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Positive error orientation as a promoter of the learning process in organizations

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INTRODUCTION

Since the papers of Edmondson (1996) and of Rybowiak, Garst, Frese and Batinic (1999), investigations about learning from errors have gained impetus and been directed toward a deeper understanding of the nature encompassing the phenomenon in its diverse dimensions. Studies can be found that explore the individual dimension of learning from errors (e.g. Zhao & Olivera, 2006), in terms of teams (e.g. Tjosvold, Yu, & Hui, 2004) and organizational (e.g. van Dyck, Frese, Baer, & Sonnentag, 2005), as well as those in which the integration of these dimensions of analysis was sought (e.g. Dahlin, Chuang, & Roulet, 2018).

In a more specific manner, relating to individual learning from errors, its occurrence has been explored across different contexts, while covering diverse occupational groups, such as service employees of airline companies (Lee, Hyun, Park, & Kim, 2020), insurance agents (Anselmann & Mulder, 2017), frontline staff members of hotels (Daskin, 2019), as well as young employees from commercial, design and information technology areas of a company manufacturer of sportswear (Rausch, Seifried & Harteis, 2017).

In these studies, the phenomenon has been analyzed through the relationship with several antecedent factors, which act as facilitators or barriers to learning. On the one hand, one notes the focus on contextual factors, as in leadership styles and behavior (Yan, Bligh, & Kohles 2014; Ye & Li, 2019) psychological safety (Lee, Hyun, Park, & Kim, 2020), organizational climate for learning from errors (Grohnert, Meuwissen, & Gijselaers, 2019). On the other, attention is directed toward individual factors as antecedent, such as an emotional reaction to error (Zhao, Seifried, & Sieweke, 2018), work motivation (Zhou, Mao, & Tang, 2020). Moreover, there are those researchers that have investigated the influence of error attributes – as in who committed the error and its severity – in learning from errors (Homsma, van Dyck, De Gilder, Koopman, & Elfring, 2009; Horvath, Klamar, Keith, & Frese, 2021).

However, empirical studies have not covered the theme through an integrative perspective of the process of learning from errors, in which it is analyzed as a result of a process made up of detection and correction stages of the error and which are influenced by individual characteristics and resources, as well as the work context. In the literature, one even notes the lack of measuring scales across the detection of errors on their individual levels, even though this represents the first crucial step toward initiating the process of learning from errors (Frese & Keith, 2015). In addition, these previous empirical studies, which contain individual learning from errors as a unit of analysis or dependent variable, do not verify the depth of understanding of the relationship between the stages of error correction and learning derived from the error, except for a few studies that point in this direction (Bauer & Mulder, 2007; Leicher & Mulder, 2016; Leicher, Mulder, & Bauer, 2013).

Furthermore, the issue relative to the way the person who made the error influences the acquisition of learning from errors is still shown to be little understood. Horvath, Klamar, Keith, and Frese (2021), in a study guided by vignette experiments, verify that employees participating in the investigation learn more from errors committed by themselves than errors committed by their work colleagues. A possible explanation for this could be the occurrence of more intense emotional and cognitive reactions to their own errors than those related to the errors of others, and through such could force an individual to adopt an attitude of greater attention and involvement toward errors committed by their very selves. Moreover, the approaches and models proposed for the study of individual learning from errors does not make any distinction between one's own errors and those committed by others.

Through recognition of the importance of the procedural approach to the study and understanding of individual learning from the error, we aim at proposing and testing a model

of orientation to individual learning from own error (OILOE). The OILOE model concerns the propensity of the individual to behave in a favorable way to acquire new learning, under error situations at the workplace. In addition, the model integrates the stages of the error detection and error correction process (reflection, development of a new action strategy and implementation of the new strategy) to relevant factors of individual error orientation (error competence, error strain and error communication) as well as organizational factors that facilitate learning from errors.

Through the present study, the intention is to contribute to the existing literature by means of the proposition of a model that allows for the analysis of individual learning from errors. This is based on a processual perspective and is the integrator of the different stages of the approach to the error, as well as bring together individual and contextual elements that influence this process. The possibility of investigating the phenomenon in diverse contexts, by means of the same model, can go on to contribute toward the widening of the understanding into this type of learning and its relationship to its main antecedents. From the practical point of view, the model could collaborate in the diagnosis, by managers, of the perceptions of organizational members in relation to their own willingness and the conditions offered through the organizational context to engage in learning from errors and, as such, in the identification of actions that lead to an increase in this type of learning.

Following this, the article is structured in the following manner: first, the theoretical foundation and development of hypotheses are put forward; next, the methodological procedures and results are described; finally, a discussion of the results is delivered.

THEORETICAL BACKGROUND AND HYPOTHESES

The error and learning from the error

In those studies, related to learning in organizations, error is seen as deriving from human action, and as such refers to "[...] inappropriate actions committed while performing a task" (Ohlsson, 1996, p. 242). Such actions concern unintentional or avoidable deviations from goals, standards, or any unexpected result (Cannon & Edmondson, 2001; van Dyck et al., 2005), that are the result of individual decisions and behaviors (Zhao & Olivera, 2006).

Among the most frequent justifications for investigating errors at the workplace, one notes the concern of organizations in relation to negative impacts of errors on organizational processes and results. However, despite the emphasis placed on conceptual definitions of the phenomenon on the association between human error and negative results (Cannon & Edmondson, 2001; Bauer & Mulder, 2007; Goodman et al., 2011), one understands that the error will not always lead to negative consequences (Lei, Naveh, & Novikov, 2016).

Naturally, in some specific work contexts, as those that involve business operations of transportation industries, hospitals or engineering and construction companies, errors can lead to consequences both for the client and user, as well as for organizational reputation and results (Tucker & Edmondson, 2003; Grigoriou, Labib, & Hadleigh-Dunn, 2019; Ibrion, Paltrinieri, & Nejad, 2021) and, for such reasons, should be ostensibly avoided. In other environments, contrarily, as those aimed at innovation technology and those of startups that insert new solutions into the market, the errors are shown as an inherent element of work processes, as it is due to means of experimentation that one gains improvements in products and services, as well as with process stability (Bledow, Frese, Anderson, Erez, & Farr, 2009; Cannon & Edmondson, 2005; Lei, Naveh, & Novikov, 2016).

A low tolerance level to error can lead the organization to seek out prevention in a deliberate way with emphasis placed on it much more than those organizations with a more flexible level of tolerance to error, but in both situations, when the error occurs, it is necessary to learn how to avoid their repetition. To this end, in addition to systems and practices aimed at

error prevention, it is especially by means of people that learning through error may be constructed, thus leading to the refinement of the way in which the work is conducted, and the results are monitored. Research by Rybowiak et al. (1999, p. 543) proposes that learning from errors could refer to "[...] the ability to prevent errors in the long term by learning from them, planning, and changing work processes", which would depend, according to Ohlsson (1996), on the direction of the individual cognition for two main activities, which are the detection and correction of the error.

Learning that may be acquired from an error, results from the adequate approach and handling of the error situation, in which the individuals employ their knowledge and ability for reflective analysis to a process composed of several stages. Such stages involve the identification of the error and its causes, the generation and checking of alternative solutions that are aimed at avoiding the repetition of the error, and the implementation and the evaluation of solutions that lead to procedural and behavioral changes in the workplace, when shown to be necessary (Bauer e Mulder, 2007; Zhao, 2011).

Upon engaging in this process, the individual may be required to build new knowledge bases, which guide and stimulate improvements to the work process, in the form of efficiency and quality of process outputs, which are necessary for error correction activities. However, we consider that learning from one's own errors is not restricted only to specific knowledge to block the recurrence of the error, as through the handling the error situation, there may occur, for example, improvements to the capacity to deal with errors (Frese & Keith, 2015).

If the individual notes, in the present, that the adoption of a structured and systematized approach for dealing with error led to positive results, in future situations, the individual can avoid approaches of the tentative and error type, which tend not to generate the desired effects or lead to undesired negative consequences (van der Linden et al., 2001). Additionally, as shown by Zhow, Mao, and Tang (2020) learning from errors can have a positive influence on the self-development of the individual, i.e., the way in which the individuals seek and acquire relevant information to increase their performance.

According to the aforementioned, we define the individual learning from the error variable as the acquisition of new information and/or experiences due to an error that has been committed, which lead to changes in attitude and/or behaviors and/or knowledge, within the work context. Highlighted here is that learning from errors can be acquired through a process of approaching the error committed in both the individual and the collective manner – in this case, there exists the involvement of colleagues, managers or even individuals outside the organization, such as clients and suppliers.

In the OILOE model, individual learning from the error is an endogenous (dependent) variable. Following this, we provide the theoretical background for the remaining model constructs: first, the contextual and individual factors that influence the learning, these are the variables of organizational factors that facilitate learning from errors and positive error orientation; next, the stages of detection and correction stages of the error, by means of the variables error detection and error correction.

Organizational factors that facilitate learning from errors

The approach of a productive mode to an error situation, from which there can occur learning, is seen as a process influenced by not only individual attitudes and behaviors, but equally by dynamic organizational factors, relevant to the work context (Rybowiak et al., 1999; Zhao & Olivera, 2006; Harteis, Bauer, & Gruber, 2008). Through their literature review, Putz, Schilling, Kluge, and Stangenberg (2013) identified four categories of organizational factors that can influence learning from errors committed by individuals - supervisor's behavior, colleagues' behaviors, task structures and operating procedures, along with organizational principles and values.

The factors supervisor's and colleagues' behaviors refer to ways that managers and colleagues act as stimulators and facilitators of learning from errors, such as those covered by the notion of psychological safety. Research by Edmondson (1999, p. 354) shows that psychological safety at the team level, i.e., "[...] shared belief that the team is safe for interpersonal risk taking", is an element that influences one's individual willingness to admit, reveal and discuss one's own errors with colleagues, according to the perception of the possibility of suffering embarrassment or punishment. The establishment of psychological safety, in turn, is dependent on the supportive behavior of leaders, and through which they help individuals to deal with and talk about errors made (Edmondson, 1999; Cannon & Edmondson, 2001). Concerning the role of managers, in a laboratory study with business undergraduate student, Zhao (2011) verified that an attitude toward intolerance to errors, noted in managers, is related both positively and significantly to the negative emotions experienced by employees in relation to their own errors.

The factor of task structures and operating procedures addresses adequate conditions and opportunities toward errors, by means of an organizational support context that guarantees resources, information, expert assistance, and training necessary for executing the work. This perspective is related to the notion of workplace culture of learning from mistakes proposed by Harteis, Bauer, and Gruber (2008) as an organizational environment endowed with favorable conditions for learning from errors, through the structuring of opportunities to search for information about the error situation, to define new work processes, and to establish new strategies for monitoring and supervising the job. Following on from this perspective, Dahlin, Chuang and Roulet (2018) show that it is necessary that the work context come from learning opportunities from errors to the people involved. This includes creating opportunities for information access as well as sufficient information on the error situation and its causes, along with providing the necessary time to reflect on and analyze the error event, implement response and learning actions from the error.

Finally, the factor organizational principles and values comprises of elements that stimulate, among the people in the organization, the assessment of the error as something important to learning at the workplace. In addition to elements that promote a culture toward managing errors, where at the same time as seeking to reduce errors, shows itself as understanding that they occur (van Dyck et al., 2005; Frese & Keith, 2015). Through the adaptation of the team psychological safety scale of Edmondson (1999), Carmeli and Gittell (2009), the organization's shared beliefs were measured regarding the number of individuals who, for example, considered that a committed error could turn back against them or those that felt safe to address and discuss the topic of their errors. In the study, involving employees from various organizations, verification was made into whether psychological safety at the organization level is positively associated with learning from errors (Carmeli & Gittell, 2009).

Putz et al. (2013) consider the four factors – supervisor's and colleagues' behaviors, task structures and operating procedures, and organizational principles and values – as dimensions of the error-related learning climate, understood as shared perceptions of the extent to which organizational elements help or block learning from errors. The results from the study conducted by the authors, using employees from various categories, show that error-related learning climate is positively correlated with constructive handling of errors (relative to reflection on the causes and correction of the error) and positively related to the individual appraisal of the effectiveness learning from errors. Additionally, research by Grohnert, Meuwissen and Gijselaers (2017) replicates the subscales of supervisor's behavior, colleagues' behaviors and organizational principles and values for measuring organizational climate for learning from errors, while identifying that this is positively related to learning from errors of junior auditors.

Following this line, based on Putz et al. (2013), we define organizational factors that are facilitators of learning from errors as the support and resource elements, which are present in the organizational work context and go on to facilitate the approach to the error situation, as well as learning through this experience. These factors are considered as being made up of three dimensions. The first, support from the immediate manager and colleagues, is defined as the recognition by the individual that the manager and colleagues present an opening and readiness to cooperate, with them, in dealing with an error situation. The second, organizational principles and values, deals with the individual understanding that, in the workplace, the addressing of the error is guided toward a conduct for the positive handling of the error situation and toward learning. The third dimension, resources of support for the error correction, is defined as the evaluation that, in the work context, there are available and accessible material resources and necessary information for dealing with an error situation.

Positive error orientation

Rybowiak et al. (1999), the first to operationalize the concept of error orientation, did so from the theoretical perspective of coping strategies (cf. Lazarus & Folkman, 1984), adopted by individuals in the face of adverse or psychologically stressful situations that occur in everyday life. Adaptation responses to a situation may be in the form of avoidance or confrontational behavior. Along this line, according to Rybowiak et al. (1999), the error orientation of an individual describes the degree to which they believe that errors can occur and the degree that these are evaluated negatively. In addition to the way they tend to deal with the error situation, i.e., if they are capable of regulating the tension generated by the error, and resolve the situation and learn with it or if there is an inclination toward covering over the occurrence of the error, and in this way does not deal with the situation.

The error orientation questionnaire (EOQ), developed by Rybowiak et al. (1999), is formed of eight representative constructs of attitude and confrontational behaviors related to workplace errors: error competence, learning from errors, error risk taking, error strain, error anticipation, covering up errors, error communication, and thinking about errors. Since then, these subscales have been replicated or adapted, wholly or partially, in empirical studies that investigate both the orientation to error and the specific attitudes and behaviors toward errors in the work environment, operationalized in line with the variations of the EQQ (e.g. Casey, Riseborough, & Krauss, 2015; Chughtai & Buckley, 2010; KC, Staats, & Gino, 2013).

In the OILOE model, positive error orientation, considered the inducing of the individual factor of learning from errors, is defined as the individual disposition favorable to approaching error situations in a productive way. This involves the belief that one can deal with the error, the self-control of any tension generated by the error and the predisposition to share the occurrence of the error with others, should this be deemed as necessary to contain its negative consequences or its effective correction. The construct is formed of three dimensions that arise from the EOQ, these are error competence, error strain and error communication, which are shown be aligned with the operational definition of positive error orientation.

Through the revision of the infrequent studies based on structural equation modeling, one notes that the dimensions of the EOQ tend to be modeled as reflective first-order latent variables (Amini & Mortazavi, 2013; Gronewold & Donle, 2011). In this study, in turn, positive error orientation was modeled as a second-order emergent construct, in alignment with the theoretical criteria indicated by Coltman, Devinney, Midgley, and Venaik (2008) for formative models. Related to its very nature, the construct positive error orientation is formed by the combination of latent variables of the first order (error competence, error strain and error communication). In terms of the direction of causality, the variation in the latent variables of the first-order causes variation in the positive orientation to error construct and first-order latent variables do not share a common theme.

Following this, a brief theoretical discussion is made into each of the dimensions of the construct of positive error orientation.

Error competence

The individual perception of the importance of errors that occur at work can vary from the view that they are negative events, and as such should be avoided, to the understanding that errors can constitute an opportunity to apprehend the complexity of work and learning (Harteis, Bauer, & Gruber, 2008). Nevertheless, the adoption of responses to cope with the error situation may require the mobilization of personal resources and behaviors such as self-efficacy, action-orientation after failure, need for achievement, and initiative, constructs which Rybowiak et al. (1999) identify as being positively correlated with error competence.

Following this line, based on Rybowiak et al. (1999), we define error competence as the individual understanding that one has mastered the knowledge necessary to immediately deal with the error situation and contain its effects; and despite the error committed, is able to adopt the initiative, oriented toward achievement and action. Highlighted here is that error competence does not cover the actions necessary for correcting the error, as in reflection on the causes of the error, the development and implementation of corrective actions, nor the possible positive consequences of the error handling process, as new learning. However, error competence is a predictor of reflexive activity (Hetzner, Gartmeier, Heid, & Gruber, 2011).

Error strain

It is possible that, upon committing an error at the workplace, the individual will experience emotions or negative affective states such as fear, embarrassment and blame, sadness and depressive thoughts (Rybowiak et al., 1999). This occurs as errors can be considered by those who erred, as well as by others, as a detrimental indicator to individual performance and to work results. In addition, depending on the severity of the error, some negative emotions can occur due to the exposure of who erred, the negative consequences not only falling on oneself but on the organization (Homsma et al., 2009).

As suggested by Zhao (2011), negative emotions are thought to reduce personal motivation to engage in new learnings, as these are seen as an emotional valence whose motivational system is one of aversion and which encourages the adoption of a behavior to avoid the source that generates the stimulus (for example, the committed error). The effect of negative emotions on learning, however, appears to be modulated by the intensity of the negative state experienced. The results from the study by Zhao (2011) suggest that low levels of negative emotions, such as sadness, guilt, anger at yourself and nervousness, may enhance motivation to learn, whereas only moderate or strong levels of negative emotions could negatively affect motivation to learn, inclusive, in situations of learning from errors.

In this study, negative emotions are addressed by the error strain construct, as in the definition given by Rybowiak et al. (1999, p. 543), whatever error strain refers to "[...] generalized fear of committing errors and by negative emotional reaction". Therefore, the intensity of the stress to error experienced by the person and the way in which they deal with such stress can have adverse effects on the approach to the error, in the form of blocks or in the taking of actions necessary to handle the error or delayed actions (Frese & Keith, 2015; Tulis, Steuer, & Dresel, 2017, Zhao, 2006).

Error communication

From the point of view of Zhao and Olivera (2006, p. 1012), the reporting of errors is understood as "[...] act of individuals communicating their errors to their managers or supervisors, either verbally or through formal error reporting systems", which, nonetheless, does not always happen when someone detects that they have made a mistake. In some

situations, to correct an error and contain its negative effects, it is necessary that the occurrence is communicated. However, instead, due to the understanding of having potential negative consequences through the reporting of the error, such as punishment or damage to one's professional image (Zhao & Olivera, 2006), the individual may act to direct their effort to cover up or ignore the error, thus removing the opportunity to gain learning from the situation (Rybowiak et al., 1999).

In addition to the error situation itself, specifics of the work context must be taken into consideration. Depending on the job responsibilities and levels of task complexity, the tendency is that the occurrence of the error is shared with the immediate manager of who committed the error. Conversely, for those that hold managerial positions or act in more complex work environments, communication of errors does not necessarily reach the manager, as the process of error correction involves other authors in the working context, internal and external to the organization, as colleagues, customers, or suppliers (Rodrigues & Bido, 2019).

In this context, we define error communication as the individual attitude of sharing one's own errors, be that with the immediate manager or with any other actor within the workplace context. These actors can take the form of colleagues, subordinates, partners, and agents external to the organization (as clients, suppliers or business partners), which, in some shape or form, are important to the process of correction and containment of eventual negative effects from the error.

According to the aforementioned, the following hypothesis is established:

H1: Organizational factors that facilitate learning from errors positively influence positive orientation to the error.

Error detection

The detection of the error represents the inducing factor of the process for addressing the error, in the sense that when an individual is unable to identify an error that has been committed or even to allocate his or her own responsibility to the error, this individual will not recognize the need to actively deal with the error situation or could even resist participating in activities for correcting the error (Tjosvold, Yu, & Hui, 2004; Zhao, 2006; Frese & Keith, 2015). However, errors are not always identified upon their occurrence, since problem situations can emerge during the execution of the work, which are shown in the form of negative results, obstacles to the accomplishment of a task or malfunction of a work process (Sellen, 1994; Rodrigues & Bido, 2019). Hence, it is through the investigation of such situations that the error committed can be identified.

There are those errors that can be detected the moment they occur through observation of the very actions themselves (Sellen, 1994), as for example when making a telephone call, and one presses one or more numbers incorrectly. In the case of identifying other errors, however, it is necessary that one verify the consequences of one's own actions, through the comparison of the result obtained, with that which was expected (Sellen, 1994; Ohlsson, 1996), as in those cases in which a management decision made incorrectly does not generate the predicted positive effects. In these situations, the detection of the error can be made by the individual who erred or by others, internal or external to the organization and who, in some way, are involved with the error situation (Love & Josephson, 2004). For this reason, being open to feedback and opinions expressed by other people, as well as having the capacity to reflect on the content of such evaluations are seen as valuable elements in the identification of errors and the recognition of these by those who committed the error, since these can point, for example, to the non-fulfilment of goals or expectations of the internal and external customers, or to the occurrence of misunderstandings (Cannon & Edmondson, 2011).

Keeping in mind that, in this study, the focus is placed on individual learning from one's own errors, starting from Zhao (2006) and Frese and Keith (2015), the error detection variable

is defined as the individual behavior aimed at identifying and recognizing one's own errors, even though, at that moment, the causes of the error are not understood. In the structural model, error detection was modeled as an emergent construct, since its "indicators are defining characteristics of the construct" (Jarvis, MacKenzie, & Podsakoff, 2003, p. 203), i.e., its items represent a set of actions that constitute the behavior aimed at the detection of errors.

In light of the aforementioned, we establish the following hypothesis:

H2: Positive error orientation positively influences error detection.

Error correction

Error correction can be understood as the process of acquiring knowledge and information that is necessary for improving individual future actions (Ohlsson, 1996), by means of the identification and understanding into the causes of the error, along with the development and implementation of solutions that prevent repetition of the error. In those cases of repetition, the error correction process should lead to a reduction of eventual negative consequences (Bauer and Mulder, 2007; Zhao, 2011; Dahlin, Chuang, & Roulet, 2018).

Such a process requires a posture based on reflective analysis, through which one expects that the individual that erred reach a deeper understanding of the error situation, which led to the development of effective action strategies to avoid recurrence of the error (Putz et al., 2013). This perspective shows itself to be especially relevant to situations where the nature and causes of the error are not evidently clear (Gartmeier, Bauer, Gruber, & Heid, 2008).

Bauer and Mulder (2007) propose that actions taken for correcting an error be considered as a process of engaging in learning activities, even though, at the time of correcting an error, the individual is not deliberately focused on acquiring new knowledge or skills. Along this line, after the detection of the error, the first step or activity consists of individual reflection on the possible cause of the error, which may occur by means of interactions and exchanges with colleagues or the immediate manager. The next step constitutes the identification of ways to act on the cause of the error and the planning of implementation of changes that impede the recurrence of the error, for which it may be necessary to search for information and allocate resources. Finally, the third step is equivalent to implementing the actions for improvement and monitoring their results.

However, it is the performance of such activities, in an individual or socially shared context (Leicher & Mulder, 2017), that provides learning from the error, which is expressed through the application of acquired knowledge into the improvement of work processes (Rybowiak et al. 1999) and into the modification of individual behavior (Zhao, 2011). As such, based on Bauer and Mulder (2007), error correction is defined as the performance of activities necessary to understand the error situation and its causes, and to identify, plan and implement actions that prevent the recurrence of the error.

The definition given here constitutes three dimensions. The first, reflection, is defined as the activity of "[...] performing a root-cause analysis in order to identify probable causes of an error" (Bauer & Mulder, 2007, p. 124). The second, development of a new action strategy, involves the execution of "[...] processes of considering strategies to change the cause, alternatives for future acting, allocation of information and resources, and planning of the implementation" Bauer & Mulder, 2007, p. 124). Finally, implementation of the new strategy is defined as the activity of "[...] experimenting with the new behavior and evaluating it after experiences in similar situations" (Bauer & Mulder, 2007, p. 124-125).

Based on that presented in the latter sections, we still hypothesize that:

H3: Error detection positively influences error correction.

H4: Organizational factors that facilitate learning from errors positively influence error correction.

H5: Error correction positively influences learning from errors.

Figure 1 presents the structural model considered in this study, in accordance with the previously hypotheses formulated.

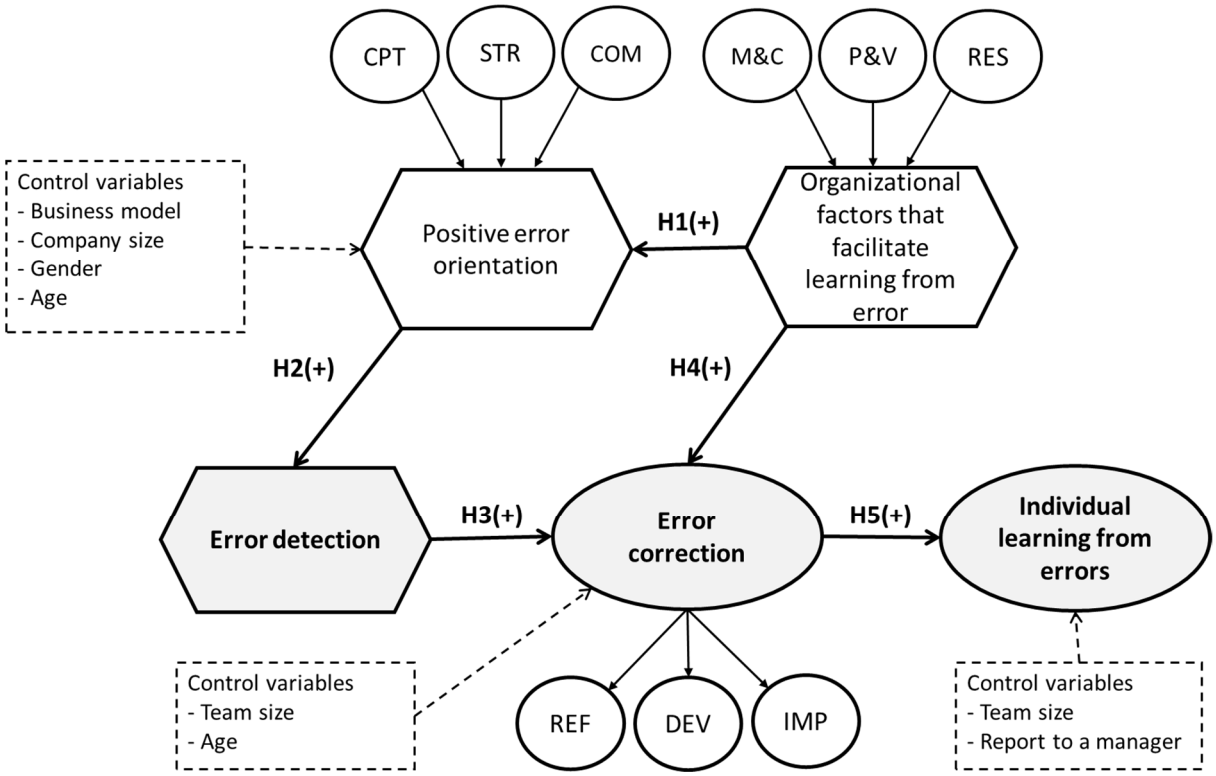

Figure 1. Research structural model – OILOE model
CPT: error competence; STR: error strain; COM: error communication; M&C: support from immediate manager and colleagues; P&V: organizational principles and values; RES: resources of support for the error correction; REF: reflection; DEV: development of a new action strategy; IMP: implementation of the new strategy
The process of error detection to individual learning from the error has been highlighted in gray
Constructs represented as ellipses are reflective and hexagons are formative (Henseler, 2021).

METHOD

Participants and procedure

The questionnaire used for the data collection was generated and made available by means of the platform Google Forms. Over the period between June and August 2020, the link of the questionnaire was disclosed via social digital networks (Facebook and Linkedin) and instantaneous message applications (WhatsApp). Adopted as the inclusion criteria were that participants would be 18 years old or over and working or had previous work experience. As part of the questionnaire, there was made available, to the potential respondents, the informed consent form with the following information: objective behind the research, non-disclosure of participants, use of data for survey goals and scientific publication, risks and benefits in participating, and identification and means of contact with the researchers. In order to respond to the questionnaire, it was necessary to grant formal acceptance of participation.

All returned questionnaires were validated (checking for missing data or other problems) and, as such, the survey sample was composed of 298 participants, Brazilian workers and professionals. As we are dealing with the method of Partial Least Squares Structural Equation Modelling (PLS-SEM), and for which the analysis of statistical power is indicated (Hair, Hult, Ringle, and Sarstedt, 2013), the software G*Power 3.1.9 was used, which determined the minimum sample of 270 cases, with the following parameters: significance

level of 5%, average effect size (Cohen's f^2) of 0.15 and statistical power of 80%. The descriptive statistics of the final characteristics of the sample are presented in Table 1.

Table 1. Descriptive statistics of sample characteristics ($N = 298$).

Category	*n*	%	Category	*n*	%
Gender			*Report to a manager*		
Female	136	44.6	Yes	258	86.6
Male	162	54.4	No	40	13.4
Age range			*Team size*		
25 or less	73	24.5	Work alone	18	6.0
26-30	61	20.5	2-5 people	89	29.9
31-40	79	26.5	6-9 people	54	18.1
41-50	41	13.8	10-19 people	56	18.8
50 or more	44	14.8	20 or more people	41	13.8
			Uninformed	40	13.4
Educational level					
High school	55	18.5	*Company sector*		
Higher education	108	36.2	Retail	38	12.8
Postgraduate degree	135	45.3	Manufacturing	53	17.8
			Service	188	63.0
Professional relationship			Others	19	6.4
Employee	154	51.7			
Civil servant	60	20.1	*Company size**		
Entrepreneur	25	8.4	Micro	64	21.5
Others	59	19.8	Small	54	18.1
			Medium	26	8.7
Hierarchical position			Large	154	51.7
Operation/technical operation	132	44.3			
Supervision/team leadership	57	19.1	*Business model*		
Analyst	64	21.5	Technology-based company	61	20.5
Middle management	25	8.4	Traditional-based company	237	29.5
Top management	27	9.1			

*Company size defined according to Brazilian Institute of Geography and Statistics.

Measures

Regarding the variables that form the positive error orientation dimension, error competence was measured by means of the replication or adaptation of three items to Portuguese from the subscale of error competence (identified as cpt1, cpt2 and cpt3 on the original scale), developed by Rybowiak et al. (1999) and by an item prepared by the authors themselves. Error tension was measured by means of the adaptation of the subscale of five items of tension through error, developed by Rybowiak et al. (1999). Error communication was measured through the replication of one item (com1) from the subscale communication of the error and from the adaptation of three items (cov3, cov4 and cov5) from the subscale covering errors, both developed by Rybowiak et al. (1999).

As for the variables of the dimension organizational factors that facilitate learning from errors, most of the items were adapted from the organizational learning scale from the error, developed by Putz et al. (2013). For support from the immediate manager and colleagues, two items were adapted; for organizational principles and values, three items were adapted; and for resources of support for the error correction one item was adapted and another two were developed from the literature (Harteis, Bauer, & Gruber, 2008).

The variable error detection was measured by means of four items developed by the very authors themselves, based on a literature review (Cannon & Edmondson, 2001; Ohlsson, 1996; Rodrigues & Bido, 2019). In terms of the variables of the error correction dimension, the items used for measuring were developed based on the model for learning from the error

proposed by Bauer e Mulder (2007). For the variable reflection on the cause of the error, four items were developed; for development of an action strategy, three items; and for implementation of the new strategy, three items.

Concerning the variable individual learning from the error, its measurement was given by the adaptation of two items (ape1 and ape2 on the original scale) and from the replication of another two items (ape3 and ape4) from the subscale learning from errors, developed by Rybowiak et al. (1999). All the variables from the questionnaire were evaluated by means of a 7-point scale, varying from never (1) to always (7).

As control variables, the following were included: age (1 = up to 25 years, 2 = from 26 to 30 years, 3 = from 31 to 40 years, 4 = 41 to 50 years, 5 = above 50 years), gender (0 = feminine, 1 = masculine), report to a manager (0 = reports to a manager, 2 = does not report to a manager), size of the work team (1 = only the participant, 2 = from 2 to 5 individuals, 3 = from 6 to 9 individuals, 4 = from 10 to 19 individuals, 5 = 20 or more individuals), business model base (0 = traditional-based organization, 1 = technology-based organization), size of the organization (1 = micro, 2 = small, 3 = medium, 4 = large). Age was considered the control variable due to the study results as in Carter and Beier (2010), which suggested that individuals of more advanced ages benefit more from instructions received in management training of errors than younger colleagues. In regard to gender, Ye and Li (2018) found that gender moderates the indirect relationship between inclusive leadership and learning from errors, being stronger for women than for men.

Validation and pilot study

For content validation of the instrument, the scale was submitted to an evaluation by five experts, which act as professors and researchers in the areas of learning in organizations, and psychology, as well as human behavior in organizations. These expert judges issued their opinions and recommendations regarding the pertinence of the items to the variables, the intelligibility of the items and the adequacy of the format used for the instrument. After the analysis of the evaluations by the experts, adjustments and improvements were made; in a way to assure that the scale reflects in an effective manner the constructs under consideration. Following on from this, to reach a semantic validation, the instrument was answered and evaluated by six people who make up the target audience of the research. Likewise, an analysis and adjustment were performed on the elements that could present some type of difficulty in the understanding of the instructions and items.

For the final verification of the adequacy of the instrument and its items, a pretest was performed using 41 individuals who make up the research target audience. The evaluation of the measurement model was implemented by means of PLS-SEM (partial least squares structural equation modeling), for this stage as for the final data analysis; the software SmartPLS 3 was employed. Regarding convergent validity, discriminant validity and reliability, at the level of reflective latent variables, the values were adequate, that is, average variance extracted (AVE) above or close to 50% and composite reliability ≥ 0.7. There were low factor loadings for one item of the learning from errors variable (maintained in the scale); two support items from the manager and colleagues (excluded from the scale); one item for the implementation of the new strategy (reformulated and kept in the scale) and an item for competency in error handling (kept in the scale).

Data analysis

Initially, in the treatment of the data, the analysis of the pattern of the answers was conducted across the individual answers for identifying whether any atypical cases occurred, i.e., when a respondent gives the same answer at a rate higher than 80% over the items, according to the criteria indicated by Schwartz (2016), within the scope of European Social

Survey Education Net. Only one atypical case was identified (88% of the items with the same answer), which represents only 0.34% of the sample, and as such was maintained.

Given that, the structural model contains one second-order latent variable in endogenous position (organizational factors that facilitate learning from errors), the repeated indicator approach (repetition of items of first-order variables on the second-order variable) makes the structural coefficients of the relationships of this variable always equal to zero. For this reason, a two-step approach was adopted.

Firstly, the analysis of the principal components for each first-order reflective latent variable was performed, and through such, the factor scores were generated for each one of the variables, using the mean of their composite items. The scores were then added to the data set and, following this, used as indicators of the second-order latent variables, in substitution of the first-order variables.

The items of the scale and the generated factor scores are given in the Appendix. As these present low factor loads, four items were excluded from the measurement model.

RESULTS

Evaluation of the measurement model

Reflective latent variables

Table 2 presents the results for the evaluation of the measurement model, at the reflective latent variables level. Convergent validity is shown to be adequate, since the values for the average variance extracted (AVE) are greater than 0.5. Regarding the discriminant validity, one notes that the values for the square root of AVE (in bold) are higher than the correlations for the latent variables. In terms of reliability, the results are also suitable, above 0.8 (Hair, Black, Babin, & Anderson 2010).

Table 2. Matrix of correlations between latent variables (N = 298).

Variables	1	2	3	4	5	6	7	8	9	10	11
1 Org_factors	*E*										
2 Pos_err_orientation	0.392	*E*									
3 Err_detection	0.339	0.518	*E*								
4 Err_correction	0.342	0.480	0.520	*0.845*							
5 Indiv_learn_error	0.280	0.444	0.456	0.501	*0.713*						
6 Business model	0.054	0.067	0.061	-0.008	-0.015	*S*					
7 Company size	-0.001	0.042	0.046	-0.026	-0.047	0.132	*S*				
8 Gender	0.061	0.079	0.040	0.016	0.047	0.047	0.045	*S*			
9 Age	-0.009	0.095	-0.076	0.115	0.014	-0.159	0.058	0.068	*S*		
10 Team size	0.090	-0.074	0.052	0.077	0.141	0.047	0.079	0.066	-0.095	*S*	
11 Report_manager	-0.106	-0.072	-0.055	-0.031	0.119	-0.029	-0.453	-0.034	0.087	-0.078	*S*
Composite reliability	E	E	E	0.882	0.805	S	S	S	S	S	S
AVE	E	E	E	0.714	0.509	S	S	S	S	S	S

Org_factors: organizational factors that facilitate learning from errors; Pos_err_orientation: positive error orientation; Err_detection: error detection; Err_correction: error correction; Indiv_learn_error: individual learning from the error; Report_manager: report to a manager; E: emergent construct; S: single indicator.
The values along the diagonal (columns 4 and 5) are the square root of AVE; as their values are higher than the values outside of the diagonal (correlations), there exists discriminant validity (Hair Jr et al., 2016).
Correlations higher or equal to |0.119| are significant at 5%.

When checking the crossloading matrix, at the items levels, no problems of discriminant validity are identified. In the Appendix A, there is a list of scale items and their factor loadings.

Emergent constructs

Table 3 shows the results for the assessment of the measurement model, in relation to emergent constructs. In these cases, reliability and convergent validity are not considered, as it is expected that there is no correlation between the indicators (Hair, Howard, & Nitzl, 2020). Based on the results, there are no problems regarding multicollinearity, given that the variance inflation factor (VIF) for the indicators is < 3.0.

Table 3. Measurement assessment of the formative constructs (N = 298).

Indicator	factor weights	p-value	VIF	factor loads	p-value
Organizational factors that facilitate learning from error					
M&C	0.313	0.034	1.193	0.621	0.000
P&V	0.084	0.733	1.286	0.533	0.006
RES	0.802	0.000	1.304	0.948	0.000
Positive error orientation					
REF	0.824	0.000	1.016	0.882	0.000
STR	-0.042	0.777	1.022	0.055	0.757
COM	0.478	0.001	1.037	0.575	0.000
Error detection					
ED1	-0.006	0.946	1.022	0.122	0.218
ED2	0.598	0.000	1.060	0.755	0.000
ED3	0.458	0.000	1.028	0.568	0.000
ED4	0.484	0.000	1.045	0.597	0.000

ED1 to ED4: indicators of the formative error detection construct.

In the assessment of the relative contribution of the indicators for the formation of the constructs considered, as indicated by Hair, Howard and Nitzl (2020), one notes that the weight factors are shown to be significant (valor-p < 0.05), except for ED1, STR and P&V. When analyzing the absolute contribution of these indicators for the formation of the constructs to which they refer, it appears that the factor loading is ≥ 0.50 only for P&V, so it is recommended that the indicator be maintained in the model (Hair, Howard, & Nitzl, 2020). In reference to ED1 and STR, although these demonstrated factor loads < 0.50 and do not demonstrate significance, from the theoretical point of view these are considered relevant to the operational definition of the constructs and, as such, were maintained in the model.

In the Appendix B, there is a list of scale items and their factor weights.

Structural model assessment

In Table 4, the results of the assessment for the structural model are presented, which was performed in three stages (Models 1, 2 and 3). In Model 1, only the control variables were included along with their respective endogenous variables, where one notes that all the control variables present significant effects. In Model 2, there are no control variables, as this was used only to assess the variation of the structural coefficient of each hypothesis, after the inclusion of the control variables. In Model 3, one has the complete or final model; since all the control variables present significant effects, these were maintained in the model.

When comparing the adjusted R^2 of the hypotheses, of Model 1 with those of Model 3, one notes that the model explains 4.1% of the positive error orientation variance (ΔR^2 = 15.6% – 11.5%), thus highlighting that all control variables were significant in Model 1 and not significant in Model 3. It is therefore understood that organizational factors that facilitate learning possess a shared variance with organizational characteristics (technology-based or traditional-based), along with the individual characteristics (gender and age).

Table 4. Structural model assessment ($N = 298$).

Model 1	Hypotheses	f^2	Path coefficient	Standard error	t-value	p-value	R^2 adj.
Business model → Pos_err_orientation	control	0.030	0.165	0.061	2.70	0.007	
Company size → Pos_err_orientation	control	0.022	-0.140	0.065	2.16	0.031	0.115
Gender → Pos_err_orientation	control	0.045	0.199	0.057	3.50	0.000	
Age → Pos_err_orientation	control	0.062	0.237	0.059	3.99	0.000	
Age → Err_correction	control	0.026	0.160	0.056	2.86	0.004	0.029
Team size → Err_correction	control	0.013	0.115	0.052	2.21	0.027	
Team size → Indiv_learn_error	control	0.029	0.168	0.045	3.76	0.000	0.038
Report_manager → Indiv_learn_error	control	0.021	0.142	0.050	2.84	0.004	
Model 2							
Org_factors → Pos_err_orientation	H1(+)	0.176	0.387	0.057	6.79	0.000	0.147
Pos_err_orientation → Err_detection	H2(+)	0.383	0.526	0.046	11.5	0.000	0.274
Err_detection → Err_correction	H3(+)	0.265	0.459	0.063	7.24	0.000	0.295
Org_factors → Err_correction	H4(+)	0.041	0.181	0.066	2.73	0.006	
Err_correction → Indiv_learn_error	H5(+)	0.339	0.503	0.050	10.0	0.000	0.251
Model 3							
Org_factors → Pos_err_orientation	H1(+)	0.179	0.387	0.056	6.90	0.000	
Business model → Pos_err_orientation	control	0.004	0.056	0.060	0.95	0.345	
Company size → Pos_err_orientation	control	0.001	0.027	0.060	0.44	0.658	0.156
Gender → Pos_err_orientation	control	0.002	0.045	0.068	0.66	0.511	
Age → Pos_err_orientation	control	0.012	0.102	0.066	1.55	0.122	
Pos_err_orientation → detec_erro	H2(+)	0.366	0.518	0.065	7.92	0.000	0.265
Err_detection → Err_correction	H3(+)	0.287	0.469	0.061	7.69	0.000	
Org_factors → Err_correction	H4(+)	0.042	0.179	0.065	2.78	0.005	0.318
Age → Err_correction	control	0.036	0.157	0.050	3.11	0.002	
Team size → Err_correction	control	0.004	0.051	0.047	1.09	0.278	
Err_correction → Indiv_learn_error	H5(+)	0.341	0.497	0.052	9.62	0.000	
Team size → Indiv_learn_error	control	0.018	0.114	0.040	2.84	0.005	0.275
Report_manager → Indiv_learn_error	control	0.029	0.144	0.046	3.11	0.002	

In terms of the remaining constructs, after disregarding the effect of the control variables, the model explains around 27% of the variance for detection of the error (27.4% in Model 2 and 26.5% in Model 3), 28.1% of the variance for correction of the error ($\Delta R^2 = 31.8\% – 2.9\%$) and 23.7% of the variance for learning from the error ($\Delta R^2 = 27.5\% – 3.8\%$).

Furthermore, when comparing the structural coefficients of Model 2 with Model 3, the variation is noted as approximately 0.01 or lower, which indicates that even the model without the control variables presents unbiased (beta) results.

Hypothesis 1, organizational factors that facilitate learning from the error positively influences positive orientation to the error, is supported ($\beta = 0.387$, $p < 0.00$), in alignment with previous studies (Edmondson, 1999; Gronewold & Donle (2011). According to the classification by Cohen (1997), the size of the effect of the organizational factors that facilitate learning from the error on positive orientation to the error is average ($f^2 = 0.179$).

Hypothesis 2, positive orientation to the error positively influences detection of the error, is supported ($\beta = 0.518$, $p < 0.00$). Despite the previous literature highlighting the identification of the error as necessary to the involvement of the individual in addressing the error situation (Zhao, 2006; Frese & Keith, 2015), no model is identified that contemplates the

association between individual orientation to the error and detection of the error. Additionally, the size of the effect of positive orientation to the error over error correction was noted as large ($f^2 = 0.366$), which strengthens the understanding that individual disposition when dealing with error situations stimulates the adoption of favorable behaviors toward the identification and recognition of one's own errors.

Hypothesis 3, detection of the error positively influences correction of the error, is supported ($\beta = 0.469$, $p < 0.00$), the effect size was medium to large ($f^2 = 0.287$). This result shows itself as aligned to existing literature, which stresses the necessary detection of the error as a condition for dealing with the error situation, by means of executing the activities for its correction (Tjosvold, Yu, & Hui, 2004; Zhao, 2006; Frese & Keith, 2015).

Hypothesis 4, organizational factors that facilitate learning from the error positively influence correction of the error, is supported ($\beta = 0.179$, $p < 0.01$). Previous literature points to the relationship between elements of the organizational context that encourage learning from the error and activities related to correction of the error, at the level of work teams (Edmondson, 1999; Cannon & Edmondson, 2001), whereas, in this study, this relationship is evidenced at its individual level. The size of the effect, however, is small ($f^2 = 0.042$), which indicates importance, for the organizational factors that facilitate learning toward the correction of the error, less than expected.

Hypothesis 5, correction of the error positively influences learning from the error, is supported ($\beta = 0.497$, $p < 0.00$), with a large effect ($f^2 = 0.341$). Existing literature emphasizes that it is, especially, through means of the activities of error correction, that learning takes place from the error situation (Ohlsson, 1996; Bauer & Mulder, 2007; Zhao, 2011; Dahlin, Chuang, & Roulet, 2018), however, a model that includes and measures the relationship between error correction and individual learning from the error is not identified.

Regarding the control variables, the basis of the business model used by the organization (technology-based or traditional-based), gender and organization size did not demonstrate significant effects. On the other hand, age ($\beta = 0.179$, $p < 0.036$) presented a significant relationship with error correction, and size of the team ($\beta = 0.114$, $p < 0.005$) and leadership ($\beta = 0.144$, $p < 0.0002$) present significant relationships with learning from the error.

DISCUSSION

In this study, attention was focused once again on the understanding of the orientation to individual learning from the one's own error, a notion introduced by the authors and investigated by means of OILOE. This is an integrative structural model of the stages of the error detection and correction process, concerning those factors related to individual error orientation and of organizational factors that facilitate this type of learning. To reach this goal, some subscales were replicated or adapted from previous studies based on field studies, while others were developed by the authors.

The results from this study confirm relationships of the effect between constructs that make up part of the individual learning process from the error, specifically, that organizational factors that contribute to learning from the error strengthen the positive orientation to the error and that this promotes the detection of the error. Additionally, the results open the possibility to evidence and empirically confirm the predictive relationships of organizational factors in relation to error correction, as well as correction of the error in relation to individual learning from the error.

Theoretical implications

The general orientation of the individual signals in which way he/she will tend to act when confronted not only in an error situation, but also in view of the possibility of having committed an error. These tendencies can fall into deal actively and strategically with the

situation, in order to resolve it and learn from it or, on the contrary, avoid dealing with the situation, ignoring it or even camouflaging it (Harteis, Bauer, & Gruber, 2008; Harteis & Frost, 2012). Positive orientation to the error – individual disposition favorable to addressing error situations in a productive manner – stems from characteristics and resources related to both the individual and his/her work context.

Regarding the work context, the results from this research confirm those findings from previous studies (e.g. Putz et al., 2013) in that the orientation to the error is influenced by organizational factors considered to be facilitators of learning from the error. In this study, these cover three dimensions, which are the support from the immediate manager and colleagues, organizational principles and values regarding errors, and resources of support for the error correction provided by the organization. However, one notes that the level of explanation given for the variance of positive orientation to error, by the model, is low.

There are two reasons considered for this result. First, organizational factors that facilitate learning are seen as possessing a shared variance with organizational and individual characteristics, measured by the control variables (technology-based or traditional-based, gender and age). Technology-based organizations have a necessity to present more tolerance to errors (Cannon & Edmondson, 2001), since part of their operations is based on new processes and technologies or are poorly structured, which through its demand for more experimentation, exposes individuals to more frequent errors (Frese & Keith, 2015). These organizations, however, may possess other elements that are characteristic of the management model and of work processes, besides those indicators contemplated by the dimensions of the organizational factors of learning from the error, which also influence positive orientation to the error.

Second, the error orientation construct is shown as being multifaceted (Rybowiak et al. 1999) and, only in relation to the EOQ, different combinations of its subscales are found in the literature, in order to measure error orientation (Arenas, Tabernero, & Briones, 2006; Bledow, Carette, Kühnel, & Bister, 2017; Hetzner et al., 2011; Schell & Conte, 2008). In the formation of positive error orientation, it is considered that two dimensions of error orientation, in particular, may be relevant, these being error anticipation and error risk taking.

Error anticipation deals with the expectation that errors may occur, even in areas of professional dominance (Rybowiak et al., 1999) and, according to that suggested by the results from the study by Seckler, Gronewold & Reihlen (2017), the adoption of work behaviors based on error anticipation collaborate in the development of cognitive and emotional strategies favorable for dealing with error situations.

In turn, error risk taking, understood as the attitude of openness toward the possibility of erring, according to the nature of the objective one desires to achieve (Rybowiak et al., 1999), is shown to be an element relevant to the formation of positive orientation to the error. As taking on the risk of the error and its negative consequences, with a posture that is at the same time flexible and responsible, is conducive to the error recovery process itself (Tjosvold & Yu, 2007). It is understood that this occurs precisely because of the required posture of flexibility and adaptation, which is used in eventual error situations.

Another result reported by this study is related to the empirical evidencing of the role performed by the detection of the error in the process of learning from the one's own error; noted here is that error detection is favored by positive error orientation and detection provides an opportunity for error correction. The behavior adopted by the individual in situations where they should be able to identify and recognize one's own errors is, in part, dependent on their conceptions relative to this type of event. This is evident through that identified by Harteis, Bauer and Gruber (2008), where except in more serious situations, people tend to differ in relation to the same situation whether it is an error or not. By not properly classifying a problem situation arising from human error as an error situation, the individual may react in a way that is not conducive to taking advantage of the learning potential through their dealing with the

situation, as for example, in not turning their attention to examine the causes of the error and how to prevent it.

Furthermore, in relation to individual concepts concerning error situations, it is necessary to take into consideration that the capacity to recognize one's own errors arises, also, from an individual viewpoint on the possibility that errors will occur during the performing of work tasks (Rybowiak et al., 1999). If the individual holds the belief that errors can occur during the execution of his/her work, it is possible that he/she is likely to identify, more frequently, one's own errors than those that hold an excessively optimistic attitude or one of avoidance in terms of errors. This occurs, as suggested by Zhao and Olivera, (2006), through the understanding that error anticipation makes the person direct their attention to the monitoring of their own action and performance, which would favor the immediate identification of errors or the willingness to assess the possibility of these having occurred.

In addition, the results from this study illustrate the positive influence of organizational factors that facilitate learning from errors concerning correction of the error, principally, on the individual level of learning. However, through the research model, it was found that organizational factors had a low practical importance ($f^2 = 0.042$) for the correction of the error, which could be associated to the level of complexity of the errors considered by the respondents The study by Homsma et al. (2009) corroborated that the intensity of effort employed in dealing with the error depends on the severity of its consequences. Understood in a way that the more severe the apparent consequences greater the involvement will be of individuals in activities for generating insights and ideas for dealing with the error, along with the implementation of improvement measures to correct and prevent the recurrence of the error. Through such, in the case of this study, a possible explanation is that part of the errors experienced and considered by the respondents, present a low level of complexity. In light of the previously mentioned, it was not considered necessary to intensively apply, or even access, the support resources of the organizational environment, such as supervisor and peer support, or significant resources in the form of new information or time to deal with the error correction.

Furthermore, in this study, the relationship between error correction and individual learning from the error was modeled and measured, thus confirming that the dimensions of the correction stage – reflection, development of a new action strategy and implementation of the new strategy – demonstrate a significant practical importance ($f^2 = 0.341$) for the formation of new learning. Bearing in mind the need for conceptual clarity as a condition for the proper understanding of learning from the one's own error, it is considered relevant to make a tangible delimitation of the stages of the error treatment process (such as detection and correction) and of the learning as a result of this process. Therefore, it is considered useful, for the theoretical development of the phenomenon that learning from errors is not defined in such a way as to be confused with the error treatment process (cf. Rybowiak et al., 1999; Bauer & Mulder, 2007; Zhao, 2011) and, in fact, as the acquisition of new information or ways to act, as a result of an error situation.

Practical implications

It is understood that it is not possible to eliminate the occurrence of errors in the work context and, for this reason, organizations should identify ways through which they can benefit by means of increasing the learning that individuals obtain from such events. Based on the model analyzed in this study, one notes two aspects of the organizational context that, if actively managed, can favor the learning of individuals.

First, positive error orientation is highlighted as a promoter of learning in individuals. This means that organizational managers should include, within the training programs of corporate universities, learning and development activities related to situations of error in the workplace. To raise awareness and help individuals develop a positive individual error

orientation, such programs could cover learning activities that allow individuals to understand their beliefs in regard to errors and how these tend to deal with such situations. These should include, instrumental training activities, in which individuals learn problem-solving methods based on errors.

Second, however, people need to identify with a psychologically safe environment (Edmondson, 1999) that they can approach, share, and confront their own errors, and which is conducive to the acquisition of new learning. To reach this goal, as shown through the results from this research, the formation of positive orientation to the error depends, in part, on the individual understanding that, when faced with an error situation, it is feasible and productive to seek support from the manager and colleagues, and that it is possible to access the informational and instrumental resources necessary to correct the error. In other words, it is necessary that organizational managers seek to establish a culture of learning from errors (Harteis, Bauer, & Gruber, 2008).

Moreover, the OILOE model has the potential to support the diagnosis, in organizations, of the perceptions of organizational members in relation to their own readiness and the conditions offered by the organizational context to engage in learning processes from errors. When the results are analyzed both by the dimension of the error detection and correction process and by the dimensions of the individual and organizational factors that influence this process, they may indicate areas that need more attention concerning management effort, aimed at increasing learning of individuals based on the error.

Limitations and future research

The first limitation reported, regarding this study, refers to the fact of not having had collected data relevant to the attribute of criticality of the errors on which the respondents were based when answering the questionnaire, since we know that the results of studies suggest that the level of perceived severity for the consequences of the error can influence the lessons learned from the situation. In other words, the tendency to disclose the error, an important condition for increasing the possibilities of learning, would be associated with the occurrence of more severe consequences (Homsma et al., 2009), also errors with consequences evaluated as less relevant may not receive much attention and, therefore, not be addressed through correction and blocking activities (Horvath et al., 2021). It is for this reason that future studies are suggested that explore the influence of the gravity attributed to the consequences of the error in the engaging of the individual in the error correction process and its generated learning. In the context of organizational factors that facilitate learning, it would be relevant to consider how the principles and values of the organization can induce the importance given by people to errors with consequences assessed as not very expressive.

One of the main strengths of this work represents, at the same time, its second limitation, which concerns the model being aimed at the evaluation of learning based on the one's own errors made at work, because as proposed in Horvath et al. (2021, p. 111), "[...] People may learn more from errors made by themselves as opposed to errors made by someone else", depending on the cognitive and affective outcomes of higher learning rates observed for one's own errors. As the results for individual learning from the error, reported in this study, are concerned with, specifically, those errors committed by the very person themselves, new studies could focus attention toward the aspect of how the agent of the error impacts on learning, resulting from their specific handling, while comparing situations of the error committed by the individual themselves and those committed by others. On many occasions, the error is identified not by those who commit the error, but through other individuals who are in some way or other involved, such as colleagues or a manager, and it is at this moment that the individual can take part in the process of dealing with the error, together with the individual that erred.

Finally, the third limitation of the study relates to the already commented restricted capacity of the model to explain the variance of the positive orientation to the error. As such, it is suggested that studies be performed that evidence and examine the influence of specific elements of the work contexts of technology-based organizations in the formation of error orientation of individuals. In addition, it is considered opportune that new investigations that focus on the understanding of positive error orientation, besides considering the specific context of action from an individual, also take into account the various facets of the construct, such as error competence, error strain, error communication, error anticipation and error risk taking.

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Appendix A. Scale items (*N* = 298)

Item	Content	Mean	S.D.	F.L.
CPT1	When I have made a mistake, I know immediately how to correct it	4.829	1.170	0.796
CPT2	When I do something wrong at work, I correct it immediately	6.265	0.971	0.542
CPT3	When it's possible to correct a mistake, I know how to do it.	5.547	1.025	0.807
CPT4	In my work, errors occur that I don't know how to solve right away. (R.I.)	3.547	1.461	x
STR1	I feel stressed when I make mistakes at work.	2.292	1.481	0.744
STR2	I fear making mistakes at work.	2.909	1.783	0.816
STR3	I feel embarrassed when I make mistakes at work.	3.111	1.912	0.809
STR4	I get irritated when I make mistakes at work.	2.742	1.671	0.733
STR5	I get concerned that I might do something wrong at work.	2.463	1.520	0.721
COM1	When I make a mistake at work, I tell others about it in order that they do not make the same mistake	4.960	1.554	0.797
COM2	It is to my advantage to discuss my mistakes with others in my work.	4.896	1.760	0.758
COM3	Hiding my mistakes at work can be helpful. (R.I.)	6.040	1.284	x
COM4	I prefer to keep my mistakes at work to myself. (R.I.)	4.762	1.660	0.780
M&C1	When I make a mistake at work, I can enlist the help of my manager to correct the mistake.	4.500	2.196	0.851
M&C2	When I make a mistake at work, I can enlist the help of my colleagues to correct the mistake.	4.876	1.779	0.851
P&V1	In my work, people consider mistakes to be useful for acquiring new learning.	4.329	1.788	0.787
P&V2	When an error occurs in my work, people consider it more important to determine the causes of the error, not who made the mistake.	4.376	1.719	0.857
P&V3	In my work, those who make mistakes suffer negative consequences, such as dismissal or damage to their professional image. (R.I.)	4.856	1.755	0.689
RES1	In my work, I have access to the information or knowledge necessary to correct a mistake.	4.383	1.341	0.828
RES2	In my work, I have access to the material and technological resources necessary to correct a mistake.	5.292	1.414	0.868
RES3	When I make a mistake at work, I take the time to correct the mistake.	5.144	1.538	0.530
REF1	Before correcting my mistakes at work, I reflect on what happened.	5.930	1.180	0.782
REF2	After detecting that I made a mistake, I think about why the error occurred.	6.191	1.038	0.802
REF3	Before correcting my mistakes at work, I analyze their possible causes.	5.755	1.275	0.725
DEV1	If I am correcting a mistake of mine at work, I think about how to act on the cause of the mistake.	5.886	1.137	0.737
DEV2	If I'm correcting a mistake of mine at work, I don't spend time evaluating different solution alternatives. (R.I.)	4.745	1.716	0.737
DEV3	If I'm correcting a mistake I made at work, I plan the solution first, then take action.	5.430	1.372	x
IMP1	Even though I've planned how to correct a mistake I made at work, I don't implement corrective actions. (R.I.)	5.383	1.668	0.724
IMP2	After taking corrective actions for a mistake at work, I verify that they were effective in preventing the mistake from recurring.	5.671	1.305	0.724
IMP3	If I find that the actions taken to correct a mistake at work have not been effective, I look for new alternative solutions.	6.007	1.025	x
ILE1	Mistakes made by other people help me to improve my work.	5.601	1.454	0.700
ILE2	The mistakes I observe provide me with useful information to do my job.	5.883	1.071	0.663
ILE3	My mistakes help me to improve my work.	6.134	1.123	0.733
ILE4	My mistakes have helped me to improve my work.	6.154	1.043	0.770

S.D.: standard deviation; F.L.: factor loading obtained in the analysis of principal components carried out in jamovi software; R.I.: reversed item; x: indicator removed from the measurement model because of presenting low factor loading.

Appendix B. Items of the formative variable error detection and the factorial scores generated for the latent variables (***N* = 298**)

Item	Content	Mean	S.D.	F.W.
ERR1	In my work, I notice when I perform a procedure differently than I should have.	5.389	1.377	-0.049
ERR2	In my work, when I get a result different from what was expected, I analyze the situation to identify if I made a mistake.	6.107	1.106	0.410
ERR3	When a problem occurs in my work, the opinions and advice I receive from others help me identify if I have made a mistake.	5.664	1.240	0.491
ERR4	When I make a mistake at work, I'm the first to notice.	4.997	1.252	0.655
CPT_score	Factorial score obtained by the average of the items CPT1, CPT2 e CPT3	5.547	0.763	0.840
COM_score	Factorial score obtained by the average of the items COM1, COM2 e COM4	4.872	1.292	0.456
STR_score	Factorial score obtained by the average of the items STR1, STR2, STR3, STR4 e STR5	2.703	1.282	-0.106
M&C_score	Factorial score obtained by the average of the items M&C1 e M&C2	4.688	1.692	0.311
P&V_score	Factorial score obtained by the average of the items P&V1, P&V2 e P&V3	4.520	1.363	0.047
RES_score	Factorial score obtained by the average of the items RES1, RES2 e RES3	5.273	1.066	0.824
REF_score	Factorial score obtained by the average of the items REF1, REF2 e REF3	5.959	0.894	0.838*
DEV_score	Factorial score obtained by the average of the items DEV1 e DEV2	5.658	1.049	0.855*
IMP_score	Factorial score obtained by the average of the items IMP1 e IMP2	5.839	0.990	0.840*

S.D.: standard deviation; F.W.: factor weight (formative construct) obtained in the estimation of the structural model in SmartPLS 3.

* Factor loading obtained in the estimation of the structural model in SmartPLS 3.

Answer options: *7*-point Likert scale from never to always.