Olivera 2006). To this end, we collected statements from employees in the chemical industry by using a description of a near-miss situation (Bauer and Mulder 2007; Oser et al. 2012; Phimister et al. 2003 latent error: Ramanujam 2003; Ramanujam and Goodman 2003; Reason 1990) as a prompt. On the basis of interviews with ten experts in two production plants, we show that constructive handling of errors has to be considered as dependent on emotional, motivational, cognitive and social factors. In this examination two influencing factors seem to be particularly relevant in the area researched—the perception of an error as a learning opportunity, and psychological safety within working groups. In the next section, we will describe and specify the applied models of organisational culture and the influencing factors which affect learning from errors at the workplace. Based on these theoretical considerations, our findings and strategies that are likely to be relevant for future examinations will be laid out and discussed.

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[1] We follow the understanding of culture as "beliefs, ideologies, and values, and the ways these are transmitted through symbols, languages, narratives, and practices", Schneider et al. 2011a, p. 373, with a recourse on Trice and Beyer (1993), see also Alvesson (2011).

Learning from Errors in the Workplace—Analysis on Different Levels

Dealing with error learning processes is difficult both within and across disciplines (e.g. Pedagogy, Industrial Psychology, Organisational Psychology, Medical Science, Neurology or Engineering Sciences), as the term 'error' is used differently in many contexts. Reasons can be found in domain-specific views, as well as in linguistic barriers—particularly as a lot of relevant research is conducted in English-speaking countries. There, terms such as 'error', 'failure', 'fault', 'slip' or 'mistake' are not synonymous, but rather imply a difference in intent (Senders and Moray 1991). In addition to the well-known classification given by Reason (1990: slips and lapses are seen as execution failures, in contrast to mistakes as a result of inadequate planning), Keith and Frese (2011), for example, which differentiates errors and terms such as inefficiency (reaching the intended goal, but missing the standard of efficiency), failure (which refers to negative outcome, but not every error leads to failure) or deviation from norms or standards (intended deviation, whereas an error is a deviation that is not intended). Different research methods in psychology conceptualise errors as either: (1) planned actions that miss intended objectives (definition in industrial psychology research, e.g., Reason 1990), or (2) deviations from routines, usual procedures or actions (view of organisational psychology research, e.g., Van Dyck et al. 2005) (Putz et al. 2012a, b).

With regard to individuals, learning from errors can be seen as the individual engagement in reflection upon errors and the acquisition of knowledge which is linked to one's own or others' errors (Harteis et al. 2008). Experience-based reflection processes triggered by errors could lead to knowledge acquisition (Kolb 1984). With regard to learning from errors, the idea of "negative knowledge"—knowledge that helps to prevent the repeat of errors made in the past—was established (Gartmeier et al. 2008; Gartmeier and Schüttelkopf 2012; Minsky 1994; Oser and Spychiger 2005; Oser et al. 2012). Negative knowledge can be described as knowledge which is not directly useful, but heuristically valuable (e.g., knowing which way not to take, even if it is the shortest one). It incorporates both procedural (how something does not work; Minsky 1994) and declarative knowledge (what something is not and what one does not know; Parviainen and Eriksson 2006). The basic idea is that people recognise their 'shortcomings' when they make errors and, as a consequence, initiate a reflection process. Whether the potential connection with the acquisition of negative knowledge can actually develop and result in knowledge acquisition depends on whether deeper reasons for errors are analysed and reflected upon. From the perspective of organisational learning from errors, aspects such as fear of negative consequences, emotional coping, or the necessity of knowledge distribution are also addressed. In their survey, Putz et al. (2012a) consider four learning stages to be of importance: (1) Error detection, (2) error attribution and emotional coping, (3) error analysis and correction, and (4) dissemination of knowledge. To support error learning processes, an organisational culture which supports the interrelated reflection processes on an individual level and on an organisational level, is needed. Following are the two aspects to which our analysis refers:

(1) To determine the levels of analysis, the consideration of different levels from individual (micro) level to global (macro) level is relevant (Erez and

Gati 2004; Klein et al. 1994; Putz et al. 2012a; Yammarino and Dansereau 2011). In this paper two levels of an organisation are focused upon—the individual and the collective level. The individual level is the person with his or her cultural self-representation (e.g. values, principles). The collective or group level contains team values (e.g. a shared learning orientation, psychological safety within the working team, interpersonal trust, respect and support) (Bunderson and Sutcliffe 2003; Edmondson 2002; Schilling and Kluge 2009).

(2) The visibility of a culture can be assigned to two different theories of action: the *espoused theory* and the *theory-in-use* (Argyris and Schön 1978, 1996). To gain a deeper understanding of processes and structures of an organisation, internally represented and documented values, the norms and rules of individuals who act as agents of the organisation, need to be analysed. This level of espoused theory clarifies and explains the existing patterns of action within the organisation.

These patterns can be described by careful consideration of the theory-in-use, which in turn can lead to an understanding of implicit actions. If this understanding is achieved, organisational learning and cultural changes can be implemented. Overlaps or divergences in both theories of action offer a starting point for learning in organisations and can lead to single-loop or double-loop learning (Argyris and Schön 1978, 1996). In summary, culture can be defined as (group) patterns of behaviour and actions learnt during a specific time period to achieve external adaptation and resolve internal integration problems (Schein 2004). With regard to learning from errors, the error management culture of an organisation is distinguished by sharing error knowledge, helping in error situations, and quickly detecting and handling errors. As for the handling of errors, Putz et al. (Putz et al. 2012a, b) emphasise the relevance of supervisors' behaviour (e.g. support vs. sanctioning or constructive feedback vs. blaming), the structure of tasks and procedures (including the clarity of goals) and the organisational values. Van Dyck et al. (2005) suggest an error management culture which can lead to optimal company performance by decreasing negative error consequences (via control of these consequences) and simultaneously increasing positive error consequences (via learning, initiative, and innovation). The results of meta-analyses also demonstrated the effects of error management training on performance, especially for novel tasks. In this regard active exploration and error encouragement proved to be particularly effective elements (Keith and Frese 2008).

An in-depth analysis of determinants of learning from errors offers various perspectives on a learning error management culture, which is characterised by "open communication about errors, sharing error knowledge, helping in error situations, rapid error detection and damage control, and coordinated and effective error handling" (Keith and Frese 2011, p. 147; see also van Dyck et al. 2005). Research on organisational learning from errors shows that both an active approach and a positive attitude towards errors are necessary (Argote and Todorova 2007; Frese 1995; Rybowiak et al. 1999). In this paper, we propose a model based on Rybowiak et al. (1999) and Bauer (2008) which is grounded in the learning theories of experiential learning and negative knowledge (Argyris and Schön 1996; Ellström 2006; Kolb 1984;
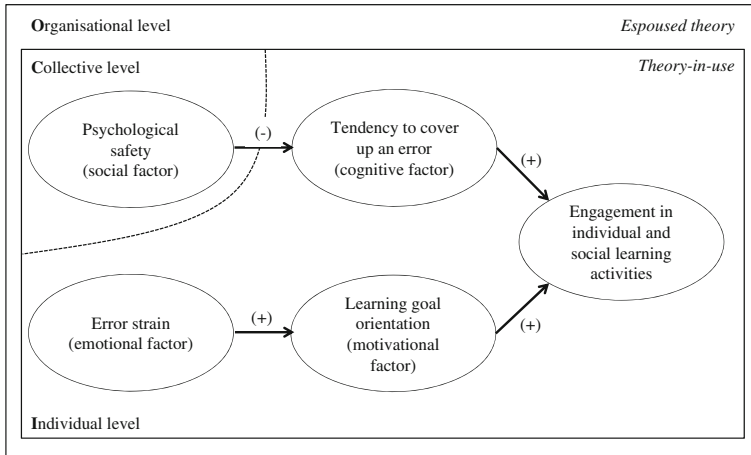
Fig. 1 Mediation model according to Bauer (2008) (modified)

Kolodner 1983). The *mediation model* by Bauer (2008, see also Bauer et al. 2012) lists four predicting factors which are likely to have an impact on the development of a learning error management culture in hospitals (Fig. 1):

- error strain from emotions such as anger, fear, guilt, shame or doubt (emotional factors);
- the conceptualization of an error as a learning opportunity and the underlying goal orientation through the outcome or learning goals (motivational factors);
- the tendency to cover up errors after an assessment of costs and benefits of error reporting (cognitive factors);
- psychological safety arising from mutual trust and respect (social factors).

The model establishes a positive relationship between the emotional strain created through errors and the amount an individual may learn from errors. However, psychological safety and the tendency to cover up errors are negatively related. In the model, learning from errors is operationalised as engagement in individual and social learning activities, which should be developed for each specific domain. The relevant determinants of learning from errors at the workplace are outlined in the following section.

(1) *Emotional Error Strain:* The literature on errors emphasises the assumption that errors are linked with stress and related to negative emotions (e.g. fear, anger, guilt, or shame) (Bauer 2008; Edmondson 1999; Keith and Frese 2005, 2011; Oser and Spychiger 2005; Rybowiak et al. 1999; Tangney et al. 1992; Zhao and Olivera 2006). However, assuming that negative emotions hinder learning from errors is not comprehensive enough and ignores supportive aspects. With regard to the moral implications of error learning, Oser and Spychiger (2005) distinguish between negative and positive "embarrassment" which is connected with negative and positive effects. Negative emotions such as mourning, shame or anger at oneself (Bauer 2008), which are more inwardly focused, increase with

the personal relevance of an error situation and foster reflection and insight after an error, which can support the construction of negative knowledge. In contrast, a more outward focused blaming approach involves the discovery of errors by third parties. This kind of shaming is likely to hinder negative knowledge as it can lead to exposure or reproach. Errors can be covered up due to humiliation or the violation of individual integrity. Rather than encouraging individuals to learn from errors, negative shaming contributes to repressive and defensive reactions to error on the part of employees. As a consequence, a blaming approach will presumably not have the same effect on learning from errors as self-initiated emotions (Bauer 2008; Keith and Frese 2011; Tjosvold et al. 2004; van Woerkom 2012). Overall, there is empirical evidence that emotions can support or prevent learning from errors.

(2) *Learning Goal Orientation:* Identification with the goals of an organisation plays a key role in error detection (Zhao and Olivera 2006). Generally speaking, goals can be divided into process and outcome goals, or learning goal orientation and outcome goal orientation (Kleinbeck 2004). Learning goal orientation involves an increase in one's own (modifiable) competencies and feedback (errors are informative; the focus is put on individual or factual reference standards). However, outcome goal orientation centres on the goal of demonstrating one's own performance in front of others and respectively also covering up one's own weaknesses. Individual abilities are here considered as largely stable, and feedback is only held in great esteem in the case of success (errors are threatening; the focus is set on social standards). VandeWalle et al. (2001) have shown that learning-goal-oriented people exhibit better performance than their outcome-goal-oriented counterparts. Thus, in order to learn from errors, the individual learning goal orientation appears to be relevant, as one can assume that plan- and action-orientation will be increased by a high learning goal orientation (Rybowiak et al. 1999).

(3) *Tendency to Cover up an Error:* When it comes to a high-error management culture and learning from errors in social contexts (and thereby on a collective level), the decision of individuals about covering up or reporting an error appears to be crucial (Van Dyck et al. 2005). After an error has occurred, individuals and organisations assess the specific error situation and start balancing the costs and benefits of error reporting (Billett 2008; Zhao and Olivera 2006). Possible *costs* of reporting errors can be material issues (e.g., bonus deduction for individuals or recalls for organisations) or damage to the company's image. Furthermore, additional effort costs (time, cognitive and physical effort) have to be taken into account. The ramifications of this can be investigated using root cause analysis. One possible *benefit* of error reporting for the individual is the extension of the self-concept (the sum of attributes, by which individuals characterise themselves, Pinder 1998). On the collective level, error reporting can save potential victims who run the risk of committing similar errors (Barach and Small 2000; Paget 1988). Individuals who have a strong tendency to cover up errors, consider errors as threatening and will mainly concentrate on possible costs of reporting an error instead of positive error consequences. Learning from others` errors and engagement in social learning activities become impossible.

(4) *Psychological Safety:* Edmondson (1999, p. 350) defines psychological safety
     as the result of "a shared belief held by members of a team that the team is safe
     for interpersonal risk taking". Against this background, psychological safety can
     be seen as a fundamental part of an error culture, and a supportive social context
     is widely considered to be a precondition for a learning orientation and active
     learning engagement (Cannon and Edmondson 2001; Edmondson 1996, 1999;
     Hetzner et al. 2011; Tjosvold et al. 2004; Tucker and Edmondson 2003). The
     approach of psychological safety is based on the confidence that, within groups,
     nobody will be embarrassed, rejected or punished as a result of reporting an
     error. Such confidence necessarily demands mutual trust and mutual respect.
     Following Robinson (1996, p. 576), trust can be seen as "the expectations,
     assumptions, or beliefs about the likelihood that another's future actions will be
     beneficial, favourable, or at least not detrimental to one's interests". A respectful
     co-operation makes a person feel recognised in his meaning and his value
     (Dillon 2007).

   Discussion of a safe team climate is based on a different academic tradition,
namely research on organisational climate. Schneider et al. (2011a) stress differences
in culture and climate research, but describe climate and culture as being mutually
dependent, (e.g., with regard to research interests and strategies). As such, a view on
results in this field may also be helpful. It can be shown that the attitude of executives
towards an organisation's safety climate significantly impacts a team climate (Mitchell
and Wood 1980; Putz et al. 2012a; Reason et al. 1998; Zohar 1980). Clearly, if
executives attach importance to both personal engagement and contribution regarding
a safety climate, this leads to a positive team and safety climate, e.g., through safety
actions, training and emphasis on safety issues. In particular, focused problem-
solving, as well as the support and advice of executives, seem to encourage psycho-
logical safety (Reason et al. 1998).
   Taken as a whole, learning from errors can be described as an integrated process of
cognitive, social, motivational and emotional aspects on different aggregation levels
(Fig. 1). In a best case scenario, espoused theory and theory-in-use on the different
aggregation levels were found to be consistent. However, often an espoused theory as
well as a theory-in-use exists on each level. The espoused theory of action comprises
organisational knowledge, which involves both components of an error culture, knowl-
edge of the local value of errors, and knowledge about norms and rules of error handling
within formal corporate documents of an organisation (Bauer et al. 2004; Schein 2004).
Collective, as well as individual learning from errors or the dominant theory-in-use
are influenced by the collaboration of emotional, motivational, cognitive and social
factors (Bauer 2008; Rybowiak et al. 1999). In the following, we concentrate on the
theory-in-use on an individual and on a collective level and the associated influencing
factors, while still examining the espoused theory on organisational levels.

Research Questions

In order to increase our understanding of factors which support learning from errors
in HROs, we examined the theory-in-use within two production plants of a global

chemical company. To this end, we used interview techniques to obtain detailed answers to two research questions that are central for investigating learning from errors in the chemical company that we studied:

(a) How far are the different facets of Bauer's model (emotional error strain, goal orientation, tendency to cover up errors, psychological safety) emphasised by representatives of the chemical industry?

(b) From the point of view of the representatives of the chemical industry—what are the crucial factors for error learning processes in the chemical industry?

Method

The research questions were investigated using semi-structured interviews (problem-centred interviews). To analyse the transcribed interviews we developed a coding book on the basis of our theoretical considerations. The study sample was selected based on a purposive sample of two "best practice" production plants of a global chemical company (Table 1).

Sample

The organisation is a German DAX 30 company (German share index), which has been operating in the market for over 100 years. Today it is operating in more than 80 countries. Its range of products stretches from plastics to agricultural chemicals and fine chemicals. The company is organised by a matrix management system. With regard to the espoused theory, the following remarks are of interest: During the past decade the corporate safety goal changed from an outcome-oriented goal of "zero accidents" towards a process goal "100 % safe behaviour", which concentrates on employee behaviour. This process goal encourages each employee to act in a safe way. As far as occupational safety in this organisation is concerned, worldwide efforts exist to implement regulations and requirements, which involve safety programs, safety checks by qualified safety experts, risk assessments, safety trainings and accident databases at an organisational level and at a production plant level. One aspect all these measures have in common is to prevent and to identify (potential) incidents and weaknesses within work processes, which can lead to an error management culture and organisational learning.

In Europe the implementation of the "Globally Harmonized System" (GHS) to classify and identify chemicals and the "Classification, Labelling and Packaging of substances and mixtures" (CLP Regulation) is strongly supported by the organisation. Furthermore, a global safety initiative was founded to put in place specific success factors (e.g. role model function of supervisors, active participation by employees in error handling, error reporting, safety seminars). The initiative's main goal is to foster an open error culture on an organisational level. Particularly high importance is attached to the reflection on errors and root causes. Alternatives for error handling are identified with the help of methods like peer group supervision or root-cause analysis. Moreover, statements in corporate-wide media are addressed to employees and can be regarded as highly normative (see Höpfer 2010). A study on safety culture

in the organisation, as well as the corporate values of the organisation, all indicate the relevance of error reporting and work to establish an open culture of communication. For example, one member of the board mentions in an interview that error culture particularly challenges executives.

Interview Sample

The first sample criterion was the restriction to production plants within the group of companies. The exclusion of laboratories, workshops and administrative units aimed at avoiding systematic bias in work processes, the organisational chart structure (e.g. characteristics of hierarchy) or in educational background of the employees. The first plant (which produces chemicals that are used to make detergents or care products) was chosen by its high number of employees attending a relevant internal safety training seminar (30 %). The second plant (production of alkyl groups that are used as reagents for several further chemical reactions) uses an internally developed process and team-oriented approach to work. In this approach team orientation is understood as the systematisation of learning and optimising processes based on the individual responsibility of each employee. Theoretically, a safe team environment should imply an increased involvement in error handling (Edmondson 1996, 1999; Rybowiak et al. 1999; Tjosvold et al. 2004; VandeWalle et al. 2001). Therefore, both production plants are characterised by high levels of involvement in learning from errors. The selection of the two plants, which are considered to be "best-practice" within the company by occupational health and safety practitioners, ensures the conceptualisation of the error topic's relevance by the interviewees, and also indicates increased reflection on action by the employees. Differences of the production plants can be identified in size and operation (Table 1). In this case continuous operation means that the production process proceeds without interruption and few product changes. Discontinuous processes are used to produce a set amount of different substances. Semi-continuous operations are mixtures of continuous and discontinuous processes. One can imagine that the error probability increases with increasing complexity and discontinuity of operations. Employees of both plants are working with hazardous substances, which require safety awareness. In both plants meetings of safety representatives, safety inspection tours in other production plants and risk assessment at a team level take place. This ensures a climate for reflective and preventive handling of errors. Neither plant voluntarily documents near-miss events in the corporate database.

The interview sample included ten interviewees (Table 2). All were male and evenly spread over both production plants. It can be assumed that the selection of solely male interviewees did not lead to a distortion in the results since the workforce concerned mainly consists of men. The respondents had, on average, been working in their respective plants for more than 15 years. Factory managers, who are familiar with their teams and who can estimate the expertise and experiences on occupational safety of their colleagues, supported the selection of the interviewees. Six of the interviewees operate as executives (EXE: factory managers, foremen, shift foremen), four are staff production workers (STAFF: safety representatives, shop steward). The assessment was conducted over a two-week period (January 2010). The

Table 1 Characteristics of the investigated production plants

Characteristics	Production plant A	Production plant B
Size	± 50 employees	± 100 employees
Operation	Completely discontinuous	Continuous, semi-continuous, discontinuous
Operation with hazardous substances	Yes	Yes
Number of safety representatives	5	16
Meetings of safety representatives	2–3 times yearly at division level	10 time yearly at subdivision level
Safety inspection tours in other production plants	At division level	Monthly
Risk assessment in the team	Yes	Yes
Entry of near-miss events into the corporate accident database (voluntary)	No	No

interviews took between 45 and 60 min and were carried out at the workplace of the interviewees.

Procedures

The interview analysis was based on the four factors described in the *mediation model* by Bauer (2008) and focused on rule- and knowledge-based errors, with the testing field being a near-miss event. In HROs, especially, near-misses are relevant due to their potential to result in loss, to give insight into possible accidents and to serve as learning opportunities. However, near-misses can also be covered up, because there are no easily identifiable serious consequences. The near-miss case

Table 2 Interviewees

Interview respondent	Production plant	Gender	Years of plant employment	Function
Respondent 1	A	Male	8	Foreman (EXE)
Respondent 2	A	Male	27	Foreman (EXE)
Respondent 3	A	Male	2	Factory manager (EXE)
Respondent 4	A	Male	17	Safety representative (STAFF)
Respondent 5	A	Male	20	Shop steward (STAFF)
Respondent 6	B	Male	12	Factory manager (EXE)
Respondent 7	B	Male	25	Safety representative (STAFF)
Respondent 8	B	Male	2	Factory/Process manager (EXE)
Respondent 9	B	Male	24	Shift foreman (EXE)
Respondent 10	B	Male	17	Safety representative (STAFF)

EXE executives, *STAFF* staff production worker

used in the interviews was created based on data from corporate accidents statistics and assessed as practical and realistic by internal industrial psychologists, safety representatives and production workers. In the organisation we studied most occupational accidents are physical injuries, mainly to the hand. These are most frequently caused by mechanical equipment in personal workspaces. The accident ratio of chemical accidents to mechanical accidents is about 1 to 14. During preliminary testing it became apparent that, for sensitive questions, a fictional third person should be invented for this case study and that the interviewees should be asked to adopt this fictional persona. This mimics a previous approach which was successfully applied in other studies in emotion research (Levorato and Donati 1999). The example near-miss case and central questions are shown in Table 3.

In this analysis, interviewees were kept anonymous and the interview was analysed using a structured content analysis (Mayring 2000) based on a theory-driven category system with four main categories (see Appendix I and Table 3). Firstly, initial codes and example statements were identified, improved and described in a coding book. Using the coding book, two trained coders (namely the two authors of this paper) rated the interviews independently. Altogether, about 273 statements were coded and analysed. Intercoder reliability was satisfactory (Cohen's Kappa=.73).

Table 3 Example case, categories, and interview questions

Near-miss event (short version): A young, inexperienced employee (YIE) gets advice from an experienced employee on how to use a kitchen knife instead of a safety knife to finish the delegated task within the available time. YIE heeds his counsel and starts working, but then slips and nearly injures his hand.

Main category	Subcategories	Interview questions
1 Emotional error strain	Fear, anger, shame, guilt, doubt, other	(a) In your opinion: How does the YIE feel after this experience?
2 Learning goal orientation	Abilities, feedback, reference standard, other	(b) In your opinion: How will the YIE act in future after this event?
3 Tendency to cover up errors	Learning benefit, stimulating of group or organisational learning, identification with potential victims, self-concept benefit, material costs, damage to personal image, effort costs, economic costs on collective level, reputation costs on collective level, other	(c) YIE could speak openly to somebody in his team about his situation. In your experience what benefit can the YIE gain from speaking openly?
		(d) In your opinion, why do employees sometimes decide to conceal such experiences?
4 Psychological safety	Trust, respect, other	(e) Assume the YIE decides to openly report his knife experience to a colleague. In your experience, how would his colleagues react?
		(f) Imagine you are the YIE's supervisor: What would you—as a supervisor—do to prevent such a case in future?

A safety knife has a retractable blade, which automatically retracts into the knife handle, in case the knife slips from the object being cut. In most production plants safety knives are compulsory and used to cut carton, plastics or straps. The handling of safety knives requires some training to get used to simultaneously pressing the security button and cutting

Empirical Findings

Altogether, N=273 statements of ten respondents were interpreted, while these statements are spread relatively evenly over the four main categories "emotional error strain" (71 statements), "learning goal orientation" (50 statements), "tendency to cover up errors" (77 statements) and "psychological safety" (75 statements) (Fig. 2). To examine whether these references foster or hinder learning from errors in the organisation that we studied, we will consider each main category and its values more closely (see Tables 4, 5, 6 and 7). The frequencies listed in the tables represent how often a reference of a subcategory was made and by how many study participants. It can be interpreted as an indicator of the degree to which the subcategories are perceived to be relevant by the respondents (Bauer and Mulder 2007).

Emotional Error Strain With regard to the feelings experienced after a near-miss, an overall "high" emotional strain is perceptible (52 of 71 indications, see Table 4). In regard to self and public image, high emotional strain mostly (41 of 52 indications; this information is not shown in Table 4) refers to the individual rather than third parties. For example, respondent 1 said that in such a situation, one is mad with oneself, but not with the person who offered the knife. When questioned about emotions, nine respondents (13 statements) stated doubt about themselves, the method of operation or the experienced worker. The most frequently mentioned emotion was fear (13 references by eight respondents). Anger was seldom mentioned, with guilt and shame being hardly mentioned at all. Six out of nine respondents stated fear as the answer to, "why are errors covered up" (see Table 6 for further information on the aspect "tendency to cover up errors"). This relates to our theoretical expectations that fear would lead to covering up of errors (Edmondson 1999; Rybowiak et al. 1999; Zhao and Olivera 2006). In addition, respondent 6 and respondent 10 described how anger stems from being conscious of how the near-miss could have
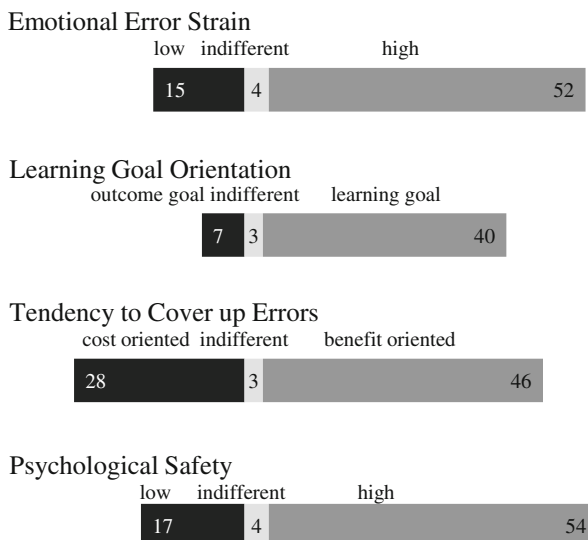

Emotional Error Strain
low   indifferent   high
15   4   52

Learning Goal Orientation
outcome goal indifferent   learning goal
7   3   40

Tendency to Cover up Errors
cost oriented indifferent   benefit oriented
28   3   46

Psychological Safety
low   indifferent   high
17   4   54

Fig. 2 Number of references per main category

Table 4 Emotional error strain—Example statements and frequencies for the subcategories

Value	Subcategory	Example statement	n/s
High (52)	Doubt	"He [the YIE] will doubt that what a so-called experienced colleague told him was rubbish" (R 6).	9/13
	Fear	"You get scared of being held responsible for something that you don't think is actually your fault and worry about the consequences, of course" (R 6).	8/13
	Anger	"He [the YIE] knows full well that if he hadn't taken the knife, nothing would have happened to him that will make him angry" (R 6).	4/7
	Guilt	"I should have questioned whether the advice he gave me was really right" (R 1).	2/3
	Shame	"Shame, I guess, that it was just me that it happened to" (R 9).	1/1
	Other	"If he [the YIE] is quite young and shy, he will probably feel clumsy and unqualified" (R 7).	6/15
Low (15)	Doubt	"Doubt: No, I don't think so, because the experienced employee explained or showed it to him [the YIE] and gave him the knife" (R 5).	1/1
	Fear	"I would think that since I'm a newcomer I would probably have had some inhibitions to opposing it" (R 1).	1/1
	Anger	"The experienced employee meant well for the YIE, didn't he? So really, the YIE is not angry with him" (R 4).	3/4
	Guilt	"I don't think that he [the YIE] will blame the experienced employee now" (R 1).	1/1
	Shame	–	0/0
	Other	"He [the YIE] thinks that he didn't make a mistake. He feels safe, I'd say" (R 5).	6/8
Indifferent (4)	Other	"That depends on the relation between the two. It also depends on how the experienced employee explained it to him [the YIE]" (R 6).	3/4

n number of answering interviewees, *s* number of statements, *R* respondent

been avoided—by using the knife that was originally supplied. These statements can be linked to the concept of anger by Oser and Spychiger (2005) who hold the view that anger is the immediate reaction to a behaviour that does not fit one's own standard.

Learning Goal Orientation The data indicates that learning goal orientation seems to be quite distinctive in both of the plants examined here (40 out of 50 statements indicates a learning goal orientation, seven statements an outcome goal orientation, and three statements are coded as "indifferent", see Table 5). Evidence for a high level of learning goal orientation could be that almost all respondents refer to the feedback due to an error as a process promoting learning (nine respondents, 22 statements). Feedback from an error can be represented by the consequences of the accident itself, as well as one's own and others' experiences, explanations and information. Furthermore, six interviewees (nine statements) consider the abilities and skills of the employees as modifiable, whereas three respondents (four statements) assume

Table 5 Goal orientation—Example statements and frequencies for the subcategories

Value	Subcategory	Example statement	n/s
Learning goal orientation (40)	Feedback promotes learning	"In this case it is important to examine whether the work can theoretically be done with the electronic knife in the time permitted. If that is not the case, it should be communicated that everybody can learn something from this case and that something should change" (R 3).	9/22
	Abilities and skills are modifiable	"If he [the YIE] learns from the mistake and if he takes heed not to do it again, the case is settled" (R 6).	6/9
	Factual/individual reference standard	"The essential thing, so that he [the YIE] learns something out of that near-miss, is not to denounce him" (R 6).	4/7
	Other	"Nobody will say, 'Yes, from now on we only use these knives,' That is a learning process" (R 6).	2/2
Outcome goal orientation (7)	Feedback is only valued in case of success	–	0/0
	Abilities and skills are stable	"Don't think so much about it. It's not necessary to be aware of the whole issue [error]" (R 7).	3/4
	Social reference standard	"I would say nothing, he [the YIE] could think 'that was a near-miss'. Maybe the older colleagues would say something like 'You idiot!'" (R 10).	2/3
	Other	–	0/0
Indifferent (3)	Other	"Depends on the character, how strong the person is" (R 1).	2/3

n number of answering interviewees, *s* number of statements, *R* respondent

stability. To give an example of a modifiable skill, Respondent 3 commented that: "Since he [the YIE] knows what went wrong and that it could have turned out worse, he will think long and hard about not working according to operating instructions in the future". Factors hindering learning processes were also mentioned, e.g. lack of time, complex methods of operation and complicated formulation of regulations. Moreover, insufficient awareness of having made a mistake was regarded as an obstacle to learning processes.

As far as reference standards are concerned (standards against which the interviewees pit their own performance), four interviewees (seven statements) referred to individual or factual reference standards (e.g. operating instructions, risk analyses or the appeal to one's own behaviour). However, individuals who were concerned with social reference standards expressed strong self-doubt in this context. Since these doubts are associated with social context, the probability of shame and fear arising increases, which in turn has a negative effect on learning. The reference standard, and therefore the quality of feedback on error reports, seem to be crucial for learning from errors in this context.

Tendency to Cover up Errors When it comes to the empirical findings of the assessment of benefits and costs of error reporting, it is striking that, despite high benefit orientation, indications of cost orientation were frequently found in both plants. Most (namely 46 out of 77) statements indicate "benefit orientation", whereas at least 28 statements emphasised a "cost orientation" (Table 6). The benefit of error reporting was stressed by nine out of ten study participants who categorised the learning benefits of each individual level (14 statements) as well as each collective level (16 statements) as "high" by reporting that near-miss. With regard to the costs of error reporting, aspects such as materials, effort, or economic costs were occasionally mentioned. The main aspect seemed to be the fear of image problems in the work team. Seven out of ten interviewees (eight statements) mentioned damage to one's personal image in front of colleagues or executives as a reason for covering up errors. Respondent 9 explained for instance: "He [the YIE] doesn't want a bad image. He will behave as inconspicuously and positively as possible". These results confirm findings from earlier studies which indicated that individuals often fear that errors can lead to a loss of reputation within a working group, as well as consequences for career progression or interpersonal relations (Barach and Small 2000; Edmondson 1999). In addition, the self-confidence of each individual and the work climate are mentioned here as preconditions for error reporting. A negative correlation between self-confidence and the tendency to cover up errors has already been shown by Rybowiak et al. (1999), confirming what we observed. Work climate and reactions to errors were also mentioned in regard to readiness to report errors. This sustains the hypothesis that highly psychologically safe working environments foster error reporting (Edmondson 1999).

Psychological Safety Assuming every group member worked with the 'wrong' knife, negative reactions of colleagues towards the error being reported would be expected. But without this assumption, almost all interviewees believed that acceptance within the work team could be expected when reporting an error. Accordingly, 54 out of 75 statements indicated "high" psychological safety, whereas 17 statements could be seen as an indicator of a low level (Table 7). All interviewees (29 statements) mentioned trust. Honesty, as well as the focus on factual or individual (anonymous at best) reference standards, were considered fundamental. In association with a safe work climate, three aspects seemed to be crucial to the interviewees: Firstly, the support of colleagues and executives in problematic situations; secondly, the discussion of potential measures through an intact information flow; and thirdly, the reaction to errors by operating managers.

Interim Summary Upon close consideration of the statements from the interviewees, it can be concluded that individual negative knowledge and experiences can be used to detect errors independently and to generate additional negative knowledge. The attention paid and the sensitivity to errors and the motivation to perceive an error as a learning opportunity needs to exist on an individual level. This is most distinct when negative knowledge already exists, and when constructive criticism leads to an individual learning orientation. However, if destructive criticism is used, it leads to a tendency towards a negative cost-benefit-ratio and hence to the covering up of errors, whereby the motivation to learn from an error decreases. This motivation-

Table 6 Tendency to cover up errors—Example statements and frequencies for the subcategories

Value	Subcategory	Example statement	n/s
Benefit oriented (46)	Organisational and collective learning	"If there is anything to improve, such as the knife issue, and it is discussed and realised that it works better than before, you have to adjust the operating instructions accordingly" (R 2).	9/16
	Individual learning	"In a team he [the YIE] will learn more than alone" (R 8).	9/14
	Identification with victims	"What happened to the YIE, I would say, can happen to anybody else. Therefore, one should address the case immediately" (R 7).	3/8
	Self-concept	"And thereby the opportunity to learn something about oneself by discussing with others is provided" (R 8).	1/1
	Other	"A benefit could be that he bonds with some colleagues, who agree with him and who can help him out with the discussion. They are equivalently experienced staff who can tell the experienced worker that actually the YIE, even though he is only new, is right" (R 1).	3/7
Cost oriented (28)	Damage to personal image	"It is certainly conceivable that he [the YIE] will be regarded as blundering or clumsy by his colleagues" (R 8).	7/8
	Effort costs	"A process [e.g. root cause analysis] is initiated, which is related to effort" (R 6).	2/4
	Material costs	"You have to expect unpleasant questions. Cases like this may have an effect on staff appraisal through safety reduction" (R 8).	2/2
	Economic costs on collective level	"Measures which can arise out of such a situation may complicate the everyday work of the employees such as forcing them to wear more personal protective equipment for example. You have to keep your own limits in mind and try to avoid unreasonable disadvantages for the team" (R 8).	2/2
	Reputation costs on collective level	"If I joined such a team, as a young colleague, and I made the whole thing so public so that you had to discuss it with the whole team, I can imagine that one or two would become annoyed. They would say, 'Just because of that little scratch, he makes a big deal out of it instead of taking me aside first' for example" (R 1).	1/1
	Other	"They keep it to themselves because they expect difficulties if they reported something like that" (R 6).	5/11
Indifferent (3)	Other	"Of course you weigh problems against benefits in such a situation. Thus, if he expects negative consequences he will avoid the problem. If he expects a positive reaction, the problem will be reviewed" (R 8).	3/3

n number of answering interviewees, *s* number of statements, *R* respondent

Table 7 Psychological safety—Example statements and frequencies for the subcategories

Value	Subcategory	Example statement	n/s
High (54)	Distinct trust	"If you work in a team with a foundation of trust […] you can address such things as happened to the YIE without any personal consequences" (R 4).	10/29
	Respect for counterpart	"In this way he [the YIE] can show his colleagues that he appreciates them and he will probably get this appreciation back in return" (R 8).	8/12
	Other	"But in general, you achieve more with the team. That's what I think. Before, I didn't think that much about it, but since all of the training I have started to" (R 10).	7/13
Low (17)	Lack of trust	"The YIE won't trust people that much. He will pay more attention to what is written in the operating manual" (R 5).	5/8
	Little respect for counterpart	"'You idiot, how did you do that?' This is how it is with people, there are inconsiderate ones. 'Are you too stupid to handle a knife?'" (R 10).	5/7
	Other	"If your executive belittles you, because of such a case, you keep such errors to yourself" (R 7).	2/2
Indifferent (4)	Other	"In our history of different operating managers, you can see a significant influence in the culture within the plant. How they handled information, depended on whether they were receptive or reserved" (R 8).	3/4

n number of answering interviewees, *s* number of statements, *R* respondent

oriented influencing factor of learning from errors can be summarised as intrinsic individually triggered learning motivation. Furthermore, the findings show that values such as respect, trust and integrity are seen as preconditions for the discussion of errors. This means that, psychological safety needs to be built into corporate values and objectives in order to foster a safe team climate and transparency and to support decentralised actions. As a result, the values of the team and the reaction of experienced executives and colleagues could influence the espoused theory as well as the theory-in-use. For this reason, a one-sided construction of negative knowledge on an individual level is not enough to produce optimal conditions for learning from errors within an error management culture. Collective support within the working team needs to be generated in order to create a safe team climate and foster error communication.

Discussion

The goal of our investigation was to be able to describe how a near-miss in "best practice" production plants of the chemical industry are handled, and to find empirical evidence for the values of the influencing factors by using

interview techniques. It can be shown that the four factors in the mediation model suggested by Bauer (2008) are indeed important for the constructive handling of errors by the respondents. Similar to findings of previous studies, we showed that interpreting an error is an opportunity to learn and that the perception of social context as safe is crucial for learning from errors (Cannon and Edmondson 2001; Edmondson 1996, 1999; Van Woerkom et al. 2002; Tjosvold et al. 2004). Furthermore, our results correspond with the theory of emotional strain. However, the separation of negative emotions which are initiated by oneself (doubt, guilt) and initiated by others (fear, shame), which could arise after an error, receives more attention in our examination compared with previous studies (Dewey 1938; Edmondson 1996; Rybowiak et al. 1999; Oser and Spychiger 2005; Zhao and Olivera 2006). Self-confidence and the past experiences of a person with error reporting have an impact on the emotions which result from an error. Depending on his or her emotional reactions, an employee either recognises an error as a chance to learn (as a reaction to high self-initiated emotional strain) or covers it up (as a reaction to high emotional strain exhibited by others). The individual perception of errors as offering learning opportunities is a reference to *individually triggered learning motivation*, which is found to lead to error reporting. Simultaneously, the social context in which each employee finds himself has to be considered (*collective support within work teams* in the model). If such an effect does not exist, negative knowledge stagnates on the individual level and cannot be passed to the collective level by error reporting. If only collective support exists, this can result in the team perpetuating behaviours without reflecting on them and learning from errors.

As far as individual triggers are concerned, approaches for successful error management training already exist. They are distinguished by emotional management and metacognition: awareness of negative knowledge (Kanfer et al. 1996; Keith and Frese 2005). When it comes to the influence of negative and positive shaming and the prevention of rigid thinking, these methods can provide a starting point for individual self-regulated activities. Reflection on these approaches appears to be important for future applications and an efficient error management system. In summary, we conclude that the reporting of errors on a collective level contributes to learning from errors as long as the following conditions exist: (1) individually triggered learning motivation, self-initiated emotional strain and negative knowledge, and (2) collective support within working teams including positive expectations of reactions of team colleagues. However, if both factors are negative, other-initiated emotional strain exists, negative knowledge is low and error experiences are covered up, this then inhibits learning on a collective level. Figure 3 shows both factors within a four-grid matrix.

Although our findings are consistent with numerous results from previous research, they also introduce several new factors that have rarely been taken into account in previous studies. In this context, values upon which psychological safety are based prove to be a crucial foundation for learning from errors. To date, these values have rarely been considered, except in the context of errors (Whiteley et al. 1998). The roles of organisations and of authority figures such as executives seem to be the absolute deciding factors regarding both the definition of values and norms and their implementation and integration into
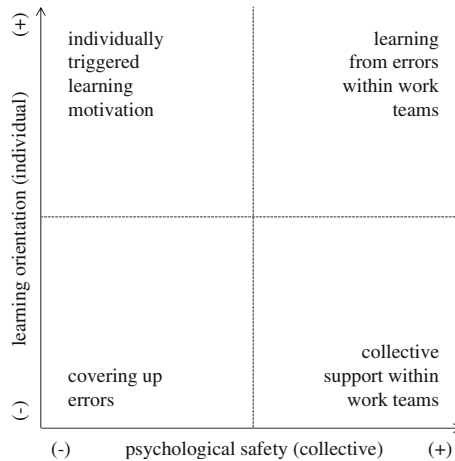
Fig. 3 Interaction of individual learning goal orientation and psychological safety within working teams

theory-in-use. With regard to the initial model of Bauer (2008), both consistencies and a deeper understanding regarding the chosen categories can be attained. A relationship between certain self-initiated negative emotions (e.g., guilt) and the estimation of errors as learning opportunities can be identified, while the tendency to cover up errors clearly depends on the existence of a safe team climate. However, these cannot be regarded merely in a linear relation to each other. Instead, they need to be seen within an integrated dynamic approach that describes further influencing factors and interdependencies, such as the division into negative and positive shaming, the influences of experiences on a collective level and personal factors (e.g. self-confidence). Furthermore, the distinction between motivational and cognitive factors proved to be insufficiently differentiated in our examination. The learning aspect is found within goal orientation and benefits of error reporting, which is why both factors are not distinguished separately. It is therefore likely that some of the interviewees perceived learning effects following an error as both a motivational factor and a benefit.

The limitations to the foregoing study are obvious. In view of the small sample size and the interview technique used, light was shed on only a fraction of the field of interest. In principle, interview techniques are advantageous if the underlying theories are overly complicated, insufficiently developed, or too narrowly interpreted to be quantified with survey methods (Lee et al. 2011). This is not the case with the mediation model by Bauer, which is well established in the domain of nursing. In our case, the advantage of the chosen research strategy can be seen primarily in that it overcame the barriers of study participation and the effect of social desirability bias with regard to this delicate topic. In particular, the use of the near-miss event as a prompt was useful for data collection, as well as for a deeper interpretation and understanding of the reflection and error learning processes. In our study, access to the field was not easy. We were not able to use a hybrid approach, in which we would have combined the interview sample with information gained by the use of a standardised questionnaire, due to limitations imposed by the workers'

council (but currently, an extensive project will be discussed with the chemical company to gain deeper insight into the circumstances and conditions surrounding error learning processes in the chemical industry). As such, details about the relationship between the crucial factors on error learning in our field of interest remain unclear.

There are numerous questions which can be answered with further research. To test the quality of the relations we developed and the category system we implemented, the extension to a broader empirical basis would prove useful. In this case, examination of cognitive decisions concerning the consequences of an error would be interesting. It is likely that cognitive decisions will depend on different error consequences, therefore a cost-benefit analysis of different kinds of errors—for example knowledge-based errors or latent errors with varying consequences should be carried out (Reason et al. 1998). Moreover, a alternative view on the relationship between more cognitive and emotional-motivational factors in general (Keith and Frese 2011) should be studied. Other topics to consider are individually triggered learning goal orientation, tendency to cover up errors, error strain and psychological safety. Furthermore, a deeper investigation into the theory-in-use should be considered for future studies, through the study of the actions of individuals combined with semi-structured interviews. One additional aspect which could be considered is the extension of the sample to the management level. This would present an interesting field to investigate with regard to the importance of the executives' reactions to the errors identified in the present study. Finally, it is still unclear what types of errors are beneficial for error learning—e.g., knowledge and rule-based errors or latent errors—along with their likely consequences and results of cognitive decisions (Reason 1990; Weingardt 2004, pp. 178f.; see Keith and Frese 2011, for further open questions).

Appendix I

Table 8 Category System and coding rules

I. Category System and coding rules

1. Individual level

#	main category	subcategory	value	definition	example statement	coding rule
1	**emotional error strain** Bauer (2008) Dewey (1938) Rybowiak et al. (1999) Zhao & Olivera (2006)		high	High subjective uncertainty through fear, embarrassment, guilt, anger or shame. - Doubt arises (self-confidence and performance decrease).	That's an uncomfortable, uneasy feeling.	The majority of subcategory statements indicate "high" emotional error strain. Otherwise code as "low emotional error strain".
			low	Low subjective uncertainty through fear, embarrassment, guilt, anger or shame. - No doubt noticeable.	He thinks that he didn't make a mistake. He feels safe, I would say.	The majority of subcategory statements indicate "low" emotional error strain. Otherwise code as "high emotional error strain".
1.1		fear Zhao & Olivera (2006) Oser & Spychiger (2005)	high	Caused by hurdles which allow an undesired product to possibly emerge.	You get scared of being held responsible for something that you don't think is actually your fault and worry about the consequences, of course	The statements indicate predominantly a "high" emotional condition of fear.
			low		I think since I'm a newcomer I probably have some inhibitions to opposing it.	The statements indicate predominantly a "low" emotional condition of fear.
1.2		anger Oser und Spychiger (2005)	high	Anger is defined as subjective responsiveness for the (always imperfect) appropriateness of behaviour or produced knowledge.	He [the YIE] knows full well that if he hadn't taken the knife nothing would have happened to him and that will make him angry.	The statements indicate predominantly a "high" emotional condition of anger.
			low		He [the experienced employee] meant well for the YIE, didn't he? So really, he [the YIE] is not angry with him.	The statements indicate predominantly a "low" emotional condition of anger.
1.3		shame Levorato & Donati (1999) Oser & Spychiger (2005)	high	Caused by discrepancy between the desired and experienced self-image.	Shame, I guess, that it was just me that it happened to.	The statements indicate predominantly a "high" emotional condition of guilt.
			low		-	The statements indicate predominantly a "low" emotional condition of shame.
1.4		guilt Tangney et al. (1992) Oser & Spychiger (2005)	high	Caused by the assessment of someone's own behaviour as an error and the focus on one's own causes which set up the error.	I should have questioned whether the advice he gave me was really right.	The statements indicate predominantly a "high" emotional condition of guilt.
			low		I don't think that he [the YIE] will blame the experienced employee now.	The statements indicate predominantly a "low" emotional condition of guilt.
1.5		doubt Dewey (1938), Argyris & Schön (1996)	high	Caused by the experience of a problematic situation, which is set up through a difference between the expected results and the results actually achieved.	He will doubt that what a so-called experienced colleague told him was rubbish.	The statements indicate predominantly a "high" emotional condition of doubt.
			low		Doubt: No, I don't think so, because the experienced employee explained or showed it to him [the YIE] and gave him the knife.	The statements indicate predominantly a "low" emotional condition of doubt.
1.6		other	high		-	
			low			

2	goal orien-tation Kleinbeck (2004) Frese et al. (1987)		learning goal oriented	High subjective estimation of an error as a learning opportunity to increase competency.	In this case it is important to examine whether the work can theoretically be done with the electronic knife within the time permitted. If that is not the case it should be communicated that everybody can learn something from this case and that something changes.	The majority of subcategory statements indicate learning goal orientation. Otherwise code as "outcome goal orientation".
			outcome goal oriented	High subjective estimation of an error as an opportunity to demonstrate one's own performance to others and to hide weaknesses.	I would say that [reflection] lasts about 5-6 minutes and then he continues to work.	The majority of subcategory statements indicate outcome goal orientation. Otherwise code as "learning goal orientation".
2.1		abilities and skills	learning goal oriented	Abilities are considered as modifiable in a positive way.	If he [the YIE] learns from the mistake and if he takes heed not to do it again, the case is settled.	The statements indicate predominantly characteristics of the definition.
			outcome goal oriented	Abilities are considered as stable.	Not with all that fuss. Not being aware of the whole issue [error].	The statements indicate predominantly characteristics of the definition.
2.2		feedback	learning goal oriented	Feedback is considered to be information relevant to learning. In particular, errors are seen as a significant support of the learning processes.	You can only learn from errors if you have made an error and can talk about it.	The statements indicate predominantly characteristics of the definition.
			outcome goal oriented	Feedback is only valued in case of success. Errors are seen as threatening.	-	The statements indicate predominantly characteristics of the definition.
2.3		reference standard	learning goal oriented	Orientation on individual or factual reference standards. Assessment of learning outcomes by own success or error.	The essential thing, so that he [the YIE] learns something out of that near-miss, is not to denounce him.	The statements indicate predominantly characteristics of the definition.
			outcome goal oriented	Orientation on social reference standards. Assessment of learning outcomes by success or errors of other persons.	Um, I would say nothing. He [the YIE] could think 'that was a near-miss'. Maybe the older colleagues would say something like 'You idiot!'	The statements indicate predominantly characteristics of the definition.
2.4		other	learning goal oriented			
			outcome goal oriented			

2. Collective level

#	main category	subcategory	value	definition	example statement	coding rule
3	**tendency to cover up errors** Barach & Small (2000) Zhao & Olivera (2006)		high / benefit oriented	High subjective motivation to report an error.	A benefit could be that he bonds with some colleagues, who agree with him and who can help him out with the discussion since they are equivalently experienced staff who can tell the experienced worker that actually the YIE, even though he is only new, is right.	The majority of subcategory statements indicate "high" error reporting (subcategories 3.1-3.4). Otherwise code as "low error reporting".
			low / cost oriented	Low subjective motivation to report an error.	They keep it to themselves because they expect trouble if they report something like that.	The majority of subcategory statements indicate "low" error reporting (subcategories 3.5-3.9). Otherwise code as "high error reporting".
3.1	extension of the personal self-concept Pinder (1998)		high / benefit oriented	An advantage is seen in experiencing more about the own individual's attributes.	Although reporting helps to me recognise why I acted in that way, and thereby provides me with the opportunity to learn something about myself by discussing with others, it depends on the degree of self-reflection of the employee. Thus, the possibility of optimising and refining one's own behaviour does exist.	The statements indicate predominantly characteristics of the definition.
3.2	learning benefit Rybowiak et al. (1999)		high / benefit oriented	An advantage is seen in initiating individual learning processes by error reporting.	In a team he [the YIE] will learn more than if he is alone.	The statements indicate predominantly characteristics of the definition.
3.3	stimulation of group or organisational learning Edmondson (1999)		high / benefit oriented	An advantage is seen in initiating group or organisational learning by error reporting.	If there is anything to improve, such as the knife issue, and it is discussed, and it is realised that it works better than before, you have to adjust the operating instructions accordingly.	The statements indicate predominantly characteristics of the definition.
3.4	identification with potential victims Paget (1988)		high / benefit oriented	An advantage is seen in avoiding potential victims by error reporting.	What happened to the YIE, I would say, can happen to anybody else. Therefore one should address the case immediately.	The statements indicate predominantly characteristics of the definition.
3.5	material costs		low / cost oriented	Reprisals as financial costs, suspension or loss of job.	You have to expect unpleasant questions. Cases like this may have an effect on staff appraisal through safety reduction.	The statements indicate predominantly characteristics of the definition.
3.6	damage of personal image Edmondson (1999)		low / cost oriented	Harm to the individual's perception about his own competence and professionalism.	It is certainly conceivable that he [the YIE] will be regarded as blundering or clumsy by his colleagues.	The statements indicate predominantly characteristics of the definition.
3.7	additional effort		low / cost oriented	Time exposure, cognitive and physical effort.	A process [e.g. root cause analysis] is initiated, which is related to effort.	The statements indicate predominantly characteristics of the definition.
3.8	economic costs		low / cost oriented	Disadvantages, which occur to the collective or organisation by error reporting.	Measures which can arise out of such a situation may complicate the everyday work of the employees by forcing them to wear more personal protective equipment, for example. You have to act by meter and try to avoid unreasonable disadvantages for the team.	The statements indicate predominantly characteristics of the definition.

3.9	damage of the group image	low / cost oriented	Harm of the professionalism or abilities of a collective.	If I joined such a team, as a young colleague, and I made the whole thing so public so that you have to discuss it with the whole team, I can imagine that one or two would become aggravated. They would say, 'Just because of that little scratch he speaks up and addresses it in public instead of taking me aside first' for example.	The statements indicate predominantly characteristics of the definition.
3.10	other	benefit oriented			
		cost oriented			
4	**psychological safety** Edmondson (1999)	high	The majority of the team members share the opinion that the team is safe from interpersonal risks.	The relationship with colleagues and with executives is the essential thing.	The majority of subcategory statements indicate "high". Otherwise code as "low psychological safety".
		low	The majority of the team members share the opinion that the team is not safe from interpersonal risks.	It depends on the work climate in the corresponding production site. If you have a bad work climate none of the staff will tell you anything.	The majority of subcategory statements indicate "low". Otherwise code as "high psychological safety".
4.1	trust Bauer (2008); Robinson (1996)	high	Expectations, assumptions or opinions about the tendency, that future actions of another person are useful or at least not harmful for own interests.	If you work in a team with a foundation of trust […] you can address such things as happened to The YIE without creating any personal consequences.	The statements indicate predominantly "high" respect.
		low		The YIE won't trust people that much. He will pay more attention to what is written in the operating manual.	The statements indicate predominantly "low" trust.
4.2	respect Edmondson (1999); Dillon (2007)	high	Attitude towards a person, that makes an individual realise a reason, which justifies paying attention to this person. Action takes part in such a way that via resonance the person receives the feeling that he is recognised in his or her importance and value.	In this way he [the YIE] can show his colleagues that he appreciates them and he will probably get this appreciation back in turn.	The statements indicate predominantly "high" respect.
		low		'You idiot, how did you do that?' This is how it is with people, there are mischievous ones. 'Are you too stupid to handle a knife?'	The statements indicate predominantly "low" respect.
4.3	other	high			
		low			

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