What Do We Learn From Errors? Multidimensionality and Motivational Underpinnings of Error Learning

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Abstract

Learning from errors involves analysis and identification of error causes, as well as implementation of solutions to prevent similar errors in the future. The present thesis extends this conceptualization: Integrating research on errors from different contexts, from high reliability organizations to training environments, service occupations, and creative settings, this thesis submits that individuals may experience a variety of error learning types that include task, prevention, response, coping, and meta-learning. The thesis also presents a corresponding Learning from Errors (LFE) measurement inventory with five distinct error learning constructs and offers initial evidence of their validity. Furthermore, the thesis investigates the role of growth- and security-related motives in attaining the five error learning types. Specifically, relying on regulatory focus theory (Higgins, 1997, 1998), the thesis presents a model linking growth concerns with error learning types that maximize achievement and security concerns with error learning types that minimize threat. The findings from three samples confirm distinct influences of growth and security concerns on error learning, however the observed distinctions are different from those hypothesized. Contrary to expectations, security concerns exhibited wide-ranging positive associations with all error learning types, with particularly sizeable contributions to prediction of task, prevention, and response learning. Growth concerns, on the other hand, showed relatively modest influence on prevention and response learning, while positively contributing to task, coping, and meta-learning. Overall, this work highlights the multifaceted nature of learning from errors by providing an integrated theoretical typology, empirically validating the proposed error learning types, and highlighting distinctions in their motivational antecedents.
Keywords

Errors, experiential learning, regulatory focus, error prevention, error management.
Summary for Lay Audience

Encounters with errors at work commonly elicit ideas about learning, such as “errors are a stepping stone to success” or “errors are our best teachers.” The present thesis unpacks the general notion of learning from errors and examines what this learning is actually about. In doing so, the thesis shows that the lessons learned from errors may vary in their nature and content, suggesting that errors may be harnessed for one’s improvement in more ways than one. Specifically, the thesis presents a typology with five distinct types of learning.

From this diversity of potential lessons, what we actually learn depends on our fundamental human needs for growth and security, whether stable or transient. Pre-occupation with self-development and self-actualization is particularly beneficial for learning of new skills and emotional coping strategies, while concern for one’s security is instrumental for realizing the full range of learning benefits offered by errors, including learning to prevent errors and to respond to them when they occur. Thus, both motivations – aspiration for growth and concerns with security – play an important role in learning from errors.

Overall, this work enables researchers to investigate distinct error learning outcomes and suggests a theory linking growth and security motives with different types of learning from errors.
Co-Authorship Statement

I hereby declare that this thesis incorporates some material that is a result of joint research. Chapter 2 is part of the paper that is co-authored with Dr. Fernando Olivera. As the first author on this paper, I was in charge of all aspects of the project including formulating research objectives, literature review, development of a theoretical model, and writing of the manuscript. The co-author contributed to defining the theoretical framework and reviewing the written work.

Additionally, Dr. Fernando Olivera was in charge of designing the qualitative element of the methodology described in Chapter 4.

With these two exceptions, I certify that this dissertation and the research to which it refers are fully a product of my own work.
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Chapter 1

1 Thesis Motivation and Overview

Scholars have long recognized the role of errors in individual and collective learning (Edmondson, 2002; Zakay, Ellis & Shevalsly, 2004; Sitkin, 1992). Errors are decisions and behaviors that result in discrepancies between aspired and actual states that could have been avoided (Zhao & Olivera, 2006). As such, errors provide information about one’s performance relative to goals and are therefore a form of negative task feedback (Zhao, 2011). Errors can motivate individuals to pause and assess the causes of their errors, leading to improved cause-and-effect mental structures and task schemas (e.g., Steinhauser & Kiesel, 2011). In the context of training, errors may contribute to learning of new skills (Keith & Frese, 2005). Additionally, errors can highlight ineffective organizational practices and result in improved systems or processes (Ramanujam & Goodman, 2003).

Although there is evidence that individuals can learn from errors in various contexts, research to date has offered a rather ambiguous account of what is actually learned from errors. The present thesis exposes the “what”, or the content, of learning from errors and, in doing so, advances a multidimensional perspective on the nature of error learning.

In this chapter, I explain the motivation to develop a multidimensional framework of error learning. I begin the chapter by illuminating the diversity of lessons derived from error experiences, as well as some previously observed contradictions involved in attaining these lessons (Section 1.1). This discussion of alternative and sometimes conflicting manifestations of learning will help me make the case for development of a typology of error learning that accounts for a variety of lessons that may be learned from errors.

I then follow this discussion with another observation that motivated this study, namely, inconsistent findings regarding some contextual effects on error learning (Section 1.2). Thus, in the respective section, I briefly outline some of the currently known antecedents of error learning, the challenges in interpreting these models, and the potential role of a multidimensional error learning framework in addressing the search for clarifications and boundary conditions in
these models. I then introduce regulatory focus theory as a useful lens for addressing these research objectives.

Lastly, in the final section of this chapter, I identify the expected theoretical contributions of this work and provide an overview of the main body of this thesis.

1.1 What Is Learning from Errors?

1.1.1 Diversity of Error Learning Types

Much research to date has focused on how errors generate new task knowledge that is helpful for avoiding similar errors in the future (e.g., Ellis, Mendel, & Nir, 2006; Harteis, Bauer, & Gruber, 2008). The principle behind this approach is that as individuals reflect upon their mistakes, they discover the linkages between their actions and the undesired results and integrate these linkages into their cognitive maps of the task. Then, equipped with better knowledge, they are able to avoid making similar mistakes. Accordingly, improvement in overall task knowledge and reduction in error occurrence are two key indicators of error learning (Keith & Frese, 2005; Ellis et al., 2006).

Besides, there are additional aspects of learning from errors that go beyond acquisition of task knowledge and error prevention. For instance, there is some evidence that individuals may learn how to respond to error situations, without necessarily improving their task expertise or reducing error occurrence. For example, a restaurant server may learn to apologize for his mistakes and offer discounts to a customer (Tax & Brown, 1998). In light of the growing recognition of human fallibility in virtually all settings, learning of error response practices appears a promising, yet undertheorized issue.

Similarly, errors create an occasion for improved self-management and resilience (Boyatzis, 2001; Engel, Rosenthal, & Sutcliffe, 2006). Since errors are often accompanied by psychological strain and negative emotions (Brodbeck, Zapf, Prümper, & Frese, 1993), individuals may adopt various coping practices, such as seeking of social support (Bauer & Mulder, 2013) or re-evaluating the significance of an error (Gilovich & Medvec, 1995). Accordingly, development of new practices of emotional coping with errors is another important, yet previously unattended outcome of learning from errors.
Lastly, errors may prompt individuals to learn about learning itself, by for example revising one's process for analyzing errors (Visser, 2007). This revision of error processing practices may be referred to as meta-learning, or learning how to learn. While some discuss this type of experiential learning, it has not been explicitly included in discourse on errors.

Although scholars have alluded to the diversity of potential learning benefits of errors (e.g., Frese & Keith, 2015), we lack a comprehensive theoretical framework that accounts for these various types of individual error learning. Furthermore, error scholarship increasingly emphasizes organizational error management approaches that go beyond prevention of errors (Van Dyck, Frese, Baer, & Sonnentag, 2005). To inform this line of scholarship and ultimately offer holistic and integrated advice to organizations, it is important that we begin exposing a greater variety of adaptive practices and lessons that errors may teach.

1.1.2 Conflicting Error Learning Types

As noted above, learning from errors is typically associated with a reduction in error rates, or improved error prevention (Chang & Mark, 2011; Dahlin, Chuang, & Roulet, 2018; Ellis, 2012; Reason, 2000; Zhao, 2011). That is, recurring errors signal lack of learning, while reduction in errors indicates that learning has taken place. Such focus on error prevention is logical: given that errors may result in undesirable consequences for individuals and organizations (Baker & Norton, 2001; Mangels, Butterfield, Lamb, Good, & Dweck, 2006; Reason, 2000), avoidance of these consequences is often the dominant concern for learning.

This perspective is particularly prominent in high reliability contexts, such as healthcare, aviation, and power plants, where errors may be extremely consequential, costly or even lethal (Reason, 1990). From the Hippocratic Oath “First, do no harm” in healthcare to the proverbial “Safety first” in aviation, high reliability organizations (HRO) instill in their employees a clear idea of errors as negative performance states to avoid and emphasize learning to perform reliably (Catino & Patriotta, 2013; Weick, Sutcliffe, & Obstfeld, 2008). Given that HROs have traditionally been the setting of much research on errors, improved reliability and low error rates have become virtually synonymous with learning from errors. This theme is apparent not only in various definitions of error learning, but also in empirical studies that often use reliability
performance metrics, such as error count or number of correctly executed task elements, as an indicator of learning (e.g., Keith & Frese, 2005; Zhao, 2010).

Increasingly, scholars have been noting some paradoxes resulting from this view of error learning. One particular tension deals with the simultaneous importance of preventing errors on one hand and allowing errors on the other hand: The former is integral to safety and reliability and the latter contributes to task expertise (Lei & Naveh, 2018; Lei, Naveh, & Novikov, 2016). The basis of this tension is that gains in task mastery are often realized at the expense of making more (rather than fewer) errors (Katz-Navon, Naveh, & Stern, 2009). In other words, adoption of error prevention strategies may in fact inhibit acquisition of task expertise. Notably, current conceptualizations of error learning do not account for this tension and in effect subsume conflicting outcomes under the same notion of learning from errors.

Another example of conflicting learning outcomes deals with adoption of error response practices that may come at the expense of error prevention. To the extent that individuals develop convenient practices to deal with errors after their occurrence, they are less likely to engage in the analysis of error causes and identify ways to prevent errors in the future. A number of studies illustrate this argument. In one such study, for example, hospital nurses showed a tendency to correct failures so as to quickly resume their work, which perpetuated similar failures further (Tucker and Edmondson, 2003). Hence, although both error prevention and error correction may be important in the workplace, they may also be at odds with one another, where the learned correction practices interfere with error prevention and vice versa.

In sum, while literature is abundant with claims of the learning benefits of errors and a vast body of studies document occurrence of error learning, it is clear that these studies often speak about different phenomena. As a result, interpreting and integrating reports of error learning from various research domains is challenging and less informative without reference to the content of this learning. Greater care is needed in discerning what type of learning is being achieved, as well as what type of learning is being foregone. In other words, given the diversity of error learning outcomes and the potential trade-offs among them, a multidimensional approach to studies of error learning appears logical.
Our comprehension of and scientific conversation about the phenomenon of learning from errors is inhibited to the extent that existing conceptualizations imply a general and unidimensional nature of learning. Use of such general conceptualizations is particularly problematic in the context of extant empirical literature showing that the same antecedent (e.g., error tolerance) could be beneficial and detrimental to learning or that the same performance outcome (e.g., innovation) could be helped and hindered by learning from errors. In the following section, I consider one specific area of such contradictory evidence and show how a multifaceted view on error learning provides an opportunity and an instrument for interpreting conflicting findings and enhancing our understanding of the motivational underpinnings of error learning.

1.2 Antecedents of Error Learning: In Search of Boundary Conditions

Recognizing the benefits of errors for individuals and organizations, scholars have dedicated much attention to the studies of conditions affecting error learning. These studies are consistent in their reliance on motivational mechanisms behind various contextual effects on learning, yet they present some contradicting findings that are described below. These contradictions call for a closer examination of the said motivational mechanisms and exploration of their boundary conditions. A typology of learning from errors could provide some answers in this search of boundary conditions.

Motivation to learn is arguably the most frequently theorized mechanism behind various contextual effects on learning (Colquitt, LePine, & Noe, 2000; Dahlin et al., 2018). In the error literature specifically, the motivational mechanisms that underlie contextual effects typically fall in one of the two categories: those inducing growth and development aspirations or those appealing to safety and security concerns. With respect to the former, a fitting example comes from the well cited experimental study by Heimbeck and colleagues, where they instructed participants to explore a given experimental task and seek helpful information in error feedback (Heimbeck, Frese, Sonnentag, & Keith, 2003). Here, the training intervention explicitly emphasized the developmental benefits of feedback and thereby positively affected error learning. Similarly, a large number of studies suggest that learning from errors is particularly likely in environments that emphasize growth and development, such as a learning culture (Nikolova, Van Ruysseveldt, De Witte, & Van Dam, 2014), collaborative team contexts
(Tjosvold, Yu, & Hui, 2004), creative occupations (Thomke, 1998), active learning climate (Katz-Navon et al., 2009), and mastery goals (Keith & Frese, 2005).

The second kind of motivational properties germane to the error learning domain involves factors that threaten one’s sense of security. For instance, Van Dyck and colleagues showed poor error learning outcomes as a function of error aversion organizational culture and its characteristic concern with self-image (Van Dyck et al., 2005). Similarly, studies have shown to date that a blaming culture (Khatri, Brown, & Hicks, 2009), punitive leadership (Chikudate, 2009), competitive team contexts (Tjosvold et al., 2004), and performance goals (Keith & Frese, 2005) may negatively influence individual error learning by virtue of instilling perceptions of threatened self and concern for one’s security. Also telling is Edmondson’s seminal paper (1999), where she explains that psychological safety is an important precursor to learning because “it alleviates excessive concern about others’ reactions … that have the potential for embarrassment or threat” (p. 355) and “is likely to reduce insecurity and defensiveness” (p. 356).

In a similar way, Vogus and Sutcliffe showed that trusted leaders can diminish concerns for one’s security in the face of errors and thereby increase discussions of errors (2007). Overall, a large number of studies suggest an inverse relationship between one’s concern for security and learning from errors.

There is some evidence, however, suggesting a non-universal role of growth- versus security-inducing contexts. Specifically, while mastery goals are considered conducive to learning from errors (Dweck, 1986), they have been shown to actually increase occurrence of errors (Keith & Frese, 2005). At the same time, while blaming culture is frequently discussed as an impediment to error learning (Pearn & Mulrooney, 2017), Tjosvold and colleagues actually observed a positive relation between blaming and error learning (Tjosvold et al., 2004). Similarly, some organizational accountability mechanisms, despite generating concerns with “face saving” and upholding of professional image, may result in constructive attributions of errors and lead to learning (Bohns & Flynn, 2013). These findings are inconsistent with the majority of studies that show the supporting role of growth aspirations and hindering role of security concerns.

Such inconsistencies suggest that growth- and security-priming conditions and practices may vary in their effects on error learning, possibly as a function of the specific type of error learning.
In other words, it is plausible that individuals are likely to draw some lessons from their errors under growth orientation and others under security orientation. Therefore, a potentially fruitful answer to these varying effects of growth and security concerns lies in the diversity of alternative error learning types discussed above. Stated more succinctly, the specific type of learning from errors may serve as a boundary condition for the effects of growth and security motives.

1.3 What Regulatory Focus Perspective Offers

So far, in this chapter I have argued for the importance of developing a multifaceted framework of learning from errors on two accounts:

1) current conceptualizations do not account for diverse types of error learning and often subsume contradicting learning outcomes under the general notion of error learning; and
2) the learning outcomes of growth- and security-priming conditions vary and error learning type may be the boundary condition for these effects.

According to this rationale, development of the multifaceted framework of learning from errors would require not only a conceptual account and typology, but also investigation of motivational antecedents of distinct error learning types. Regulatory focus theory appears well suited for addressing this research objective for a number of reasons.

According to regulatory focus theory (Higgins, 1997, 1998), individuals may be motivated by two distinct types of outcomes: attainment of growth and advancement needs or fulfilment of safety and security needs. In turn, self-regulation in relation to growth and security concerns follows two distinct regulatory foci. This postulated distinction is particularly helpful for the present study: Given that the current models of error learning rely on growth- and security-priming mechanisms in their theorizing (as discussed in Section 1.2), the two regulatory foci provide relevant, practical, and proximal predictors of error learning.

Another reason for adopting the regulatory focus lens in this study deals with its explicit focus on reactions to failure. One of the main tenets of this theory is that not all failures are experienced and regulated in the same way. More precisely, a failure to achieve growth leads to different cognitions, emotions, and behaviors than a failure to maintain security. As a special case of failures, errors should also be experienced in two distinct ways, depending on whether growth or
security concerns are active. These differences in error-related cognitions, emotions, and behaviors are instrumental in theorizing when and which type of error learning is likely to emerge, i.e. theorizing the type of error learning as a boundary condition of growth and security motivations. While some other motivation theories have been successfully applied to study error phenomena (e.g., social learning theory, goal setting theory, etc.), regulatory focus lens is particularly advantageous due to its integration of cognitive, affective, and behavioral aspects of self-regulation following failures.

Lastly, on a practical note, since growth and security are fundamental human needs (Idson, Liberman, & Higgins, 2000), the influence of various organizational attributes on learning from errors is likely to occur through activating or intensifying these motivations. By aligning error learning types with growth and security motives, this work may stimulate ideas for future research on organizational determinants of error learning. Moreover, to the extent that various organizational factors, such as leadership (Kark & Van Dijk, 2007; Neubert, Kacmar, Carlson, Chonko, & Roberts, 2008), job attitudes (Johnson, Chang, & Yang, 2010), and incentives (Förster, Grant, Idson, & Higgins, 2001), are currently linked with growth versus security orientation, they may provide potential levers to stimulate error learning in organizations.

1.4 Anticipated Theoretical Contributions and Thesis Overview

1.4.1 From Unidimensional to Multidimensional View on Error Learning

The overarching aim of this thesis is to enhance our understanding of the nature and content of learning from errors. Scholars frequently theorize about errors as learning opportunities, with improved error prevention discussed as the principal learning outcome. This focus on reliability has permeated much of theoretical work on errors, as well as operationalization of error learning in extant empirical research. The present work advances a multifaceted view of error learning that accounts for its various manifestations, including but not limited to error prevention. Accordingly, in this thesis, I develop a typology of learning from errors and a corresponding measurement inventory that capture five distinct error learning types.

Complementing the high reliability perspective, I draw attention to error learning in a range of contexts, from training environments to service occupations and creative settings. These contexts
vary in the kind of errors that individuals may experience (e.g., knowledge mistakes versus slips or lapses of attention; see Reason, 1990) and the magnitude of error consequences (e.g., may be deadly in HROs, but usually insignificant in a training simulation). The rationale for incorporating these various domains in the present study is to expose the types of learning that largely remained in our blind spot as organizational research was dominated by studies of HROs, as well as to create opportunities for cross-fertilization among the different lines of scholarship in error learning.

The multifaceted view on error learning enhances our understanding of errors as occasions for learning and improvement. It sharpens our conceptual grasp on the phenomenon of learning from errors by delineating its typology and developing corresponding constructs. It equips scholars with a conceptual framework and measurement tools for development of more nuanced theories about antecedents and consequences of error learning.

1.4.2 Error Learning Type as a Boundary Condition of Growth and Security Motives

In the present study, I examine the effects of growth versus security concerns on the proposed five error learning types. This contribution is two-fold. First, any observed differences in motivational antecedents among the error learning types further reinforce their distinctions and emphasize the importance of their discernment in future work. Second, this examination directly addresses the inconsistent findings on the role of growth and security motives in learning from errors and thereby helps to outline their boundary conditions. More precisely, this study presents a theory linking growth motives with error learning types that maximize achievement and security motives with error learning types that minimize threat. Thus, I will argue, motivation by growth goals is not universally beneficial for error learning, and motivation by security concerns is not always a hindrance.

Regulatory focus theory is at the core of this theorizing and regulatory focus variables (promotion and prevention) are central to the empirical component of this thesis. This approach directly addresses recent calls in the error literature to explore the relation of regulatory focus theory to error-related phenomena (Frese & Keith, 2015). To my knowledge, the present study is the first to directly investigate the role of regulatory focus in generating learning from errors.
1.4.3 Thesis Scope and Overview

As errors are commonly studied alongside accidents and failures, it is important to clarify how these phenomena are different. Accidents are unintended deviations from performance goals that are due to factors beyond control of an individual (e.g., a power outage preventing an assembly line worker from completing a task). Consistent with prior research (Lei et al., 2016), this thesis leaves accidents outside the scope and considers only avoidable performance discrepancies as constituting errors (Zhao & Olivera, 2006).

Failures are also different from errors: Failures are negative or undesired outcomes that may result from a variety of causes, including errors, accidents, and chance (Hofmann & Frese, 2011). Hence, while failures and errors are not the same, they both may arise from human actions. Insofar as failures are due to individuals’ actions or leave one feeling they “should have known better” (cf. Hofmann & Frese, 2011), failures may also constitute avoidable performance discrepancies, and therefore, are included in theorizing and empirical efforts presented in this thesis.

Extant error taxonomies (e.g., Frese and Zapf, 1994; Hofmann & Frese, 2011) distinguish between errors in action and errors in judgment. Most recently, the literature on errors and error learning in organizations has focused primarily on action-based errors, i.e. those errors that occur in execution and planning of actions (e.g., Frese & Keith, 2015; Lei et al., 2016). In keeping with the current literature, this thesis is also concerned with action errors. Consideration of judgement errors, such as erroneous heuristics and cognitive biases, falls outside the scope of this thesis.

Additionally, the scope of this work is limited to manifest errors, i.e. the ones that individuals are already aware of. It is possible for individuals to learn from errors long after they made them, for example in the case of latent errors (Ramanujam & Goodman, 2003) or when a previously detected failure or accident is reassessed as one’s own error. Conceivably, how and when this awareness comes about may have implications for learning. However, the focus of the study is not on explicating the link between the error detection mode and learning, but instead on illuminating the diversity of lessons that manifest errors may teach.
Lastly, the study is conducted at the individual, rather than team or organizational, level of analysis. Errors are meaningful and formative occurrences for individuals in the workplace, as evidenced by links with expertise, job performance and resilience (Section 1.1.1). Accordingly, the documented occurrence of various learning outcomes among individuals provides a fitting starting point for development and validation of a multidimensional framework of error learning. It is plausible that teams and organizations may also attain a range of error learning types, and so these ideas could provide an extension to the framework introduced herein.

The remaining part of the thesis is structured as follows. In Chapter 2, I review the current state of research on learning from errors, noting the role of two error processing approaches – reflective and reactive. I then explain how these two approaches give rise to four conceptually distinct types of learning from errors. Further, extrapolating the reaction–reflection continuum, I introduce meta-learning, the fifth and most reflection-intensive error learning type. This chapter also discusses the interrelations and tensions among the five types of error learning.

In Chapter 3, relying on the above typology of learning from errors, I develop the study hypotheses about the motivational underpinnings of error learning. After a brief overview of the regulatory focus perspective, I theorize how the two regulatory foci may affect each error learning type.

Chapter 4 describes the methodology for development of a learning from errors measurement inventory and testing of the proposed hypotheses. Here, I discuss the phases of the study, samples used, and features of study design and procedures. The results obtained using these methods are presented in Chapter 5.

Altogether, the proposed conceptual framework, theoretical model, and its results offer new insights into the nature of learning from errors and its motivational underpinnings and open stimulating avenues for future research, which I discuss in Chapter 6.
Chapter 2

2 Typology of Learning from Errors

2.1 Reflective and Reactive Approaches to Error Learning

Zhao conceptualizes individual learning from errors in organizations as “the process through which individuals (a) reflect on errors that they have made, (b) locate the root causes of the errors, (c) develop knowledge about action-outcome relationships and the effects of these relationships on the work environment, and (d) use this knowledge to modify or improve their behavior or decision making” (2011: 436). This definition stresses the reflective nature of learning, whereby individuals acquire new knowledge by means of evaluating and analyzing their experiences and relating them to existing knowledge (Ellis & Davidi, 2005).

Such focus on learning as a reflective process is in keeping with multiple perspectives on workplace learning. For example, central to Kolb’s theory of experiential learning is reflective observation, or consideration of one’s direct experience from different perspectives (Kolb, 1984; Kolb & Kolb, 2005). Similarly, Lewin’s model of action learning maintains a key role of fact finding and analysis in reaching conclusions about one’s experience (Lewin, 1946, 1948). Dewey too stresses that learning is an “intellectual process,” whereby one gathers information and advice from others, as well as own recollections to judge the appropriateness of certain plans and methods of action (1938: 69).

As the above theories suggest, reflection is a potent mechanism for transforming one’s errors into new knowledge. Numerous studies provide empirical evidence of this perspective. For instance, scholars have found that asking questions, seeking feedback, and reflecting on one’s actions results in improved performance following errors (Carmeli & Gittell, 2009; Frese & Keith, 2015). According to Ellis and colleagues, reflection improves performance because it allows individuals to evaluate the contribution of various factors to an error and recognize their own responsibility (Ellis & Davidi, 2005; Ellis et al., 2006).

While theory and empirical findings suggest a positive role of reflective processes in creation of error learning outcomes, there is also evidence that individuals do not necessarily engage in
reflection following errors, but instead act to provide corrective solutions or remedial actions. For example, in their study of patient care failures in hospitals, Tucker and Edmondson observed nurses implement short-term fixes for various failures, “enabling them to continue caring for their patients, without taking any action to try to prevent recurrence of similar failures” (2003: 60). In another study, Pilbeam and colleagues investigated the learning practices of managers and front-line workers of three retail and logistics companies; the authors found that instances of immediate correction of safety incidents occurred about 3.5 times more frequently than episodes of reflection and discussion (Pilbeam, Davidson, Doherty, & Denyer, 2016).

Such action-oriented processing of errors has received critique in the literature. Particularly, scholars have found that foregoing reflection to instead focus on handling of the error consequences may hinder learning because it leaves faulty systems or processes unchanged (Tucker & Edmondson, 2002, 2003; Edmondson, 2004). This position is consistent with the traditional theories of experiential learning discussed above. Specifically, Dewey argues for “postponement of immediate action … until observation and judgement have intervened” (1938: 69).

However, Argyris and Schön’s (1978) seminal theory offers a somewhat different view on action-based error processing. In part, this theory parallels the above logic: It posits that learning occurs when individuals discover a mismatch between intentions and outcomes and then examine and question the conditions that led to performance mismatches. This mode of learning has been termed double-loop learning, implying that in this process not only are the mismatches corrected, but also the factors that contributed to the mismatch are adjusted. However, the authors also suggest an additional mode of learning – single-loop – whereby individuals immediately correct the discovered mismatch. Single-loop learning leaves the norms and practices that led to an error unchallenged, but rather involves adapting one’s behavior to the new situation, and modifying the strategy of goal attainment within the constraints of existing norms (Akbar, 2003; Argyris, 1976).

Some scholars have argued that action-based approaches to error processing may lead to meaningful learning outcomes. That is, acting upon one’s error immediately may provide an impetus for certain types of error learning for which reflective practices do not account. For
instance, responding to errors may lead individuals to infer appropriate error handling techniques that may be hard to conceive of through reflection alone (Palmer, Beggs, & Keown-McMullan, 2000). These ideas are consistent with Schön’s argument about professional growth as a series of problem-solving episodes, where actions following errors generate new information and experiences that over time can accumulate and form new professional practices (1983).

Central to Schön’s argument is the distinction between reflection-on-action and reflection-in-action (1983). In the former, consistent with the double-loop learning view, individuals pause and look back at the potential causes and events preceding their errors; it is a reflection on past performance. In the latter, individuals accept the manifest error as a given and seek an appropriate reaction to it. In this reactive processing of errors, the concern is with moving forward while at the same time thinking about available tools and practices. In other words, Schön does not view action-based learning as reflection-less, but rather highlights that problem-solving through a concurrent combination of thinking and doing may benefit learning.

Hence, research suggests that both reflective and reactive processing may yield important and adaptive learning outcomes, however the content of this learning will differ between those looking backward, or reflecting upon past actions, and those looking forward, or addressing a manifest error (FIGURE 1). I now move on to explaining each proposed type of error learning.

### 2.2 Reflective Error Learning Types: Task and Prevention

Errors are disruptive to the expected flow of events and disconfirm one’s expectations about the outcome (Pyszczynski & Greenberg, 1981). As a result of such “surprise”, individuals may engage in causal search and discover the cause-and-effect relationship responsible for bringing about an unfavorable outcome (Gendolla & Koller, 2001). Much scholarship shows that such analysis of errors generates new task knowledge that is helpful for avoiding similar errors in the future (e.g., Ellis et al., 2006; Harteis et al., 2008). It is worth noting however that these two outcomes – task learning and future error prevention – are neither equivalent, nor necessarily concomitant: It is possible for someone to avoid repeating mistakes without learning about the task itself (e.g., by becoming vigilant) and it is also possible to improve one’s task knowledge and still repeat mistakes (e.g., under stressful conditions). Furthermore, there is often a trade-off between gains in task expertise and error prevention, whereby adoption of vigilant strategies
effectively inhibits task learning (Katz-Navon et al., 2009). Therefore, task learning and learning of error prevention strategies are conceptually and empirically distinct in theoretically meaningful ways.

**FIGURE 1. Typology of learning from errors**

<table>
<thead>
<tr>
<th>Looking back (considering possible causes of error, preceding actions and contributing factors)</th>
<th>Moving forward (accepting the manifest error and seeking an appropriate reaction)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task Learning</strong> Recognition of previously unknown task rules and elaboration of one’s mental model of a task</td>
<td><strong>Response Learning</strong> Recognition of unmet task goals and adoption of error correction practices</td>
</tr>
<tr>
<td><strong>Prevention Learning</strong> Recognition of deviations from known task rules and adjustment in one’s vigilance practices</td>
<td><strong>Coping Learning</strong> Recognition of negative strain and adoption of coping practices or change in emotional evaluation of errors</td>
</tr>
<tr>
<td><strong>Meta-Learning</strong> Increased awareness of oneself as a learner and adjustment in one’s learning practices</td>
<td></td>
</tr>
</tbody>
</table>

Task learning, or elaboration of one’s mental model of a task, may occur in the context of training, when individuals seek to develop new skills. For example, error management training (EMT) is designed in a way that emphasizes the informational value of errors and instills an aspiration for task mastery (through statements such as “You have made an error? Great! Because now you can learn something new!”) (Keith & Frese, 2008). So in such a training task, individuals are guided to reflect on their errors to build task expertise. This reflection and examination of errors is consistent with the notion of deliberate practice that involves gains in expertise through continual task exposure and task feedback (Ericsson & Lehmann, 1996).

Outside of training environments, reflection may produce task learning in some creative settings, such as trial-and-error experiments, where individuals examine each error with a goal to discover
new information (Lee, Edmondson, Thomke & Worline, 2004; Thomke, 1998). Likewise, “fail-fast” methodologies in research & development and software design encourage continuous surfacing of errors, thereby incrementally adding to the subject matter knowledge (e.g., Khanna, Guler, & Nerkar, 2016). Similar to EMT context, in these creative domains, errors are often considered desirable outcomes, while concern for error prevention (“getting it right the first time”) is considered inhibiting (Thomke, 1998: 743). These findings further reinforce the idea that error learning does not equate error prevention, but instead may involve new insight about the tasks, systems, and processes.

Through task learning, individuals realize that some previously unaccounted factors and cause-and-effect relationships may be integral to the task (Gendolla, & Koller, 2001; Wills, Lavric, Croft, & Hodgson, 2007). For example, an EMT trainee learning a new presentation software after having failed at editing an object may discover that it is necessary to select it before trying to make changes. And so, errors result in discovery or inference of new task components, or elaboration of a mental model of a task (Heimbeck et al., 2003; Keith & Frese, 2005). Likewise, soldiers completing a navigation course in the process of after-event reviews may identify that specific ground conditions affected their pace and ultimately impacted performance (Ellis & Davidi, 2005). Inference of such if–then rules and their integration with the existing knowledge structure about the task represent task learning (Ellis, 2012).

However, as tasks become more thoroughly elaborated, scripted, familiar, and routine, knowledge-based errors become fewer, while slips of attention or instances of impaired situation awareness are more frequent (Reason, 1990). Here, reflection is less likely to provide new elements or rules of task performance, but instead may help pinpoint erroneous actions, distractions or interferences and devise a solution that blocks them in subsequent performances (Reason, 2000). I label adoption of such error vigilance strategies “prevention learning.”

Prevention learning is especially likely in organizational settings where errors may result in particularly severe or even deadly outcomes. For example, motivation to avoid errors in patient treatment in hospitals has resulted in implementation of checklists (Hannam et al., 2013; White, Trbovich, Easty, Savage, Trip, & Hyland, 2010) and overlapping task structures (Samaranayake, Cheung, Chui & Cheung, 2013). Similarly, aversion of safety risks in aviation necessitates
installment of physical reminders in the form of automated vigilance devices or safeguards that help detect potential issues before they manifest in errors (Tamuz, 2001).

However, prevention learning is not limited to organizations in high reliability sector. For instance, reminders to verify entered food orders at point-of-sale terminals in restaurants help servers adhere to customer service expectations. Across various organizational settings, such vigilance practices ensure that individuals are constantly aware or reminded of the possibility of errors and are “better able to notice the unexpected in the making and halt its development” (Weick & Sutcliffe, 2001: 3).

Most research related to error prevention has been conducted at the organizational level of analysis and portrays learning as an improvement in organizational systems and practices. These improvements, however, reflect concrete behavior changes occurring for organizational members, and therefore, give insight into what individual error prevention learning may look like. In fact, people commonly experience prevention learning in daily life. Individuals who often forget important dates, for instance, may implement a practice of writing reminders or asking someone to remind them of important dates. Analogously, learning from a wrong turn on the road may involve programming the in-car navigation system to alert to the correct turns. These vigilance devices and practices indicate improvement in one’s ability to prevent errors.

2.3 Reactive Error Learning Types: Response and Coping

Reactive error processing is common in certain kinds of organizational environments. For instance, some service delivery workers experience frequent errors and accept them as a norm, rather than a surprise that merits deliberate reflection. Moreover, as pressures for customer satisfaction are growing more intense in the service industries and customers react ever more strongly to service failures, service organizations require quick and often improvised actions from their employees in response to errors (Pina e Cunha, Rego, & Kamoche, 2009; Smith, Bolton, & Wagner, 1999; Wirtz, & Mattila, 2004). Consequently, the focus in many service settings is on successful recovery from failures and using them as a fruitful opportunity to increase overall customer satisfaction and positive word-of-mouth (Hart, Heskett, & Sasser Jr, 1990; Maxham, 2001).
Echoing this logic, research on error management has outlined a number of ways in which organizations and individuals may take advantage of errors for adaptive performance. Error management practices focus on effective dealing with errors after they occur, i.e. when the discrepancy between aspired and actual outcomes is already manifest (Van Dyck et al., 2005). From that point, the focus of performance becomes error detection and reporting, as well as handling of error consequences (Frese & Keith, 2015).

As the above lines of research suggest, errors are disruptive, but not terminal performance states, i.e. individuals and organizations must continue their operations following errors and achieve their intended outcomes. While some industries and organizations provide individuals with procedures and protocols for handling errors (e.g., aviation, Helmreich, 2000), in others individuals are often left to their own devices as they move forward from errors.

Errors put individuals into an unchartered territory with no readily available script or routine (Bledow, Frese, Anderson, Erez, & Farr, 2009). Moreover, errors may change one’s task environment by making it more vulnerable to various risks and demanding one to work around these risks (Ramanujam & Goodman, 2003). Responding to and improvising in these unfamiliar situations is how error handling practices may emerge. For instance, literature on service failures suggests that through dealing with errors, service workers may infer such aspects of proper recovery as speed, initiation, and compensation (Smith et al., 1999). Similarly, Crigger (2004) discusses how through responding to their mistakes, nurses may deduce proper ways to apologize and make amends.

Notably, while error recovery often relies on one’s task knowledge to correct missed or erroneously performed actions, learned response strategies may also be separate from one’s task knowledge. For example, learning to apologize and engage a manager following service mistakes is different from learning the rules of proper table service in a restaurant. More broadly, in responding to errors, individuals may identify and refine ways to deal with an error after its occurrence (La & Kandampully, 2004). I label such adoption or revision of error correction practices “response learning.”

Yet individuals may not always react to errors in a problem-focused way, as the emotional experience may demand alternative actions. Errors often elicit negative feelings in the form of
fear, sadness or guilt (Zhao, 2011), as well as self-conscious perceptions, for example that one lacks ability, has inadequate skills or is generally incompetent (Mangels et al., 2006; Scott et al., 2009). External error consequences such as reputational damage, loss of professional license, and risks to job security may further exacerbate the negative self-evaluations and self-conscious internal dialogue following errors (Baker & Norton, 2001; Grissinger, 2014).

Moreover, some errors have the power to shock, paralyze, and immobilize individuals, especially if they are attributed to oneself (Crigger & Meek, 2007; Scott et al., 2009). For instance, nurses and other healthcare practitioners often report extreme anguish, guilt, and isolation that come with many kinds of medical mistakes (Engel et al, 2006). Likewise, Shepherd and colleagues discuss the demoralizing and debilitating effects of frustration and grief following a failure among some scientists and entrepreneurs (Shepherd, 2003; Shepherd, Patzelt, & Wolfe, 2011).

When the severity of negative consequences is looming and anxiety becomes overwhelming, actions that provide desensitization and relief from the negative charge may become critical for overcoming inaction and ensuring adaptive performance (Parrott, 2001; Staw, Sandelands, & Dutton, 1981). Various coping practices are likely to arise from emotive reactions to errors. For example, Bauer & Mulder (2013) showed that nurses turn to venting and other means of social support to alleviate the emotionally taxing experience of errors.

Learning to cope with errors may involve not only behavioral coping strategies (e.g., seeking social support), but also a change in the emotional evaluation of errors. Thus, Gilovich & Medvec (1995) found that individuals engage in various psychological repair processes, such as identifying silver linings and offering justifications, to minimize the feelings of regret about errors. Some common justifications may be that errors are human and everyone makes them, or that no harm is done, or that things could have gone worse. These findings are in line with the work of Argyris and colleagues who discuss the learners’ inclination to look inward to their feelings and employ various defense mechanisms to cope with errors (Argyris, Putnam, & Smith, 1985).

Coping research has identified a number of coping styles and tactics, while also examining which of them and under what conditions are adaptive versus maladaptive (Brown, Westbrook, & Challagalla, 2005; Carver, Scheier, & Weintraub, 1989). It should be acknowledged that in the
context of errors individuals may learn both. Learned coping practices may help sustain attention on the task (Eysenck, Derakshan, Santos, & Calvo, 2007) and avoid so-called error cascades, where one error escalates into more errors (Frese & Keith, 2015). For example, reappraising one’s errors as less dire and accepting a more tolerant view on errors has shown adaptive benefit for performance (Bosk, 2003; Weinzimmer & Esken, 2017). However, individuals may also learn such coping practices as shifting the blame or covering up errors (Frese & Keith, 2015). These ways to cope are consistent with theorizing of Argyris and colleagues, who suggest that errors are often seen as threatening and predispose individuals to become defensive (Argyris et al., 1985). It is not the intention for this paper, however, to further elaborate the distinctions between adaptive and maladaptive coping practices, but rather the intention is to emphasize the importance of errors as occasions for coping learning.

2.4 Learning about Learning: Meta-Learning

A more recent development in the literature on single- versus double-loop learning introduces the notion of triple-loop learning. Triple-loop learning is associated with shifting one’s assumptions and habits underlying the very process of learning (Peschl, 2007; Tosey, Visser, & Saunders, 2012). At the core of this notion is the work of Bateson (1972), who suggests that individuals may reflect on the process of learning itself and adjust the rules for transforming direct experience into new knowledge. Bateson calls such adjustments “deutero-learning” and defines it as development of strategies that maximize learning of all other types.

Similar ideas are offered in the U-Theory of learning (Senge, Scharmer, Jaworski, & Flowers, 2004), whereby the left branch of the “U” represents observation and perception of oneself; then at the bottom part of the “U” one lets go of the habit to look outside themselves for explanations and becomes ready to change internally; and finally, the upward branch deals with realization and embodiment of new beliefs and outlooks. This process brings about profound changes in oneself (rather than directly affecting performance or work processes) and is sometimes referred to as “individual cultivation” (Peschl, 2007).

Similar to other metacognitions, meta-learning is complex and costly, as it requires not only using one’s mental activity, but also describing or controlling it (Allen & Armour-Thomas, 1993; Brown, 1987). In other words, it is the most reflection-intensive learning type. Meta-learning
involves increased awareness of oneself as a learner and adjustments in one’s own behaviors and beliefs related to learning from errors. It involves deliberate analysis of the past learning situations and deriving or updating learning practices based on the results of such analysis. For instance, someone who learns the driving directions by looking them up on the map may reflect upon this learning strategy, evaluate it as less efficient than asking other people for directions, and begin to communicate more with others about mistakes.

By way of reflecting on and evaluating one’s learning processes, habits, and assumptions, meta-learning is likely to lead to retention and reinforcement of effective learning practices and adjustment and revision of others. Thus, while cognitively demanding, meta-learning may positively contribute to learning of the other four types.

2.5 Relationships among the Five Types of Error Learning

As previously reviewed research suggests, there are ways in which these distinct learning types may be in conflict. Consider a driver who adopts the practice of following his navigation system so as to avoid wrong turns. Such error prevention method effectively limits the driver’s mental schema to only those routes prescribed by the navigator and diminishes opportunities to elaborate his knowledge of the road network in the area. Such conflicts between prevention and task learning are at the core of the error management training literature that shows that error avoidance instructions interfere with acquisition of task expertise (Keith & Frese, 2005).

The earlier noted tension between reactive and reflective practices can also be easily understood in terms of the learning trade-offs. For example, a driver may learn to minimize the negative emotions following errors by blaming others on the road and thereby maintaining a positive image of himself. This scenario is in line with self-evaluation research that shows that individuals may turn to favorable attributions of their failures as a means to protect their self-regard (Sedikides & Strube, 1997). While learning to cope in this manner may improve the individual’s emotional state, it may also preclude him from learning to prevent such mistakes in the future. In the same way, knowing that there is a convenient alternative route in case of making the wrong turn may prevent the driver from learning to avoid the wrong turn in the first place.
Nonetheless, because the five types of learning differ in their cognitive content (e.g., lessons about blocking potential distractions vs. lessons about oneself as a learner), it is possible that multiple types of learning may occur simultaneously in relation to the same error and even reinforce one another. For example, a person who learns the fastest route to work (task learning) may next decide to program his navigation system to remind him of this route and ensure against wrong turns (prevention learning). Analogously, a person who learns to take the next best turn on the way to work (response learning) may also realize that errors are often easy to recover from and should not be perceived as very negative (coping learning). It is also likely that someone who learns to think about wrong turns constructively rather than emotionally (coping learning) may learn that asking someone about different routes is a good way to learn (meta-learning).

Overall, the five types of error learning together provide an inventory of outcomes that one may experience after an error. Error learning may involve any one of the five types individually or in a combination with others. This line of logic implies that repeated errors (inability to prevent errors) are not necessarily a sign of a failure to learn, but potentially an indicator that some other type of learning has taken place. Accordingly, the subsequent theorizing considers the five learning types as alternative and nonequivalent constructs, rather than indicators of a higher order learning construct.

Chapter 3

3 Hypotheses Development

3.1 Regulatory Focus Theory

According to regulatory focus theory (Higgins, 1997, 1998), individuals may view their pursuits as aligned with growth and advancement needs or with safety and security needs. When individuals view their pursuits as a way to promote growth, i.e. achieve their ideals and aspirations, their self-regulation is said to occur under promotion focus. In contrast, when individuals view their pursuits as a way to maintain security, i.e. uphold their oughts and
obligations, their self-regulation follows prevention focus (Higgins, Roney, Crowe, & Hymes, 1994; Scholer & Higgins, 2013).

The two regulatory foci reflect not only what one strives toward (growth vs. security), but also how they go about it: how they attend to and process feedback, how they emotionally experience progress toward goals, and what behaviors they engage in. When individuals pursue growth (are in promotion regulatory focus), they are sensitive to positive performance states, construe performance situations as either gains or nongains, experience affective reactions along the cheerfulness–dejection spectrum, and engage in expansive or approach behavioral strategies. In contrast, when individuals pursue security (are in prevention regulatory focus), they are sensitive to negative outcomes, consider situations as either nonlosses or losses, experience emotions along quiescence–agitation scale, and employ inhibiting or avoidance behaviors (Higgins, 1997).

In the subsequent sections of this chapter, I further elaborate these key distinctions, as I theorize their contributions to error learning.

In general, regulatory focus research mirrors many of the findings observed in the organizational literature regarding the role of growth and security concerns in learning from errors. Specifically, studies have linked promotion focus with engagement in self-enhancement and self-improvement behaviors, such as learning (Leonardelli, Lakin, & Arkin, 2007; Hepper, Gramzow, & Sedikides, 2010). Furthermore, promotion focus is related with cognitive flexibility and ability to discern relationships between the parts and the whole (Zhu & Meyers-Levy, 2007). Moreover, promotion-oriented individuals are likely to persist in the face of failure (Crowe & Higgins, 1997) and maintain perception of efficacy and control over their outcomes (Langens, 2007; Lanaj, Chang & Johnson, 2012). All this evidence points to a generally positive association between promotion focus and learning from error feedback.

A contrasting case is made in extant research for the impact of prevention focus on learning from errors. First, concern for one’s security has been related to various self-protective behaviors, whereby individuals deflect the responsibility for failures and forego learning opportunities (Leonardelli et al., 2007). Second, on the cognitive side, concern for one’s security typically immerses individuals in the specifics of the situation, precluding them from seeing relationships between the parts of the whole (Zhu & Meyers-Levy, 2007). Furthermore, prevention focus is
associated with decreased self-efficacy following failures (Lanaj et al., 2012) and even quitting behaviors (Crowe & Higgins, 1997).

Overall, evidence from organizational research and social and personality psychology presents a strong case for the benefits of growth motives for learning from errors. At the same time, it makes error learning seem unlikely under security-centered mentality. The remaining part of this chapter builds on the above literatures and offers nuance to our understanding of these effects. Toward this end, I submit that both promotion and prevention foci may lead to learning, but also draw distinctions between them based on the types of error learning they produce. **FIGURE 2** below summarizes the hypothesized relationships and theorized mechanisms.

This figure illuminates two things. First, when read from left to right, it shows the differences between the two foci in the error learning they help attain. Specifically, prevention focus is theorized as a motivational predictor of prevention and coping learning, while promotion focus as a predictor of task, response, and meta-learning. Second, when reading the figure from top to bottom (looking at layers separated with dotted lines), it highlights that different mechanisms are at play for attaining reflective versus reactive learning types. So, search and attention patterns (vigilance/eagerness) and counterfactual thinking (subtractive/additive) are responsible for bringing about reflective types of learning, which in turn are distinct for the two foci (prevention/task). In contrast, perspective on errors (threat/modifiable nongain) and intensity of negative arousal (high/low) are the mechanisms behind reactive types of learning, which are also distinct for the two foci (coping/response). Lastly, explorative inclination and capacity for abstract thinking are the mechanisms connecting promotion focus with meta-learning. Below, I elaborate each of the proposed relationships.
FIGURE 2. Study hypotheses and theorized mechanisms

Prevention focus
(regulation in relation to security concerns)

- Predilection for vigilance
- Subtractive counterfactuals

View of errors as threats
High negative arousal

Promotion focus
(regulation in relation to growth motives)

- Predilection for eagerness
- Additive counterfactuals

View of errors as modifiable
Buffering of negative arousal

Mechanisms affecting
reflective learning types

Mechanisms affecting
reactive learning types

H1
Prevention Learning

H2
Coping Learning

H3
Task Learning

H4
Response Learning

H5
Meta-Learning

Exploration & experimentation
High capacity for abstract thinking
3.2 Influences of Prevention Focus on Error Learning

Prevention focus may be an individual chronic disposition that develops in childhood as result of particular child-caretaker interactions in which the child does not feel secure or validated (Higgins, 1997). However, one’s environment is often responsible for inducement of security concerns and activation of prevention focus. Specifically, environments with strict rule enforcement, social pressures, emphasis on obligation, and punishment for losses may be the source of a situational prevention focus (Van Dijk & Kluger, 2011).

In prevention focus, safety and security concerns sensitize individuals to the presence of negative outcomes, where individuals continually search for and readily perceive errors (Higgins, 1997). This heightened attention to possible errors makes individuals endorse conservative, cautious, and vigilant behaviors that help avoid mistakes and errors (Wallace & Chen, 2006; Wallace, Little, & Shull, 2008). For example, a prevention-oriented server at a restaurant may strive to uphold his responsibilities by closely following the rules and specifications of service or carefully heeding customer requests, as falling short of these expectations would threaten the acceptable status quo.

Strong performance of prevention-oriented individuals in accuracy demanding tasks, such as proof-reading, has also been attributed to their vigilance against mistakes (Forster, Higgins & Bianco, 2003). A recent meta-analysis further supports these findings by showing a positive association between prevention focus and safety performance (Lanaj et al., 2012). In other words, prevention focus enables individuals to do well in terms of minimized erring through heightened vigilance. In line with this research, other behaviors directed at reducing occurrence of errors are also likely under security motives. Consequently, prevention regulatory focus should be positively associated with prevention learning.

Studies on errors in training support these ideas. Namely, Keith and Frese show that when evaluated on adherence to specific training procedures, individuals adapt their behavior to ensure low error occurrence (2008). Here, in efforts to maintain adequate performance, individuals focus their attention on the prescribed steps of the training task, avoid exploration and experimentation, and become vigilant against distractions (Freitas, Liberman, & Higgins, 2002;
Leroy & Schmidt, 2016). Outside of laboratory environments, in organizational settings too, individuals operating under strict performance standards or safety requirements with enforced adherence to rules typically experience few errors (Wallace & Chen, 2006).

Besides strong vigilance, prevention focus may benefit learning of error prevention strategies through another mechanism. Research shows that security concerns direct reflective thought toward identifying and blocking erroneous actions. For example, in considering performance of others, prevention-oriented individuals focus on negative role models, i.e. those portraying what not to do, so as to prevent similar erroneous actions from their own performance (Lockwood, Jordan, & Kunda, 2002). Even more telling are studies showing that in prevention focus, individuals tend to construct subtractive counterfactuals, i.e. mentally remove erroneous actions from their performance, by thinking what they should not have done (Roese, Hur, & Pennington, 1999). Aiding in such reflection is the local information processing (Forster & Higgins, 2005) and focus on the specifics of the situation (Zhu & Meyers-Levy, 2007) characteristic of prevention focus. These cognitive mechanisms ensure that individuals are better able to zero in on most important contributors to the error before it can be blocked.

For example, a prevention-minded server who delivered the wrong meal may think counterfactually that they shouldn’t have assumed or guessed what the customer meant, or shouldn’t have rushed or got distracted. These identified causes of errors are directed at blocking erroneous actions, and therefore should contribute to prevention learning. For instance, continuing with the server scenario illustrated above, they may decide from that point onward to read the order back to customers so as to avoid wrong guesses. This new prevention practice will, in turn, help them stay vigilant, uphold job responsibilities, and minimize concerns with security.

In sum, heightened vigilance and subtractive pattern of reflection should lead to adoption of behaviors that minimize error occurrence. Accordingly, I advance the following hypothesis:

**H1: Prevention regulatory focus is positively associated with error prevention learning.**

Prevention focus is associated with a tendency to adopt performance-avoid goals, i.e. seek to validate one’s abilities and not lose face (Lanaj et al., 2012). This means that performing without
errors allows one to avoid embarrassment and maintain a positive self-regard, while making errors brings about feelings of insecurity and is therefore perceived as a threat. These threats in prevention focus are associated with high-arousal negative affect. Specifically, prevention failures generate feelings of agitation, anxiety, fear and restlessness that are most arousing on the emotional intensity scale (Idson, Liberman, & Higgins, 2000; Brown & Rogers, 1991).

Perceived threat accompanied with high levels of affective arousal are likely to recruit various emotional coping strategies following errors. Indeed, research shows that prevention-focused individuals tend to engage in such defensive practices as self-serving construal of events (Hepper et al., 2010), self-handicapping behaviors and other avoidance practices, including quitting, (Leonardelli et al., 2007) to deflect the responsibility for suboptimal performance and maintain a positive outlook. An example of defensive strategies employed following errors is thinking that the task is not indicative of one’s abilities or finding other reasons to discount failure feedback (Hepper et al., 2010).

A number of already cited studies on errors in healthcare support the above arguments from the regulatory focus research. Namely, they show that salience of safety concerns and strivings to uphold one’s responsibilities bring about insecurities and perceptions of threat following errors, and consequently lead to adoption of emotional coping practices (e.g. Bauer & Mulder, 2013). Accordingly, adoption of coping strategies appears instrumental for attenuating perception of threat and negative emotional arousal in prevention focus. And so, I propose the following hypothesis:

\[ H_2: \text{Prevention regulatory focus is positively associated with coping learning.} \]

In sum, prevention focus and its characteristic avoidance predilection are likely to stimulate the types of learning aimed at minimizing risks to security or inhibiting occurrence of threats, namely, by reducing errors and error-related strain. Accordingly, \textit{FIGURE 2} relates prevention focus with prevention and coping learning.

It is unclear whether prevention focus affects the other three learning types. There is some evidence of a negative association. With respect to task learning, training research suggests that security concerns limit constructive reflection and exploration and do not lead to learning of new
skills as reflected in low adaptive transfer (Keith & Frese, 2005, 2008; Frese & Keith, 2015). Similarly, the perception of threat and need to protect oneself are likely to direct one’s attention away from the problem solving necessary for response learning (cf. Kanfer & Ackerman, 1989). In this vein, studies showed that following prevention failures, individuals experience sharp drops in self-efficacy and may even quit the task (Crowe & Higgins, 1997), naturally impeding error recovery. By analogy, focus on security is unlikely to result in adoption of new learning practices, or meta-learning. On the other hand, some scholars have argued that the sense of need and obligation inherent in security pursuits may help one stay constructive following failure (Shah & Higgins, 1997). Because we currently have inconclusive theory to hypothesize about prevention focus effects on task, response, and meta-learning, I will examine these relationships in an exploratory manner.

3.3 Influences of Promotion Focus on Error Learning

Promotion focus may be a trait-like disposition to pursue growth and advancement that develops in childhood and results from caring and nurturing child-caretaker relationships. However, individuals can also be induced into a state promotion focus when their environment inspires maximal and idealistic strivings, emphasizes continuous growth and improvement, and rewards for positive change (Van Dijk & Kluger, 2011).

In promotion focus, sensitivity to positive outcomes predisposes individuals to risky behaviors and eager goal pursuit (Crowe & Higgins, 1997). Here, individuals venture into new opportunities and seek to identify various ways to attain their desired outcome. For example, a promotion-oriented server at a restaurant may strive towards his performance ideals by making her personal recommendations off the menu or injecting humor into customer interactions.

The motivation to attain gains and eager regulatory state make individuals adopt learning goals, where they actively examine and reflect upon their experience so as to derive new insights for performing a task (Lanaj et al., 2012). Also, due to the general inclination to maximize growth and achievement, promotion-focused individuals’ tend to engage in self-enhancement and self-improvement behaviors, such as competency building (Leonardelli et al., 2007; Hepper et al., 2010). For instance, promotion individuals may continually evoke thoughts about how they have grown and improved over time or seek positive role models to glean insight into ways to succeed.
(Lockwood et al., 2002). This eager regulatory state is likely to result in elaboration of one’s task domain.

Furthermore, the pattern of reflective thought under promotion focus follows the additive principle, whereby one continually identifies new actions to be added into their repertoire. Thus, in thinking about their errors, promotion-focused individuals tend to construct additive counterfactuals, i.e. identify things they should have done (Roese et al., 1999). Further helping in such reflection is the global information processing (Forster & Higgins, 2005) and relational elaboration of a situation (Zhu & Meyers-Levy, 2007) characteristic of promotion focus. These cognitive mechanisms mean that individuals are better able to discern relationships between the specifics and the whole and make connections among disparate parts of a task or situation (Zhu & Meyers-Levy, 2007). Accordingly, guided by the “big picture” view of the task, promotion-focused individuals are likely to elaborate their overall task expertise through specific errors. For the above promotion-focused restaurant server, for instance, such updating of the task algorithm may involve thoroughly learning the menu, expanding the service skillset, and harnessing the social competency to better connect with customers. Searching for and recognizing these various methods of goal attainment that occur through relating the whole of one’s job and the specific error situations are likely contributors to task learning.

In sum, eagerness to identify new ways of goal achievement combined with additive pattern of reflective thought should make task learning likely under promotion focus. Altogether, the above arguments lead to the following hypothesis:

H3: Promotion regulatory focus is positively associated with task learning.

In contrast with the threat-based view of errors adopted in prevention focus, promotion-oriented individuals view errors as nongains. In other words, for a promotion-focused person errors indicate that the goal is not met yet and other actions should be taken to ensure success. Furthermore, oriented towards growth and progressive improvement in their outcomes, promotion-focused people view the experienced obstacles as modifiable through effort and persistence (Dweck & Leggett, 1988). In the spirit of eager regulatory state, they endorse multiple actions as means of attaining their ends and see them as interchangeable (Liberman, Idson, Camacho, & Higgins, 1999). This gives them a great perception of control over the
experienced outcomes (Guo & Spina, 2015; Langens, 2007). Hence, following failures, promotion-focused individuals do not typically suffer from diminished self-efficacy, but rather tend to persist and persevere (Crowe & Higgins, 1997; Lanaj et al., 2012), likely contributing to learning of error response behaviors.

Accordingly, on the affective level, promotion-focused individuals do not suffer the emotional pains of error to the same extent as prevention-focused people do. Here, errors lead to dejection-related emotions, such as disappointment, dissatisfaction, and sadness, which are generally unpleasant but only moderately arousing (compared to the intense and self-centered agitation-related emotions in prevention focus) (Higgins, 1987; Idson et al., 2000). Overall, the experience of errors in promotion focus is relatively mild emotionally, allowing individuals to focus their efforts in the aftermath of an error on problem solving and formulating error recovery strategies.

Additionally, in promotion focus, individuals conceive of their goals in more abstract, rather than specific, terms (Semin, Higgins, de Montes, Estourget, & Valencia, 2005). For example, a restaurant server may view her job as delivering customer satisfaction or service excellence (rather than simply delivering meals). This in turn creates a buffer (or psychological distance, cf. Trope & Liberman, 2010) between the mistakes as specific immediate occurrences and the larger context of overall goal striving (Forster & Higgins, 2005). Unlike prevention-minded individuals who become immersed in the situation surrounding a specific error, promotion-focused individuals can rely on this buffer for attenuating any negative charge related to errors. Stated differently, in the face of an error, individuals are able to rise above the strain of the immediate situation and view it in a more “cool” and constructive manner. Such processing of errors is likely to stimulate remedial actions that bring the actual performance in line with aspirations.

In sum, view on errors as modifiable through effort and availability of cognitive resources for constructive error processing should help individuals to identify corrective actions or solutions and result in response learning. Accordingly, I propose the following hypothesis:

\( H_4: \text{Promotion regulatory focus is positively associated with response learning.} \)

Through their eager regulatory state, promotion-focused individuals typically seek multiple ways to attain their desired ends, rather than repeatedly employing one proven method (Liberman et
al., 1999). Focus on growth and advancement aspirations makes individuals more explorative (Friedman & Forster, 2001), open to different experiences (Lanaj et al., 2012), and inclined to experiment with a variety of alternative solutions so as not to miss an improvement opportunity (Sacramento, Fay, & West, 2013). These qualities of promotion-focused individuals fit their predilection for approaching growth and development, whereby they exhibit an appetite and enthusiasm for positive gains (Carver, 2006).

By virtue of being so expansive and inclusive in their goal pursuits, promotion-focused individuals are likely to accumulate a greater baggage of learning methods and processes compared to cautious and self-conscious prevention-minded people. Additionally, because individuals in promotion focus tend to persist in the face of failure (Crowe & Higgins, 1997), it is likely that they develop positive attitudes toward errors, such as that errors are helpful and provide learning opportunities.

Moreover, equipped with a heightened capacity for abstract thinking (Zhu & Meeyers-Levy, 2007; Semin et al., 2005; Forster & Higgins, 2005), promotion-focused individuals are well positioned for the reflective demands of cultivating self-awareness and meta-learning. Again, the training literature supports these ideas. In particular, it shows that pursuit of mastery in training is associated with normalizing errors and viewing them as constructive. Ultimately, in these studies, mastery priming has been shown to result in heightened metacognition, whereby individuals continually engaged in self-monitoring and self-evaluation (Keith & Frese, 2005). Overall, these arguments support the following hypothesis:

**H5: Promotion regulatory focus is positively associated with meta-learning.**

In sum, promotion focus and its characteristic predilection for approaching desired states are likely to stimulate the types of learning aimed at maximizing advancement, such as task, response, and meta-learning. However, the role of promotion focus in generating the other two learning types (prevention and coping) is uncertain. For example, promotion focus has been shown to increase occurrence of errors, rather than prevent errors (Forster et al., 2003). Additionally, promotion failures are not associated with particularly intense negative emotions (Idson et al., 2000; Barrett & Russell, 1999), and therefore it is unclear whether development of
emotional coping practices is likely following errors. Therefore, I will examine the role of promotion focus in prevention and coping learning in an exploratory manner.

Chapter 4

4 Methodology

4.1 Overview of the Studies and Samples

This chapter describes the methodology for development and validation of the Learning from Errors scale, as well as for testing of the advanced hypotheses. Data from four samples are used in this study (TABLE 1). The choice of these samples is due to multiple considerations. First, in order to ascertain the multifaceted nature of error learning, this study begins with a sample that is most likely to have experience with diverse types of learning. Namely, Sample 1 consists of individuals working in service delivery (restaurant servers and bartenders). Unlike high reliability industries with low error tolerance and focus on compliance (Ndubisi, 2012), service work typically emphasizes both adherence to standardized tasks and quick responses to errors when they occur (Van Vaerenbergh, Larivière, & Vermeir, 2012; Wirtz, & Mattila, 2004). These attributes make it possible for service delivery workers to experience various types of error learning.

<table>
<thead>
<tr>
<th>Sample</th>
<th>N</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>215</td>
<td>Service workers employed full-time (Qualtrics panel)</td>
</tr>
<tr>
<td>1b</td>
<td>22</td>
<td>Service workers employed full- or part-time at multiple locations of a restaurant chain in Canada</td>
</tr>
<tr>
<td>2</td>
<td>320</td>
<td>Full-time employees from various occupations (Qualtrics panel; multiwave)</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
<td>CEOs or Presidents of medium-size Canadian firms</td>
</tr>
</tbody>
</table>

While service contexts seem ideal for studies of various error learning types, it is important to establish functional equivalence and generalizability of the new Learning from Errors (further referred to as LFE) scale in alternative settings. Accordingly, the second consideration guiding the choice of samples for this study involves representation of various occupations in scale
validation efforts. Toward this end, the study recruits individuals from a variety of occupations representing both knowledge and non-knowledge workers in Sample 2.

Given the overarching intention of the paper to shift the reliability-based perspective on error learning toward a more comprehensive and multifaceted view, the empirical efforts are focused outside the high reliability sector. However, error costs and consequences remain an important consideration in error research. Hence, the third consideration in the choice of samples for the present study is the relevance and generalizability of the error learning scale in occupational settings where errors can be costly. This concern determined the use of a company CEO/President population in Sample 3. Entrepreneurs typically have ample experience with mistakes and learning from them (Cope, 2005; Minniti & Bygrave, 2001), and their mistakes are likely to result in substantial costs to their business and personal reputation (Ucbasaran, Shepherd, Lockett, & Lyon, 2013). These attributes make entrepreneurs a suitable sample for investigating the generalizability of LFE scale to contexts with high-consequence errors.

The last consideration in the choice of study samples had to do with the salience of prevention and promotion concerns among participants. In other words, the participants’ jobs had to involve both duty-like (security-focused, or prevention) and aspirational (growth-focused, or promotion) aspects. This step would ensure that administered regulatory focus items resonate with the actual jobs of the participants. As earlier mentioned, service workers are usually expected to fulfill certain job obligations and adhere to particular standards, while at the same time they are often encouraged to strive for service excellence and customer satisfaction. Similarly, while certain aspects of the entrepreneurial process (e.g., generating ideas) rely on growth aspirations and benefit from promotion focus, other aspects of the entrepreneurial process (e.g., doing the “due diligence” when screening ideas) require concern for security and benefit from prevention focus (Brockner, Higgins, & Low, 2004). Thus, both regulatory orientations plausibly relate to the work realities of the service workers and entrepreneurs used in the study samples, thereby strengthening our confidence in the regulatory focus measures.

Since construct validation is a multistep process (Hinkin, 1998), in the subsequent sections, I separately present six phases of the study, where each phase serves a distinct purpose (see
TABLE 2). I first seek to establish the psychometric properties and construct validity of the learning from errors scale, and then move to testing of the study hypotheses.

**TABLE 2. Overview of the study phases**

<table>
<thead>
<tr>
<th>Phase description</th>
<th>Samples used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct development and validation</td>
<td></td>
</tr>
<tr>
<td>Phase 1 – Measure development and factor analyses</td>
<td>1a, 2</td>
</tr>
<tr>
<td>Purpose: Assess model fit and verify factor structure.</td>
<td></td>
</tr>
<tr>
<td>Phase 2 – Convergent and discriminant validity</td>
<td>1a</td>
</tr>
<tr>
<td>Purpose: Assess item reliability, consistency, and AVE to establish convergent validity. Compare AVEs and latent construct correlation to establish discriminant validity.</td>
<td></td>
</tr>
<tr>
<td>Phase 3 – Supplementary analysis of content validity</td>
<td>1b</td>
</tr>
<tr>
<td>Purpose: Gather examples of LFE to provide additional qualitative evidence of content validity.</td>
<td></td>
</tr>
<tr>
<td>Phase 4 – Measurement invariance</td>
<td>2</td>
</tr>
<tr>
<td>Purpose: Verify that LFE scales are appropriate for use in multiple occupational settings.</td>
<td></td>
</tr>
<tr>
<td>Phase 5 – Nomological network</td>
<td>1a</td>
</tr>
<tr>
<td>Purpose: Test correlations between LFE and related constructs.</td>
<td></td>
</tr>
<tr>
<td>Hypotheses Testing</td>
<td>1a, 2, 3</td>
</tr>
<tr>
<td>Phase 6 – Tests of hypotheses</td>
<td></td>
</tr>
<tr>
<td>Purpose: Examine the influence of regulatory focus on LFE.</td>
<td></td>
</tr>
</tbody>
</table>

4.2 **Construct Development and Validation**

4.2.1 **Phase 1 – Measure Development**

Based on the proposed theoretical framework from Chapter 2, I created a Learning from Errors (LFE) inventory that conceptually captures the five error learning types. The item pool for the questionnaire was created by drawing from the literature and existing scales on learning from errors, emotional coping, error prevention, error management, and expertise. For example, based on research on error prevention in high reliability organizations (Reason, 2000), the notions of repeated errors and error elimination were identified as relevant for capturing prevention learning, and so the items were constructed to allow for sufficient coverage of these notions.
Similarly, drawing from the literature on error management (Van Dyck et al, 2005), the notions of error correction and remediation were included in the content of response learning items.

The items constructed through this process, along with descriptions of each error learning type, were presented to two experts (organizational behavior scholars), who assessed correspondence of the items with the respective scales. This effort resulted in reduction of the item pool from 71 to 57 items. The remaining 57 items were administered to four graduate students who evaluated the items for clarity. All items were deemed clear and understandable, and only small adjustments were made to the wording of some items. The resulting 57 items were administered to Samples 1a and 2 following the recruitment and study procedures described below.

*Sample 1a.* Sample 1a consists of 215 individuals employed full-time as servers and bartenders. Mean age of respondents was 34 years old, and the majority (75%) of the sample were female. Mean tenure in the current job was 6.4 years.

Participants in this sample were recruited via Qualtrics. Qualtrics is a private market research company with operations in Canada, the United States and Europe. It maintains panels of potential respondents who have volunteered to participate in research studies. The panelists go through a double opt-in process: First, their basic information is collected and verified. Then, this information is used when targeting the panelists and sending them invitations to surveys for which they qualify. The present study, for the reasons listed above, targeted individuals who worked as servers or bartenders.

During the recruitment process, participants received an email from Qualtrics’ partner panel companies that contained the name of the study, *Experience of Errors at Work*, the amount of compensation, which varied depending on the Qualtrics partner panel company recruiting the respondents, and the link to the Letter of Information. From the letter of information (*APPENDIX A*) participants learned about the purpose of the study and the procedure, at which point they decided regarding their participation.

Upon providing their consent, participants were brought to the first screen of the online survey. In the beginning of the survey, the participants read a short definition and explanation of what constitutes errors and then were asked to recall a situation when they made an error. They then
listed the recalled mistakes and described in an open-ended format how they recognized mistakes, what they felt, and what were their actions were in these situations. The purpose of this part of the questionnaire was to elicit cognitions about error experiences that would inform responses to the error-related items that followed. Following the open-ended questions, participants were instructed to consider their overall experience of mistakes at work and rate the extent to which they agreed with the LFE items using a Likert scale ranging from (1) Strongly Disagree to (5) Strongly Agree. Then, participants responded to a number of additional measures pertaining to other phases of this study and answered demographic questions.

Sample 2. Sample 2 consists of 320 full-time employees representing a variety of occupations. Mean age of respondents was 42 years old, and the majority (57%) of the sample were female. As for the career level, 9.4% of the sample were in entry-level positions, 47.8% of participants are professionals with two or more years of experience, 5.9% have first-line management jobs, 19.7% are in middle management, and 12.2% in executive or senior-level management. Mean reported in-role tenure was 9.2 years.

Recruitment and study procedures for Sample 2 were similar to Sample 1 with two notable exceptions. First, eligibility criteria for participating in this study were different: For reasons outlined above, the panel provider expanded the recruitment process to invite individuals from a variety occupations, not only servers or bartenders. The second difference in the procedure involved a two-wave data collection, where individuals were re-contacted two weeks after the initial survey to answer additional questions pertaining to this study. Participants responded to LFE items at both times. For the purposes of construct validation and factor analyses, LFE data from the initial survey (T1) were used, since it was not affected by attrition and therefore provided more data points.

4.2.2 Phase 2 – Convergent and Discriminant Validity

Besides the factor structure analysis, establishing construct validity requires evidence of convergent and discriminant validity in comparison with other conceptually related constructs (Schwab, 1980). While to my knowledge no scales measuring individual error learning exist, there are a number of scales of error learning orientations, with which the five LFE scales should correlate (TABLE 3). Specifically, Error Orientation Questionnaire (EOQ; Rybowiak, Garst,
Frese, & Batinic, 1999) includes the subscales of error learning, error competence, and thinking about errors. Error learning refers to the general orientation of individuals to view errors as helpful in improving their work. Error competence is the perceived capability to deal with errors when they occur. Finally, thinking about errors scale captures the inclination to think about and analyze mistakes.

More recently, based on the EOQ and approach/avoidance and goal theories, Schell developed an Error-Oriented Motivation Scale (EOMS; 2012). The premise of the new functional model for error orientations was that errors take on properties of goals when they create a discrepancy and motivate mastery, performance-avoid or performance-approach behaviors. The scale has an error-oriented learning subscale that corresponds with an orientation toward mastery behaviors.

A careful examination of the items included in the existing scales of error learning, thinking about errors, and error-oriented learning – suggests that often error learning is conceived as performance improvement in general, without specification of the exact content of learning (e.g., ‘I try to learn something from every error I commit [italics added]’ or “My mistakes help me to improve my work”). Alternatively, thinking about errors scale involves more than one type of learning: It has items referring to both prevention and response (“I often think: ‘How could I have prevented this?’” and “…I think long and hard about how to correct it”). The only one of the existing scales that contains references to specific learning outcomes is error competence, where all items deal with error recovery. These features of the existing error learning constructs lead us to anticipate different patterns of convergence between the five theorized learning constructs and the existing constructs. Specifically, existing constructs appear to tap somewhat into prevention and response learning, but offer little in the way of capturing task, coping or meta-learning. Overall, the five LFE dimensions should positively correlate with existing measures of individual error learning, yet demonstrate sufficient discriminant validity.

Sample 1a was used for analysis of convergent and discriminant validity of LFE scales relative to the existing error learning constructs listed in TABLE 3.
## TABLE 3. Comparison of the five LFE scales with theoretically relevant constructs

<table>
<thead>
<tr>
<th>Definition</th>
<th>Sample Items</th>
<th>Trait vs. State</th>
<th>Captures five error learning types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task learning</strong></td>
<td>Change in one’s mental model of a task</td>
<td>State</td>
<td>Task Learning</td>
</tr>
<tr>
<td><strong>Prevention learning</strong></td>
<td>Adoption of a vigilance practice or device</td>
<td>State</td>
<td>-</td>
</tr>
<tr>
<td><strong>Response learning</strong></td>
<td>Adoption of an error correction practice</td>
<td>State</td>
<td>-</td>
</tr>
<tr>
<td><strong>Coping learning</strong></td>
<td>Adoption of a coping practice or change in the emotional evaluation of errors</td>
<td>State</td>
<td>-</td>
</tr>
<tr>
<td><strong>Meta learning</strong></td>
<td>Adoption of an error learning behavior</td>
<td>State</td>
<td>-</td>
</tr>
<tr>
<td><strong>Error learning</strong></td>
<td>General orientation to view errors as helpful in improving their work (Rybowiak et al., 1999)</td>
<td>Trait</td>
<td>-</td>
</tr>
<tr>
<td><strong>Error competence</strong></td>
<td>Perceived capability to deal with errors when they occur (Rybowiak et al., 1999).</td>
<td>Trait</td>
<td>-</td>
</tr>
<tr>
<td><strong>Thinking about errors</strong></td>
<td>Inclination to think and analyze mistakes (Rybowiak et al., 1999).</td>
<td>Trait</td>
<td>-</td>
</tr>
<tr>
<td><strong>Error-oriented learning</strong></td>
<td>Orientation toward mastery behaviors in response to errors (Schell, 2012).</td>
<td>Trait</td>
<td>-</td>
</tr>
</tbody>
</table>
Notably, a number of studies to date have measured learning from errors as a contextual or organizational climate variable. For example, one such measure includes items such as “When employees make a mistake, they inform the relevant manager to enable others to learn from it” (Carmeli, 2007) and another includes items like “In my organization, employees do not dare to discuss mistakes” (Nikolova et al., 2014). These variables tap one’s perceived comfort around engagement in reflective behaviors and are therefore helpful in investigations of collective and climate-like influences on error learning. Yet these constructs do not capture the actual learning from errors that individuals experience and therefore are not conceptually similar to LFE constructs. Therefore, these contextual variables were not included in this phase of scale validation.

4.2.3 Phase 3 – Supplementary Analysis of Content Validity

To supplement the quantitative results on construct validity, Phase 3 of the study sought qualitative illustrations to further substantiate the content validity of the five LFE constructs. These illustrations were gathered not for item generation purposes – theory was the main source for this – but rather they were collected to enhance the conceptual accounts of the five error learning types with an empirical component. Toward this goal, semi-structured interviews were conducted with 22 staff members, including servers, bartenders, and hosts at four sites of a casual restaurant chain. (See APPENDIX B for the interview protocol.)

In addition to the reasons discussed above, there is another explanation for the choice of the service delivery setting for the qualitative component of the study. Errors are frequent in service organizations and service staff likely have ample experience with mistakes that individuals can draw from in the interviews. Second, while some contexts present obstacles for full disclosure of employee mistakes (e.g., fear of losing professional license), service settings employ people who are typically open and willing to share their experiences, since no major consequences or repercussions are associated with errors.

In the course of each interview, participants were asked to describe their job, the features of work that they found challenging, and errors that they had experienced at work. Further probing questions were used to understand not only the individuals’ reflections about their error, but the
whole situation surrounding the error, including any actions taken afterwards. This way, the interviews more fully exposed the content of error learning as it pertains to each of the five theoretically-derived types.

4.2.4 Phase 4 – Measurement Invariance

While focusing on service workers in Sample 1 allows us to study error learning where it is most likely to be diverse, it is important to validate the scale using different samples (Hinkin, 1998). Specifically, I sought to examine the invariance, or functional equivalency, of the LFE scales between the groups of knowledge and non-knowledge workers.

I used Sample 2 to test measurement invariance. Based on the occupations indicated in the survey, participants were coded into knowledge workers and non-knowledge workers. The principal criterion for this coding was requirement of a university degree. For example, individuals who indicated their occupation as a human resource manager or teacher were coded as knowledge workers, since these jobs typically require at least a four-year university degree. In contrast, individuals who reportedly worked as a miner or retail clerk were coded as non-knowledge workers, since having a university degree is not a requirement in these jobs. Two coders independently performed this task. Initial agreement rate was 88%. Discrepant codes were resolved through discussion and referencing occupational classifications. We were unable to confidently code occupations of 33 respondents either because they did not indicate their occupation (n=14) or because their response was too general (e.g., healthcare, nonprofit, “work in a school system”, etc.) to infer their membership in either coded group. Out of the remaining 287 participants, 47% (n=135) represent knowledge workers.

4.2.5 Phase 5 – Nomological Network

Nomological network is another aspect of construct validation that involves identifying theoretical constructs that should be related with the new construct and empirically testing these relationships (Cronbach & Meehl, 1955). Past research indicates that error communication is positively linked with learning from errors (Carmeli & Gittell, 2009). Discussing errors with others can help identify error causes and result in new knowledge (Tucker & Edmondson, 2003). Additionally, talking to others may bring about positive solutions to manifest errors (van Dyck et
and illuminate the value of communication for emotional coping and learning (Bauer & Mulder, 2013). Therefore, all five LFE scales are expected to correlate with error communication.

In contrast, hiding one’s errors from others is generally considered unconducive to learning (Bauer & Mulder, 2013): Not only may it leave the causes of error unknown, but it may also prevent individuals from identifying corrective solutions to a manifest error, exacerbate error-related anxiety and interfere with emotional coping (Meurier, Vincent, & Parmar, 1997). Hence, all five LFE scales are expected to inversely relate with covering up of errors.

Additionally, task and prevention learning should inversely correlate with in-role tenure. At lower levels of experience, errors are more likely to reveal new job elements or rules of performance and improve one’s ability to detect and prevent a greater range of errors (Ericsson & Towne, 2010). In contrast, more experienced individuals are less likely to find errors informative about their job and therefore should report lower levels of task and prevention learning. No relationship was anticipated between in-role tenure and response learning or between in-role tenure and coping learning.

Lastly, error strain should be negatively correlated with coping learning, since individuals equipped with coping strategies should view errors as less straining (Bauer & Mulder, 2013). Similarly, I expect response learning to inversely relate with error strain, as having a readily available response strategy is likely to minimize feelings of shock and anxiety related to errors. No relationship was anticipated between error strain and task learning or between error strain and prevention learning.

To test the above predictions, I used the respective subscales of the Error Orientation Questionnaire (Rybowiak et al., 1999). Sample items include “When I have done something wrong, I ask others how I should do it better” (error communication), “I would rather keep my mistakes to myself” (covering up errors), and “I find it stressful when I err” (error strain). The data on these measures were collected from Sample 1a.
4.3 Tests of Regulatory Focus Hypotheses

In addition to the two samples used in measure development and validation, a third sample was recruited to test the hypothesized relationships between regulatory focus and learning from errors.

Sample 3. Sample 3 consists of 64 CEOs or Presidents of medium-size Canadian firms. Mean age of respondents was 54 years old, and the majority (90%) of the sample were male. Mean tenure in the CEO/President role was 8.7 years. These individuals represented a range of industries, with largest representation from manufacturing (24%), construction (13%), and real estate (11%).

Sample 3 was a convenience sample of alumni of an executive education program. This program is designed for those CEOs whose businesses are past start-up and who seek education to maximize their business growth. To qualify for admission to this executive development program, individuals must be CEOs or Presidents of successful and growing companies with annual sales revenue over $10 million. The program also gives preference in admission to individuals with substantial ownership in their company.

The alumni of this executive development program were recruited to participate in the study via an email that introduced the broad research topic, *Learning from Mistakes at Work*, briefly outlined the procedure, and provided a link to the letter of information. The letter of information was similar to the one used with previous samples and informed participants of the purpose of the study and its procedure. Upon familiarizing themselves with the contents of this letter, consenting individuals proceeded to the survey.

As explained previously, the motivation to recruit entrepreneurs for this study was to examine the proposed measurement scale and hypothesized effects with individuals, whose errors could be costly and consequential. Accordingly, it was important to check whether Sample 3 participants actually met this intended recruitment criterion. Toward this end, I examined responses to the open-ended survey component, where participants described their mistakes and reactions to them. Indeed, these responses included references to the high costs of errors, such as having to shut down part of the business, creating litigation risks, wasting hundreds of thousands
of dollars and time of a large team of people. Some illustrative quotes include: “the profitability showed drastic downturn and our operating expenses were rising quickly,” “$500k in legal bills and an unsuccessful defence [in court],” “Purchased capital equipment that was not useable…and wasted significant capital,” “We invested $2 million in assets and lost $700,000 in Operating Income,” and “We were left high and dry. We thought we were done and would have to declare bankruptcy.” Furthermore, many of these individuals have substantial ownership in their companies and 37% of this sample were also founders or co-founders of their companies, suggesting that errors are also likely to have a personal cost to them in terms of economic, social, psychological, and physiological well-being (Singh, Corner, & Pavlovich, 2007). Overall, these arguments confirm that Sample 3 represents an occupational setting with high error consequences.

Across all the samples, participants responded to regulatory focus items. Samples 1a and 2 were administered the Work Regulatory Focus questionnaire (WRF; Neubert et al., 2008), while Sample 3 responded to a shorter measure, Regulatory Focus at Work Scale (RWS: Wallace, Johnson, & Frazier, 2009). Sample items from the former scale include “I focus on accomplishing job tasks that will further my advancement” (promotion) and “I concentrate on completing my work tasks correctly to increase my job security” (prevention) and from the latter scale “I focus on accomplishing a lot at work” (promotion) and “I focus on doing my duty at work” (prevention). Using a Likert scale ranging from (1) Strongly Disagree to (5) Strongly Agree, respondents were asked to indicate the extent of their agreement with the items of the respective scales.

The tests of regulatory focus effects on LFE in Samples 1a and 3 were performed on self-report data collected at one point in time and issues of common method bias were later dealt with statistically.

In Sample 2, self-reports of regulatory focus and LFE were separated by a two-week time lag to minimize common method variance. Response rate at Time 2 was 49%, making Time 2 sample size 157 individuals. I compared respondents with non-respondents on the measures collected at Time 1 and found significant differences in gender, management level and promotion focus (TABLE 4). Specifically, compared to respondents, there were proportionately more women
among non-respondents ($\chi^2(1) = 3.94, p < .05$) and more individuals from lower management levels ($\chi^2(4) = 12.69, p < .05$). Additionally, non-respondents had lower promotion focus ($t(250) = -1.99, p < .05$). No differences in age, tenure, or membership in the knowledge work occupations were observed.

<table>
<thead>
<tr>
<th>TABLE 4. Comparison of respondents and non-respondents in Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td>Male (n=139)</td>
</tr>
<tr>
<td>Female (n=181)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
</tr>
<tr>
<td>M=42.23, SD=10.90</td>
</tr>
<tr>
<td>M=41.34, SD=11.24</td>
</tr>
<tr>
<td><strong>Knowledge work</strong></td>
</tr>
<tr>
<td>Yes (n=152)</td>
</tr>
<tr>
<td>No (n=147)</td>
</tr>
<tr>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>Entry (n=30)</td>
</tr>
<tr>
<td>Professional (n=153)</td>
</tr>
<tr>
<td>First-line Manager (n=19)</td>
</tr>
<tr>
<td>Middle Manager (n=63)</td>
</tr>
<tr>
<td>Executive (n=39)</td>
</tr>
<tr>
<td><strong>Tenure</strong></td>
</tr>
<tr>
<td>M=8.48, SD=6.72</td>
</tr>
<tr>
<td>M=9.74, SD=7.53</td>
</tr>
<tr>
<td><strong>Promotion focus</strong></td>
</tr>
<tr>
<td>M=3.90, SD=.75</td>
</tr>
<tr>
<td>M=3.73, SD=.66</td>
</tr>
<tr>
<td><strong>Prevention focus</strong></td>
</tr>
<tr>
<td>M=4.33, SD=.52</td>
</tr>
<tr>
<td>M=4.24, SD=.50</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
</tr>
<tr>
<td>$\chi^2(1)= 3.94*$</td>
</tr>
<tr>
<td>$\chi^2(1)= 1.47$, ns</td>
</tr>
<tr>
<td>$\chi^2(4)= 12.69*$</td>
</tr>
<tr>
<td>$t(250)= -.64$, ns</td>
</tr>
<tr>
<td>$t(250)= 1.39$, ns</td>
</tr>
<tr>
<td>$t(250)= -1.99*$</td>
</tr>
<tr>
<td>$t(250)= -1.30$, ns</td>
</tr>
</tbody>
</table>
Chapter 5

5 Results

5.1 Factor Analyses

Data from Sample 1a and Mplus software (Muthén & Muthén, 2007) were used to conduct confirmatory factor analysis (CFA) and test the factor structure of the LFE inventory. After retaining five best items in each scale based on loadings and theoretical relevance (TABLE 5), the five-factor structure fit the data well: $\chi^2 (265) = 369.13$, RMSEA = .04, CFI = .96, and SRMR = .05.

I compared the five-factor model with alternative (four-, three-, two-, and one-factor) models (TABLE 6). Based on the chi-square difference tests and other fit indices, all tested competing models had a significantly poorer fit, thereby granting support to the theorized five-factor structure.

Similar analyses were conducted on Time 1 data from Sample 2. The results indicate a good fit of the five-factor model in Sample 2 ($\chi^2 (265) = 335.76$, RMSEA = .03, CFI = .98, and SRMR = .04). Analyses of fit indices and chi-square difference tests in Sample 2 also suggest the five factor model is superior to its alternatives (APPENDIX C). Overall, factor analyses results across two samples are consistent and support validity of the LFE inventory.
TABLE 5. Learning from Errors scale items and factor loadings

<table>
<thead>
<tr>
<th>Learning from Errors factors and items</th>
<th>Factor loadings</th>
<th>Sample 1a</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task Learning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have discovered new aspects of my job by making mistakes.</td>
<td>.65</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>Because I made mistakes, I now understand details of my job that I didn’t know before.</td>
<td>.80</td>
<td>.75</td>
<td></td>
</tr>
<tr>
<td>I have gained a deeper understanding of the tasks involved in my job because of the mistakes I made.</td>
<td>.74</td>
<td>.75</td>
<td></td>
</tr>
<tr>
<td>My mistakes have helped me better understand what my job entails.</td>
<td>.73</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>I have learned from my mistakes aspects of the job that I didn’t understand previously.</td>
<td>.74</td>
<td>.68</td>
<td></td>
</tr>
<tr>
<td><strong>Prevention Learning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have implemented solutions to ensure against similar mistakes going forward.</td>
<td>.80</td>
<td>.81</td>
<td></td>
</tr>
<tr>
<td>I have put some practices in place to stop mistakes from reoccurring.</td>
<td>.82</td>
<td>.78</td>
<td></td>
</tr>
<tr>
<td>I have developed a routine that helps me minimize the frequency of my mistakes.</td>
<td>.73</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>I have implemented safeguards against the mistakes I made in the past.</td>
<td>.74</td>
<td>.70</td>
<td></td>
</tr>
<tr>
<td>As a result of my past mistakes, I have become more attentive to preventing future mistakes.</td>
<td>.74</td>
<td>.69</td>
<td></td>
</tr>
<tr>
<td><strong>Response Learning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have learned techniques for handling the consequences of my mistakes more effectively.</td>
<td>.81</td>
<td>.75</td>
<td></td>
</tr>
<tr>
<td>After I make a mistake, I manage the situation more effectively now than in the past.</td>
<td>.64</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>I have become better at dealing with the problems created by my mistakes.</td>
<td>.72</td>
<td>.74</td>
<td></td>
</tr>
<tr>
<td>I have developed effective practices for responding to the mistakes I make.</td>
<td>.74</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>I have learned how to make amends for my mistakes.</td>
<td>.73</td>
<td>.66</td>
<td></td>
</tr>
<tr>
<td><strong>Coping Learning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have learned not to feel bad about myself when I make a mistake.</td>
<td>.71</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>I am more capable now than in the past to put myself at ease after I make mistakes.</td>
<td>.76</td>
<td>.79</td>
<td></td>
</tr>
<tr>
<td>I have improved my ability to calm down when I make mistakes.</td>
<td>.68</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>I have developed ways to overcome negative emotions that come with mistakes.</td>
<td>.82</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>I have become better at maintaining a positive emotional state despite making mistakes.</td>
<td>.76</td>
<td>.74</td>
<td></td>
</tr>
<tr>
<td><strong>Meta-Learning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have found out what usually helps me learn from mistakes.</td>
<td>.74</td>
<td>.81</td>
<td></td>
</tr>
<tr>
<td>I have learned what usually hinders my learning from mistakes.</td>
<td>.72</td>
<td>.68</td>
<td></td>
</tr>
<tr>
<td>I have learned how I should process mistakes to extract learning.</td>
<td>.76</td>
<td>.78</td>
<td></td>
</tr>
<tr>
<td>I have become more deliberate about examining my mistakes.</td>
<td>.64</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td>As a result of my past mistakes, I have become more systematic in reflecting upon my mistakes.</td>
<td>.68</td>
<td>.73</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 6. Sample 1a: Comparison of Learning from Errors factor structures

<table>
<thead>
<tr>
<th>Model and description</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$\Delta \chi^2$</th>
<th>RMSEA</th>
<th>CFI</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1: 5 (TASK, PREV, RESP, COPE, META)</td>
<td>369.13</td>
<td>265</td>
<td>.04</td>
<td>.96</td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>Model 2: 4 (TASK&amp;PREV, RESP, COPE, META)</td>
<td>683.90</td>
<td>269</td>
<td>314.77**</td>
<td>.09</td>
<td>.84</td>
<td>.08</td>
</tr>
<tr>
<td>Model 3: 4 (TASK, PREV&amp;RESP, COPE, META)</td>
<td>569.39</td>
<td>269</td>
<td>200.26**</td>
<td>.07</td>
<td>.88</td>
<td>.07</td>
</tr>
<tr>
<td>Model 4: 4 (TASK, PREV, RESP, COPE&amp;META)</td>
<td>593.17</td>
<td>269</td>
<td>224.04**</td>
<td>.08</td>
<td>.87</td>
<td>.07</td>
</tr>
<tr>
<td>Model 5: 3 (TASK&amp;PREV, RESP, COPE&amp;META)</td>
<td>902.76</td>
<td>272</td>
<td>533.63**</td>
<td>.10</td>
<td>.75</td>
<td>.09</td>
</tr>
<tr>
<td>Model 6: 3 (TASK, PREV&amp;RESP, COPE&amp;META)</td>
<td>792.24</td>
<td>272</td>
<td>423.11**</td>
<td>.09</td>
<td>.80</td>
<td>.08</td>
</tr>
<tr>
<td>Model 7: 2 (TASK&amp;PREV, RESP&amp;COPE&amp;META)</td>
<td>1024.15</td>
<td>274</td>
<td>655.02**</td>
<td>.11</td>
<td>.71</td>
<td>.09</td>
</tr>
<tr>
<td>Model 8: 2 (TASK&amp;COPE&amp;META, PREV&amp;RESP)</td>
<td>970.20</td>
<td>274</td>
<td>601.07**</td>
<td>.11</td>
<td>.73</td>
<td>.09</td>
</tr>
<tr>
<td>Model 9: 1 (TASK&amp;PREV&amp;RESP&amp;COPE&amp;META)</td>
<td>1172.90</td>
<td>275</td>
<td>802.87**</td>
<td>.12</td>
<td>.65</td>
<td>.10</td>
</tr>
</tbody>
</table>

Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning. ‘&’ signifies that the two factors were merged for that model.

$** p < .01$

### 5.2 Convergent and Discriminant Validity

Next, I examined convergent and discriminant validity of the five scales using Sample 1a data. To examine convergent validity of the LFE scales, it’s necessary to consider the item reliability, internal consistency, and average variance extracted (AVE) in a model that includes all five LFE scales, as well as other theoretically related constructs (Fornell & Larcker, 1981). Corresponding analysis is presented in **TABLE 7**.

Item reliability is reflected in the factor loading. All items in the five LFE scales are above the cut-off value of .60 and meet validity criteria (Chin, 1998). In addition, internal consistencies (alpha) of the five scales were high and ranged from .83 – .87. Finally, AVE scores for all LFE constructs are .50 or above, meeting the criterion for adequate convergent validity (Fornell & Larcker, 1981). Viewed together, these results demonstrate that task, prevention, response, coping, and meta-learning scales exhibit good convergent validity.
To examine discriminant validity of the five error learning constructs, I compared them with other conceptually related constructs (Schwab, 1980), namely error learning, error competence, and thinking about errors subscales of Error Orientation Questionnaire (EOQ; Rybowiak et al., 1999), as well as the learning subscale of Error-Oriented Motivation Scale (EOMS-L; Schell, 2012).

Examination of discriminant validity involves comparing the square root of the AVE values for each of the five scales to its correlations with other constructs. Discriminant validity is established when the square root of AVE for each construct is larger than the correlation between the two constructs (Fornell & Larcker, 1981). As shown in Table 7, the correlation between any one LFE scale and other learning measures is smaller than the root square of its AVE. These results support the discriminant validity of all five learning types.

Notably, among the existing constructs, error competence fails the test of discriminant validity. Specifically, it is not sufficiently distinct from response learning. This result is in line with the previously made observation that some existing constructs tap response learning (see Table 3). While the overlap between error competence and response learning is likely due to their focus on

<table>
<thead>
<tr>
<th>Construct</th>
<th>Latent construct correlations</th>
<th>Range of loadings</th>
<th>AVE</th>
<th>Square root of AVE</th>
<th>Internal consistency (Cronbach α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. TASK</td>
<td></td>
<td>(.65, .80)</td>
<td>.53</td>
<td>.73</td>
<td>.85</td>
</tr>
<tr>
<td>2. PREV</td>
<td>.45</td>
<td>(.73, .82)</td>
<td>.59</td>
<td>.77</td>
<td>.87</td>
</tr>
<tr>
<td>3. RESP</td>
<td>.54 .63</td>
<td>(.64, .81)</td>
<td>.53</td>
<td>.73</td>
<td>.85</td>
</tr>
<tr>
<td>4. COPE</td>
<td>.45 .44 .58</td>
<td>(.68, .82)</td>
<td>.56</td>
<td>.75</td>
<td>.85</td>
</tr>
<tr>
<td>5. META</td>
<td>.64 .51 .69 .54</td>
<td>(.64, .76)</td>
<td>.50</td>
<td>.71</td>
<td>.83</td>
</tr>
<tr>
<td>6. Error-oriented learning</td>
<td>.69 .64 .72 .47 .69</td>
<td>(.62, .81)</td>
<td>.55</td>
<td>.74</td>
<td>.89</td>
</tr>
<tr>
<td>7. Error learning</td>
<td>.65 .44 .52 .45 .62 .67</td>
<td>(.59, .73)</td>
<td>.70</td>
<td>.84</td>
<td>.90</td>
</tr>
<tr>
<td>8. Thinking about errors</td>
<td>.63 .49 .55 .26 .65 .75 .54</td>
<td>(.66, .82)</td>
<td>.57</td>
<td>.75</td>
<td>.85</td>
</tr>
<tr>
<td>9. Error competence</td>
<td>.43 .55 .72 .43 .59 .67 .47 .54</td>
<td>(.53, .78)</td>
<td>.44</td>
<td>.66</td>
<td>.73</td>
</tr>
</tbody>
</table>

Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning
All correlations are significant at p < .01
error recovery, their difference remains in that the former is a general error attitude measure, while the latter reflects one’s perception of experienced learning. The good AVE of response learning is encouraging, but the correlation with error competence suggests there is room for refinement in the measure.

5.3 Content Validity

To augment the quantitative evidence of LFE construct validity with illustrative examples, I analyzed the data from 22 interviews with the service staff of a Canadian restaurant chain. These 22 interviews yielded 62 individual error episodes and 82 instances of learning.

Following the same conceptual themes that were used in item generation, the reported learning instances were categorized against the five error learning types. For example, in the participants’ narratives, I sought for references to error elimination or error blocking to categorize reported learning under prevention learning. As another example, when interviewees alluded to themselves as a learner or to the specific learning practices that they used following errors, I categorized such references under meta-learning. TABLE 8 below provides an overview of the reported error learning types.

In sum, the accounts of the interviewed service workers contained instances of all five error learning types. The number of instances recalled for each learning type varied from 4–34 (TABLE 8). Notably, almost all study participants reported having experienced response learning and prevention learning. In contrast, instances of meta-learning appeared in only four interviews. This is however in line with research suggesting that metacognition is complex and costly, as it requires not only using one’s mental activity, but also describing or controlling it (Allen & Armour-Thomas, 1993; Brown, 1987).
### Table 8. Occurrence of error learning types reported by Sample 1b participants

<table>
<thead>
<tr>
<th>Type</th>
<th>N instances (participants)</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Task learning           | 7 (5)                      | …we set the cutlery to the left of the [plate]. And when I started, I would always just do this weird square, so that it was square on both sides……someone's like, "Hey, that's not how you do it," [and then] I changed that.  
…we have two [similar] pasta dishes here… [A customer ordered] one of them, I wasn't sure which one… so I just guessed. It ended up being the wrong pasta… [Later that day,] I actually took a menu home and looked it over so that I knew the dishes a lot better. |
| Prevention learning     | 24 (14)                    | [The server brought out a meal with onions, when the customer asked for no onions.] Now when I write things down, if there's a no whatever I'll put capital letters or I'll circle it or something, put a big arrow pointing at it or something for it to stand out on the page so I know I don't miss it.  
Sometimes, somebody will mention it's their birthday [but between this and dessert time, I will forget. So now I say,] "Okay, you guys remind me when I come back and ask you about dessert. When I clear your plates, tell me again it's your mom's birthday." I ask them to remind me, so I put that in place so that even if I forget, someone's going to tell me. |
| Response learning       | 34 (20)                    | [On multiple occasions, the server brought small pizza instead of a large one.] In order to deal with that, we actually just made them two regular pizzas to make the equivalent of a large, because it's basically the same size… It was always the same sort of situation, where all of the guests were okay with just having two of the regular size…  
[The customer] was screaming, "Oh my God. You're so awful." This is obviously a big thing, and [I learned] as soon as you have a guest that's yelling at you, you got to go get a manager right away.  
[The server brought the wrong meal.] You just apologize… You give them the option… Make a joke, make them laugh, something. |
| Coping learning         | 13 (9)                     | …that was one of those times I learned you definitely have to have thick skin…Not everyone is going to be perfect all the time. You have to let it slide sometimes.  
… it’s something that I don't think is as big of a deal. It's going to happen even if you are fully focused. As I said, other people do it too. |
| Meta learning           | 4 (4)                      | Sometimes, for me, I think that I've got it all figured out. [But then you make a mistake and think], "Whoa, wait a minute, you don't." You have things you need to learn…  
I turned around and was looking at the servers beside me because at the time I was the new one and they were the ones that had been around for a while… I was like "Okay, hey, guys, what do I do?" |
Notably, the data also shows that it is possible for individuals to experience multiple types of learning in relation to the same mistake. For instance, one individual discussed having brought the wrong bill to her table. As part of that experience, she described asking her manager to correct the bill (response learning). She also shared that “Before I'm bringing it to the table I should be looking at the bill and reading it over” (prevention learning). Furthermore, she identified a hindrance to her learning process: “After you don't make a mistake for so long... You're like, "Oh yeah I know [all I need in this job]" (meta-learning).

In short, the interviews provide qualitative illustrations of all five error learning types and thereby strengthen conclusions about the validity of the respective constructs.

5.4 Measurement Invariance

Next, I sought to extend LFE validity testing of the LFE beyond the service delivery setting and empirically establish that LFE inventory is suitable for studies of error learning in other occupations. Toward this end, I conducted a measurement invariance test using knowledge and non-knowledge workers subsamples of Sample 2 at Time 1 (Vandenberg & Lance, 2000). If supported, measurement invariance would indicate that the same construct is captured in the participants’ responses regardless of the occupation type.

As recommended by Vandenberg and Lance (2000), three tests of measurement invariance were preformed: configural invariance (identical factor structures), metric invariance (identical factor loadings), and scalar invariance (identical item intercepts). A summary of this analysis is shown in TABLE 9. For the overall five-factor measurement model, as well as for each individual LFE scale, subsequent models had a negligible change in model fit, suggesting full configural, metric, and scalar invariance across knowledge and non-knowledge workers. These findings indicate that both knowledge and non-knowledge workers had a similar conceptual frame of reference when they responded to the LFE scales.

Overall, these results reinforce the validity of LFE scales through establishing measurement invariance across different occupations. These results are important because they suggest the devised LFE inventory is appropriate for use in various samples.
### TABLE 9. LFE Measurement invariance between knowledge and non-knowledge workers in Sample 2

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$\Delta \chi^2$</th>
<th>CFI</th>
<th>$\Delta$CFI</th>
<th>SRMR</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall LFE Inventory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1: Configural invariance</td>
<td>761.51</td>
<td>530</td>
<td>.93</td>
<td>.06</td>
<td>Accept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2: Metric invariance</td>
<td>780.79</td>
<td>550</td>
<td>19.28, ns</td>
<td>.93</td>
<td>.00</td>
<td>.06</td>
<td>Accept</td>
</tr>
<tr>
<td>Model 3: Scalar invariance</td>
<td>805.59</td>
<td>575</td>
<td>24.80, ns</td>
<td>.93</td>
<td>.00</td>
<td>.07</td>
<td>Accept</td>
</tr>
<tr>
<td>Task learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1: Configural invariance</td>
<td>7.69</td>
<td>10</td>
<td>1.00</td>
<td>.02</td>
<td>Accept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2: Metric invariance</td>
<td>14.22</td>
<td>14</td>
<td>6.53, ns</td>
<td>.99</td>
<td>.00</td>
<td>.08</td>
<td>Accept</td>
</tr>
<tr>
<td>Model 3: Scalar invariance</td>
<td>15.33</td>
<td>19</td>
<td>1.11, ns</td>
<td>1.00</td>
<td>.00</td>
<td>.08</td>
<td>Accept</td>
</tr>
<tr>
<td>Prevention learning</td>
<td></td>
<td></td>
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<tr>
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<tr>
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<td>18.06</td>
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<td>2.19, ns</td>
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<tr>
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<td>.01</td>
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</tr>
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<td>7.98, ns</td>
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<td>.00</td>
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</tr>
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<td>5.80, ns</td>
<td>.94</td>
<td>.01</td>
<td>.09</td>
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<td></td>
</tr>
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<td>.03</td>
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</tr>
<tr>
<td>Model 2: Metric invariance</td>
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<td>6.20, ns</td>
<td>.97</td>
<td>.01</td>
<td>.09</td>
<td>Accept</td>
</tr>
<tr>
<td>Model 3: Scalar invariance</td>
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<td>1.47, ns</td>
<td>.98</td>
<td>.01</td>
<td>.09</td>
<td>Accept</td>
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</tbody>
</table>

### 5.5 Nomological Network

The initial assessment of LFE’s nomological network relied on the zero-order correlations between the LFE scales and other constructs measured in Sample 1a. Means, standard deviations, and zero-order correlations are displayed in TABLE 10.

As predicted, there is a positive association between the five LFE constructs and error communication. This relationship indicates that discussing one’s errors with others may be beneficial for learning of all five types. Conversely, covering up of errors was expected to
inversely relate to the LFE constructs. The above results provide support for these relationships suggesting that hiding one’s errors is a behavior not conducive to learning.

**TABLE 10. Means, standard deviations and correlations among variables in Sample 1a**

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>9</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. TASK</td>
<td>3.93</td>
<td>.70</td>
<td>(.85)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. PREV</td>
<td>4.23</td>
<td>.62</td>
<td>.39**</td>
<td>(.87)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. RESP</td>
<td>4.21</td>
<td>.53</td>
<td>.47**</td>
<td>.54**</td>
<td>(.85)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. COPE</td>
<td>3.90</td>
<td>.70</td>
<td>.38**</td>
<td>.37**</td>
<td>.48**</td>
<td>(.85)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. META</td>
<td>3.92</td>
<td>.61</td>
<td>.54**</td>
<td>.42**</td>
<td>.57**</td>
<td>.44**</td>
<td>(.83)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6. Error communication</td>
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<td>.61</td>
<td>.33**</td>
<td>.35**</td>
<td>.39**</td>
<td>.37**</td>
<td>.41**</td>
<td>(.70)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Covering up errors</td>
<td>2.29</td>
<td>.70</td>
<td>-.21**</td>
<td>-.22**</td>
<td>-.27**</td>
<td>-.14**</td>
<td>-.25**</td>
<td>-.39**</td>
<td>(.82)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. In-role tenure</td>
<td>6.44</td>
<td>6.42</td>
<td>-.16†</td>
<td>-.11†</td>
<td>-.06</td>
<td>-.01</td>
<td>-.09†</td>
<td>-.13†</td>
<td>-.13†</td>
<td>(-)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Error strain</td>
<td>3.01</td>
<td>.71</td>
<td>-.07</td>
<td>-.08</td>
<td>-.13†</td>
<td>-.31**</td>
<td>-.02</td>
<td>.09</td>
<td>.16†</td>
<td>-.16†</td>
<td>(.75)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Prevention focus</td>
<td>4.20</td>
<td>.47</td>
<td>.38**</td>
<td>.36**</td>
<td>.43**</td>
<td>.27**</td>
<td>.40**</td>
<td>.27**</td>
<td>-.24**</td>
<td>.07</td>
<td>.01</td>
<td>(.82)</td>
<td></td>
</tr>
<tr>
<td>11. Promotion focus</td>
<td>3.69</td>
<td>.58</td>
<td>.36**</td>
<td>.13†</td>
<td>.22**</td>
<td>.29**</td>
<td>.40**</td>
<td>.34**</td>
<td>-.21**</td>
<td>-.11</td>
<td>-.04</td>
<td>.33**</td>
<td>(.81)</td>
</tr>
</tbody>
</table>

Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning
N=213 (Listwise). Values in parentheses on the diagonal are coefficient alphas.
** p < .01 (2-tailed).
* p < .05 (2-tailed).
† p < .10 (2-tailed).

Interestingly, of the five LFE constructs, coping learning has the smallest negative correlation with covering up. This possibly indicates that while hiding errors may take away from improvements in coping, at the same time both error hiding and learned coping strategies address one’s avoidance concerns following errors. Accordingly, this common orientation towards self-defense may ameliorate the otherwise detrimental effect of error hiding that is more pronounced for other learning types. Additionally, covering up errors may also be considered a coping strategy, thereby minimizing the contradiction between error hiding and learning, specifically in the case of coping learning.

Further, task and prevention learning should inversely relate with in-role tenure. The correlational analysis supports this prediction, although for prevention learning the significance level is above the traditional value (p = .097). Overall, though, the data suggests that individuals with less in-role tenure experience more task and prevention learning.
Lastly, I analyzed the correlations of LFE scales with error strain. Here, I anticipated that response and coping learning would inversely relate with strain. These predictions were supported, although for response learning the significance was at \( p = .053 \). Overall, though, the data suggests that individuals equipped to handle errors perceive less stress when errors occur.

Notably, the correlations among the five LFE constructs were significant and ranged between .37–.57. These correlations may indicate that the five types of learning outcomes tend to co-occur when mistakes take place. It is also possible that different types of learning support one another, however testing these predictions is outside the scope of this thesis and a potential focus for future studies.

### 5.6 Influences of Regulatory Focus on Learning from Errors

Lastly, to test the advanced hypotheses, I performed a regression analysis on data from all three samples with five LFE scales as dependent variables and the two regulatory foci as independent variables.

Given that in Sample 1 data on both dependent and independent variables were collected from the same source at a single time point, I tested for common method bias using two approaches (Podsakoff, MacKenzie, & Lee, & Podsakoff, 2003). First, I followed the Harman’s test and compared model fit between a seven-factor model that included the five error learning and two regulatory focus variables (\( \chi^2(833) = 1189.643, p < .001, \text{CFI} = .919, \text{RMSEA} = .045, \text{SRMR} = .061 \)) and a single-factor model (\( \chi^2(860) = 3139.606, p < .001, \text{CFI} = .479, \text{RMSEA} = .111, \text{SRMR} = .107 \)). I found that the seven-factor model showed a significantly better fit (\( \Delta \chi^2(27) = 1949.963, p < .001 \)), reducing concerns about common method variance. Second, I examined a model, in which an unmeasured method factor was added to the seven-factor model. Here, all indicators in the model were loaded on both their respective variables and the latent method factor. According to extant research (Billiet & McClendon, 2000; Schermuly & Meyer, 2016), common method bias affects variables identically and is orthogonal to other measured latent variables. I therefore fixed all unstandardized factor loadings on the method factor to 1 and made it uncorrelated with other variables. The model with a method factor fit the data well (\( \chi^2(831) = 1145.880, p < .001, \text{CFI} = .928, \text{RMSEA} = .042, \text{SRMR} = .089 \)). While addition of the method factor resulted in improvement in the fit indices, the two models have a CFI difference (.009)
that is smaller than the suggested cut-off value of .01 (Cheung & Rensvold, 2002), indicating the two models are functionally equivalent. Taken together, these results suggest that the common method variance, although present, is not a major problem in this study. Accordingly, I proceeded to test the hypotheses.

**TABLE 11** displays results of the regression analysis using Sample 1a. As hypothesized, prevention focus positively relates to prevention and coping learning ($\beta = .36$ and $\beta = .21$, $p < .01$ respectively). Additionally, the findings show prevention focus also positively influences task, response, and meta-learning.

Consistent with Hypothesis 3 and Hypothesis 5, promotion focus exhibits a significant positive relationship with task and meta-learning ($\beta = .26$ and $\beta = .29$, $p < .01$ respectively). The hypothesized effect of promotion focus on response learning is insignificant. Although not predicted, promotion focus also shows a significant relationship with coping learning.

Overall, these results support our hypotheses about the effect of regulatory focus on learning from errors, with the exception of Hypothesis 4 (promotion focus and response learning). One notable pattern offered by these regression results involves the wide-spanning effect of prevention focus, whereby it positively affects all five error learning types. I investigate this pattern further in the next two samples.

**TABLE 11. Sample 1a: Results of regression analysis**

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Dependent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TASK</td>
</tr>
<tr>
<td>Prevention focus</td>
<td>.29**</td>
</tr>
<tr>
<td>Promotion focus</td>
<td>.26**</td>
</tr>
</tbody>
</table>

|                  |      |      |      |      |      |
| R²               | .20  | .13  | .19  | .12  | .23  |
| Adjusted R²      | .20  | .13  | .19  | .11  | .23  |

Note: Standardized regression coefficients are displayed.
N = 215 (listwise)
**p < .01

Similar analysis was performed on Sample 2 data. Descriptive statistics and correlations among the variables obtained from Sample 2 are shown in **TABLE 12**.
TABLE 12. Means, standard deviations and correlations among variables in Sample 2

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
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<th>2</th>
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<tbody>
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</tr>
<tr>
<td>2. PREV</td>
<td>4.16</td>
<td>.63</td>
<td>.50**</td>
<td>.87</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>3. RESP</td>
<td>4.09</td>
<td>.68</td>
<td>.57**</td>
<td>.51**</td>
<td>.82</td>
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<td></td>
</tr>
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<td>.52**</td>
<td>.66**</td>
<td>.86</td>
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<td>5. META</td>
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<td>.70**</td>
<td>.58**</td>
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<td>.86</td>
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<td>7. PREV&lt;sub&gt;2&lt;/sub&gt;</td>
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<td>.52**</td>
<td>.40**</td>
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<td>.83</td>
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</tr>
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<td>.58</td>
<td>.42**</td>
<td>.36**</td>
<td>.55**</td>
<td>.47**</td>
<td>.55**</td>
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<td>.78**</td>
<td>.80</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>9. COPE&lt;sub&gt;2&lt;/sub&gt;</td>
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<td>.40**</td>
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<td>.86</td>
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</tr>
<tr>
<td>10. META&lt;sub&gt;2&lt;/sub&gt;</td>
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<td>.67</td>
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<td>.31**</td>
<td>.53**</td>
<td>.53**</td>
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<td>.74**</td>
<td>.69**</td>
<td>.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Prevention focus</td>
<td>4.33</td>
<td>.51</td>
<td>.46**</td>
<td>.41**</td>
<td>.34**</td>
<td>.31**</td>
<td>.55**</td>
<td>.50**</td>
<td>.55**</td>
<td>.57**</td>
<td>.37**</td>
<td>.55**</td>
<td>.85</td>
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</tr>
<tr>
<td>12. Promotion focus</td>
<td>3.93</td>
<td>.73</td>
<td>.43**</td>
<td>.39**</td>
<td>.42**</td>
<td>.57**</td>
<td>.60**</td>
<td>.40**</td>
<td>.38**</td>
<td>.50**</td>
<td>.46**</td>
<td>.56**</td>
<td>.55**</td>
<td>.88</td>
</tr>
</tbody>
</table>

Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning
N=151 (Listwise). Values in parentheses on the diagonal are coefficient alphas.
** p < .01 (2-tailed).
* p < .05 (2-tailed).

In regression analysis, each of the LFE constructs measured at Time 2 was regressed on both regulatory foci measured at Time 1 (two weeks apart). These regressions results are presented in models A (shaded columns) in TABLE 13. Overall, these results are consistent with those obtained from Sample 1a. The main difference pertains to Hypothesis 4, which is now supported by Sample 2 data: Promotion focus is significantly and positively related with response learning (β = .25, p < .01).

While the regression results from Sample 2 now support all the hypotheses relating regulatory focus to error learning (H1–H5), these results also replicate the pattern of untheorized effects. Namely, prevention focus affects all five LFE constructs, and promotion focus is significantly and positively linked with coping learning. To further examine these untheorized effects, I compared regression models with prevention focus only (Models B) and promotion focus only (Models C) against the full model containing both foci. Specifically, I sought to examine the changes in explained variance of each LFE type.

Examination of models B in the above regression results suggests that removal of promotion focus greatly impoverished the prediction of coping and meta-learning (the negative changes in
$R^2$ are 10% and 9% respectively). These results indicate that while the effects of prevention focus are significant across five types of learning, promotion focus delivers a particularly sizeable contribution to coping and meta-learning. In contrast, the inclusion of promotion focus to models predicting task, prevention, and response learning yields relatively small or nil benefits (increase in $R^2$ of 3%, 0%, and 4% respectively).

In turn, examination of models C in the regression results shows that removal of prevention focus greatly impoverished the prediction of task, prevention, response, and meta-learning (the negative changes in $R^2$ are 10%, 16%, 12% and 8% respectively). These results indicate that prevention focus may indeed have a significant and substantial unique contribution to error learning that spans multiple error learning types.

To further investigate the contribution of promotion and prevention focus in explaining the five LFE types, I performed relative weight analysis. This technique is particularly useful when a model includes correlated predictors, such as ours (prevention and promotion focus are correlated at $r = .55$, $p < .01$). Relative weight refers to the proportionate contribution of each predictor to the overall predictive validity of a regression model (LeBreton, Hargis, Griepentrog, Oswald, & Ployhart, 2007; Tonidandel & LeBreton, 2015). The relative weight analysis accounts for predictor intercorrelations by 1) creating a new set of predictor variables that are uncorrelated with each other, but maximally correlated with the original predictor variables; 2) regressing original predictors on the new uncorrelated ones; 3) regressing a criterion on new uncorrelated variables; and 4) combining the squared standardized coefficients from steps 2 and 3 (Johnson, 2000). In this procedure, predictors’ relative weights sum up to the model $R^2$, thereby offering “a complete decomposition of the total predicted variance” (Dalal, Baysinger, Brummel, & LeBreton, 2012: 302). The results of relative weight analysis are presented in TABLE 14 and support a larger relative contribution of prevention focus to prediction of task, prevention, and response learning (62%, 76%, and 62% respectively), as well as a relatively larger contribution of promotion focus to coping and meta-learning (67% and 52% respectively).
### TABLE 13. Sample 2: Results of hierarchical regression analysis

<table>
<thead>
<tr>
<th>Predictors</th>
<th>TASK(_{t^2})</th>
<th>PREV(_{t^2})</th>
<th>RESP(_{t^2})</th>
<th>COPE(_{t^2})</th>
<th>META(_{t^2})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention focus</td>
<td>Model 1A</td>
<td>.38**</td>
<td>.49**</td>
<td>.54**</td>
<td>.43**</td>
</tr>
<tr>
<td></td>
<td>Model 1B</td>
<td>.49**</td>
<td>.49**</td>
<td>.54**</td>
<td>.43**</td>
</tr>
<tr>
<td>Promotion focus</td>
<td>Model 2A</td>
<td>.21*</td>
<td>.42**</td>
<td>.11</td>
<td>.37**</td>
</tr>
<tr>
<td></td>
<td>Model 2B</td>
<td>.29</td>
<td>.29</td>
<td>.13</td>
<td>.35</td>
</tr>
<tr>
<td>R(^2)</td>
<td>Model 1A</td>
<td>.28</td>
<td>.24</td>
<td>.18</td>
<td>.30</td>
</tr>
<tr>
<td></td>
<td>Model 1B</td>
<td>.24</td>
<td>.24</td>
<td>.17</td>
<td>.29</td>
</tr>
<tr>
<td></td>
<td>Model 1C</td>
<td>.18</td>
<td>.30</td>
<td>.14</td>
<td>.36</td>
</tr>
<tr>
<td>Adjusted R(^2)</td>
<td>Model 1A</td>
<td>.27</td>
<td>.24</td>
<td>.17</td>
<td>.29</td>
</tr>
<tr>
<td></td>
<td>Model 1B</td>
<td>.24</td>
<td>.24</td>
<td>.13</td>
<td>.29</td>
</tr>
<tr>
<td></td>
<td>Model 1C</td>
<td>.17</td>
<td>.30</td>
<td>.14</td>
<td>.36</td>
</tr>
<tr>
<td>ΔR(^2)</td>
<td>Model 1A</td>
<td>-.03†</td>
<td>-.10**</td>
<td>0</td>
<td>-.16**</td>
</tr>
<tr>
<td></td>
<td>Model 1B</td>
<td>-.03†</td>
<td>-.10**</td>
<td>0</td>
<td>-.16**</td>
</tr>
<tr>
<td></td>
<td>Model 1C</td>
<td>-.03†</td>
<td>-.10**</td>
<td>0</td>
<td>-.16**</td>
</tr>
</tbody>
</table>

Note: Standardized regression coefficients are displayed.

1\(N = 157\); 2\(N = 155\); 3\(N = 156\) (listwise)

** p < .01 (2-tailed).

* p < .05 (2-tailed)

† p < .10 (2-tailed).

### TABLE 14. Sample 2: Relative weight analysis

<table>
<thead>
<tr>
<th>Predictors</th>
<th>TASK(_{t^2})</th>
<th>PREV(_{t^2})</th>
<th>RESP(_{t^2})</th>
<th>COPE(_{t^2})</th>
<th>META(_{t^2})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention focus</td>
<td>rRW</td>
<td>.17**</td>
<td>.23**</td>
<td>.22**</td>
<td>.08**</td>
</tr>
<tr>
<td></td>
<td>RS–RW%</td>
<td>62.14</td>
<td>76.02</td>
<td>61.83</td>
<td>33.03</td>
</tr>
<tr>
<td>Promotion focus</td>
<td>rRW</td>
<td>.10**</td>
<td>.07**</td>
<td>.14**</td>
<td>.16**</td>
</tr>
<tr>
<td></td>
<td>RS–RW%</td>
<td>37.86</td>
<td>23.98</td>
<td>38.17</td>
<td>66.98</td>
</tr>
</tbody>
</table>

Note: rRW is raw relative weight (within rounding error raw weights will sum to R\(^2\)); RS-RW is relative weight rescaled as a percentage of predicted variance in the criterion (within rounding error rescaled weights sum to 100%)

** p < .01 (2-tailed).

* p < .05 (2-tailed).
Now I turn to the tests of regulatory focus–error learning relationships with Sample 3 data. Descriptive statistics and correlations among the variables obtained from Sample 3 are shown in TABLE 15 and results of regression analysis in TABLE 16.

**TABLE 15. Means, standard deviations and correlations among variables in Sample 3**

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>TASK</td>
<td>3.94</td>
<td>.67</td>
<td>(.81)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREV</td>
<td>3.81</td>
<td>.64</td>
<td>.15</td>
<td>(.80)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESP</td>
<td>3.91</td>
<td>.56</td>
<td>.05</td>
<td>.54**</td>
<td>(.72)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPE</td>
<td>3.76</td>
<td>.69</td>
<td>.15</td>
<td>.25</td>
<td>.47**</td>
<td>(.77)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>META</td>
<td>3.89</td>
<td>.56</td>
<td>.13</td>
<td>.36**</td>
<td>.48**</td>
<td>.24</td>
<td>(.69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevention focus</td>
<td>4.08</td>
<td>.62</td>
<td>-.14</td>
<td>.11</td>
<td>.18</td>
<td>-.11</td>
<td>.08</td>
<td>(.82)</td>
<td></td>
</tr>
<tr>
<td>Promotion focus</td>
<td>3.33</td>
<td>.91</td>
<td>-.07</td>
<td>.02</td>
<td>.24</td>
<td>.00</td>
<td>.18</td>
<td>.46**</td>
<td>(.85)</td>
</tr>
</tbody>
</table>

Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning
N=62 (Listwise). Values in parentheses on the diagonal are coefficient alphas. 
**p < .01 (2-tailed).**

**TABLE 16. Sample 3: Results of regression analysis**

<table>
<thead>
<tr>
<th>Predictors</th>
<th>TASK</th>
<th>PREV</th>
<th>RESP</th>
<th>COPE</th>
<th>META</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention focus</td>
<td>.16</td>
<td>.15</td>
<td>.08</td>
<td>.16</td>
<td>-.01</td>
</tr>
<tr>
<td>Promotion focus</td>
<td>.11</td>
<td>.10</td>
<td>.20</td>
<td>.11</td>
<td>.19</td>
</tr>
</tbody>
</table>

R²: .02 .01 .06 .02 .03
Adjusted R²: -.02 -.02 .03 -.02 .00

Note: Standardized regression coefficients are displayed.
N = 62.
All coefficients are not significant.

Across all five LFE variables, both correlations and regression coefficients are insignificant, indicating that the regulatory focus variables are not related to the error learning constructs in this sample. The possible reasons for insignificant relationships are 1) the effects do not generalize to the population from which the sample was drawn; or 2) these effects are small-to-medium size and could not have been detected given the sample size and corresponding statistical power. I consider both of these reasons below.
First, it is possible that the hypothesized effects of regulatory focus on error learning are limited to certain contexts. The purpose of recruiting a CEO sample was to test generalizability of the proposed effects to occupational settings where error costs are high. Hence, lack of significant results in a sample of such occupation may indicate a potential boundary condition. Perhaps, the costs of errors among entrepreneurs are such a substantial predictor of error learning that individual regulatory focus yields no additional explanation. Accordingly, future studies should directly test occupational boundary conditions of the theorized effects.

The second possible reason for insignificant results is that the hypothesized effects are of smaller magnitude than what Sample 3 could detect. Sample 3 size is smaller than Samples 1a and 2, with 62 cases available for analysis after accounting for missing values. The power implications of such a small sample size can be assessed using G*Power calculator (Faul, Erdfelder, Lang, & Buchner, 2007). To exceed the minimum acceptable statistical power of .80 (Cohen, 1992), based on the sample size N=62, a regression model with two predictors, and alpha of .05, the regression should at least have $R^2 = .142$, which is a medium-large effect size. This analysis suggests that Sample 3 did not have enough power to detect small-to-medium effects. Consequently, larger samples would be helpful to further assess the theorized effects among entrepreneurs.

Considering the issues of sampling variance and low statistical power in Sample 3, I meta-analyzed the findings obtained from all three samples to estimate the hypothesized effects more precisely. **TABLE 17** presents meta-analytic correlations obtained using a random-effects model. A random-effects model allows for differences in the true effect size across studies and gives relatively similar weights to the studies (Borenstein, Hedges, Higgins, & Rothstein, 2010).

I also performed a regression using as inputs the meta-analytic correlations and pooled means and standard deviations across all three samples. Overall, the meta-analytic regression results (**TABLE 18**) suggest that prevention focus has medium-to-large associations with all LFE constructs, except for coping learning where the effect is smaller. The relationship between promotion focus and LFE is of comparable magnitude for task learning, substantially smaller for response learning, insignificant for prevention learning, but larger for coping and meta-learning.
This pattern of findings suggests that the type of learning is indeed a boundary condition to the effects of promotion and prevention foci.

TABLE 17. Meta-analytic correlations of regulatory focus with LFE constructs

<table>
<thead>
<tr>
<th></th>
<th>M_{pooled}</th>
<th>SD_{pooled}</th>
<th>TASK</th>
<th>PREV</th>
<th>RESP</th>
<th>COPE</th>
<th>META</th>
<th>Prevention focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>TASK</td>
<td>4.02</td>
<td>.68</td>
<td>.44</td>
<td>[.10; .78]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREV</td>
<td>4.19</td>
<td>.60</td>
<td>.44</td>
<td>[.09; .78]</td>
<td>.64</td>
<td>[.34; .94]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESP</td>
<td>4.18</td>
<td>.55</td>
<td>.40</td>
<td>[.15; .65]</td>
<td>.60</td>
<td>[.40; .66]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPE</td>
<td>3.96</td>
<td>.69</td>
<td>.52</td>
<td>[.15; .89]</td>
<td>.52</td>
<td>[.22; .82]</td>
<td>.62</td>
<td>[.38; .85]</td>
</tr>
<tr>
<td>META</td>
<td>4.01</td>
<td>.62</td>
<td>.28</td>
<td>[.03; .59]</td>
<td>.37</td>
<td>[.12; .61]</td>
<td>.40</td>
<td>[.15; .65]</td>
</tr>
<tr>
<td>Prevention focus</td>
<td>4.27</td>
<td>.50</td>
<td>.26</td>
<td>[.02; .50]</td>
<td>.19</td>
<td>[.02; .41]</td>
<td>.33</td>
<td>[.11; .55]</td>
</tr>
<tr>
<td>Promotion focus</td>
<td>3.76</td>
<td>.68</td>
<td>.17</td>
<td><strong>p &lt; .01 (2-tailed)</strong></td>
<td>.03</td>
<td><strong>p &lt; .10 (2-tailed)</strong></td>
<td>.19</td>
<td><strong>p &lt; .01 (2-tailed)</strong></td>
</tr>
</tbody>
</table>

Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning; Values in squared brackets indicate 95% confidence interval.

TABLE 18. Meta-analytic regression results

<table>
<thead>
<tr>
<th>Predictors</th>
<th>TASK</th>
<th>PREV</th>
<th>RESP</th>
<th>COPE</th>
<th>META</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention focus</td>
<td>.20**</td>
<td>.36**</td>
<td>.32**</td>
<td>.09†</td>
<td>.23**</td>
</tr>
<tr>
<td>Promotion focus</td>
<td>.17**</td>
<td>.03</td>
<td>.19**</td>
<td>.24**</td>
<td>.31**</td>
</tr>
</tbody>
</table>

Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning

**p < .01 (2-tailed).
† p < .10 (2-tailed).

These findings also indicate that different types of error learning benefit from different regulatory focus conditions: While some are more strongly influenced by prevention focus (prevention and response learning), others seem to benefit more from promotion focus (coping and meta-learning), and yet another type (task learning) is positively affected by both foci. These results further elaborate the differences in the nomological nets of the five LFE constructs, and thereby support their distinctions.
Chapter 6

6 Discussion and Conclusions

6.1 Main Contributions

The objective of this work was to enhance our understanding of the nature and content of learning from errors. Research is abundant with claims of the learning benefits of errors, with much of this work emphasizing improved error prevention. This thesis sought to provide an integrated framework that accounts for diverse error learning types identified by scholars in various domains, including training, high reliability, creative processes, and service failures, and to explicate the conditions underpinning each error learning type.

The contributions of the present thesis are as follows. First, it shows the multidimensionality of learning from error. Quantitative and qualitative evidence obtained from samples of knowledge and non-knowledge workers and in contexts with low and high cost of error provides empirical grounds for five distinct error learning constructs. Thereby, these findings confirm that learning from errors is a multifaceted phenomenon, where individuals may experience a range of learning types and their various configurations.

The second key finding of this thesis addresses the role of growth and security concerns in learning from errors. Extant research suggests that orientation towards growth, mastery and learning may be particularly beneficial in error situations (Edmondson, 2004; Keith & Frese, 2005, 2008), while concern with security and validating one’s performance may inhibit learning (Chikudate, 2009; Keith & Frese, 2005, 2008). While some extant studies provide evidence to the contrary, these inconsistent findings remained unaddressed. So this thesis set out to examine whether concern with growth is always beneficial for error learning and concern with security is always a hindrance.

My sense in exploring these questions was that the role of growth and security concerns is contingent on the type of error learning. Accordingly, guided by the regulatory focus theory and equipped with the developed measurement inventory, I was able to explicate when the two motivational concerns affect learning. Specifically, I found that promotion focus’ effects are
particularly sizeable for task, coping, and meta-learning, while its contribution to prevention and response learning types is more modest. I did not hypothesize that promotion focus would relate to coping learning. This effect is possibly due to a variety of ways, in which individuals may learn to cope with errors: While some coping strategies may be more proactive, approach-based (e.g., seek comfort from family) and therefore aligned with promotion focus, other coping strategies may be more avoidance-based (hide errors) and characteristic of prevention-focused individuals.

At the same time, I found that prevention focus is a major contributor to learning about a task, prevention and response strategies, while its influence on coping learning is lesser. These results are important on two accounts. For one thing, they clarify the previously documented hindering role of security concerns in error learning. Namely, the emphasis on security alone is insufficient to extract from errors the full range of learning benefits. In other words, pre-occupation with security in the absence of improvement aspirations “leaves learning on the table,” as evidenced in the diminished R² across most learning types in Sample 2.

For another thing, while security focus is not all it takes to learn from errors, the present studies reveal its wide-spanning benefits for learning. These effects challenge the view on self-protection as detrimental to learning. A plausible explanation of these wide-ranging effects is the sense of obligation underlying the desire to uphold one’s responsibilities and meet security needs. In other words, when a given job must be done or a certain professional image maintained, some amount of task, response, and meta-learning becomes a necessity that has to be achieved regardless of one’s (lack of) eagerness or perceived efficacy (Shah & Higgins, 1997). This logic could also explain some prior evidence of the effectiveness of accountability mechanisms and even blaming culture in stimulating learning.

6.2 Theoretical Implications and Areas for Future Research

This thesis underscores the importance of careful discernment and more rigorous conceptual treatment of the phenomenon of learning from errors. As the presented studies show, different types of error learning may exhibit different patterns of relating to other constructs. For instance, while task learning may benefit from both regulatory orientations, prevention learning benefits from only one. It is possible that other constructs too will exhibit different strength or direction.
of relation to error learning, depending on the learning type. Consequently, this finding is directly aligned with the goal to provide a more nuanced way of theorizing about error learning and its causes and consequences.

One particularly important future extension of the LFE nomological nets is examination of the performance outcomes. A starting point for this investigation could be review of the studies on errors and reliable performance. Here, some scholars have noted that learning from errors may fail to deliver greater reliability (Katz-Navon et al., 2009), suggesting that learning and reliability are linked in a more nuanced way. This points to the possibility that not all types of error learning are made equal when it comes to increasing reliable performance, however extant theoretical models are yet to reflect these distinctions. Using a multifaceted conceptualization of learning from errors may help identify the most potent error learning types for reliable performance.

Furthermore, performance improvement so commonly sought from errors may mean different things in different settings. For example, learning from errors has been of interest in the studies of innovative performance, where the insight generated by errors may spark fruitful investigations and inform design of new products (Hammond, Farr, & Sherman, 2011; van Woerkom, 2012). Likewise, a large body of error management scholarship increasingly emphasizes the importance of resilient performance and bouncing back from errors (e.g., Weick & Sutcliffe, 2007). It is likely that different types of learning may be important for reliable, innovative, and resilient performance, and therefore, a unidimensional concept of error learning is ill suited for investigations of the learning–performance relationship. Given that errors are considered critical occasions for performance improvement in organizations, efforts are warranted to clarify the error learning–performance link through a multifaceted lens on error learning.

The proposed framework also has implications for interpreting and integrating existing research on error learning. The typology includes alternative and nonequivalent types of learning from errors, whereby attaining any one of them individually or in any combination would indicate that learning from errors has happened. This possibility of some types of error learning occurring in the absence of others presents a potentially fruitful perspective for investigation of failures to
learn from mistakes that have been evidenced in prior research (Cannon & Edmondson, 2005; Zhao, 2011). Specifically, scholars may now consider looking for learning in more places than reduced error rates and measure additional types of error learning. Recurring errors may be interpreted not as a signal of non-learning, but perhaps an indication of an alternative learning type. Since all five learning types are potentially adaptive, it is important to recognize when they take place and seek ways to harness them for improved performance.

Additionally, it would be helpful to directly investigate the relationships among the proposed error learning types. While some scholars have noted potential conflicts, and the present work also acknowledged the possible trade-offs, among the five learning types, researchers are yet to quantify these trade-offs. This is a particularly interesting line of inquiry, given that the competing perspective is also plausible: The five learning types may actually be mutually reinforcing (e.g., knowing how to cope emotionally helps formulate error response strategies and vice versa), as discussed in the conceptual development part of this thesis and suggested by significant positive intercorrelations across the samples.

Another theoretical implication of the advanced typology is its attention to reactive error processing. While some past research has warned against action-based treatment of errors (Edmondson, 2004; Tucker & Edmondson, 2003), I noted that such warnings were based on the preeminence of error aversion in high reliability organizations and only partially applied to other workplace contexts. Moreover, considering the growing recognition of human fallibility in virtually all organizational settings (Bauer & Harteis, 2012), practices that help individuals in the aftermath of errors become an important focus of learning. Discouraging reactive processing may lead to unfortunate consequences, where overcome with shock, doubt or indecisiveness, individuals fail to provide timely remediation for errors (Rudolph, Morrison, & Carroll, 2009).

All else equal, in the face of errors, having a readily available response and coping practice trumps terrified inaction. Accordingly, empowering individuals to discover effective response and coping strategies provides a useful lever for maximizing learning from errors. While scholars have dedicated much attention to the contextual determinants of error reflection (e.g. Van Dyck et al., 2005; Katz-Navon et al., 2009; Edmondson & Lei, 2014), the error literature is largely
silent on how organizations can empower relevant action-based processing of errors. This appears to be a promising focus for future research.

The final recommendation for future research is to directly examine contextual boundaries to the effects observed in the present study. While the presented three studies involved settings with both knowledge and non-knowledge workers and both low and high cost of errors, it would be interesting to test directly such occupational and other contextual influences on the relationship between individual regulatory focus and error learning. It is likely that depending on the context, the trade-offs among learning types may be more pronounced, thus, forcing individuals and organizations to prioritize which type of learning to pursue (Lei & Naveh, 2018; Lei et al., 2016). The high cost of errors in high reliability organizations may strengthen the link between individual security concerns and prevention learning. At the same time, jobs involving human interactions, where errors are often unique and idiosyncratic, could make individuals value response learning more. In contrast, prioritizing response learning in high-hazard settings, just like pursuing compliance in dynamic and unpredictable workplaces, may actually hinder one’s effectiveness. So certain industries, occupational settings and task domains may override or diminish the role of individual regulatory focus on learning, and therefore, should be considered as moderators in future theoretical models.

Aside from stable contextual demands, different times or different situations may present individuals with qualitatively different goals, and consequently require different types of learning from errors. Future research should consider the changing role of errors in learning over time: It is conceivable that individuals may use errors first to acquire new knowledge (task learning), then to adhere to the acquired norms (prevention learning), and later to become resilient when adherence fails (response and coping learning). Some research has alluded to the different uses of errors in different stages of product design (Goh, Goodman, & Weingart, 2013), but a more systematic examination of errors and learning relationship over time presents another interesting research question for future studies.

### 6.3 Practical Implications

This research has practical implications for both individuals and organizations. At the individual level, awareness of the distinct error learning types may be beneficial by highlighting ways a
person can extract the most learning value out of their error experiences. Similarly, a more nuanced understanding of what learning from errors entails, how different learning outcomes come about, and what effect they may have should assist organizations in stimulating the most relevant learning outcomes. Recognizing that errors offer a range of learning benefits, organizations can mindfully weigh their learning options and choose which types of learning to prioritize. For instance, organizations and business units with low error tolerance may choose to prioritize prevention learning. Alternatively, dynamic organizations with high turnover and regular influx of new employees, such as some service organizations, may prioritize task learning. Learning from errors is not ‘one size fits all’, and so this work encourages organizations to view error learning as a matter of choice and priority, rather than universal and unequivocal benefit.

This work also suggests practices and interventions for stimulating the desired types of learning in the workplace. Specifically, this work may inform employee selection and job design practices that would ensure fit between stable individual motivations and the learning demands of one’s job. This way, work tasks and assignments can be crafted so that their error learning requirements match the motivational dispositions of individuals performing these assignments. When little flexibility in job crafting is available, organizations may focus on ensuring the person-job fit through targeted recruitment of individuals with the desired regulatory orientations.

Furthermore, besides considerations of fit, stimulating relevant error learning outcomes may involve adoption of particular incentives and leadership behaviors by managers. For example, organizations profiting from employee talent development, such as creative companies, may promote continuous task learning through a greater emphasis on gains, relative to losses, in their reward system and leader communications. Alternatively, organizations with priority on safety and reliability that require both task and prevention learning might be better served by a more balanced mix of incentives combining rewards for mastery and reminders of compliance.

Much organizational research attests to the benefits of a growth mindset, and management practitioners alike increasingly strive to cultivate a growth mindset among their employees (Dweck, 2014; Grant, Slaughter, & Derler, 2018). Growth-centered interventions and initiatives
are decidedly important in encouraging experiential learning in organizations. However, in these rising aspirations for continuous growth and self-actualization, it is important to not lose sight of the value of vigilance, accountability, and responsible actions. This study suggests that for most types of learning from errors – and perhaps we can extrapolate to learning from experience in general – cognizance of one’s responsibilities and obligations is beneficial. While this does not necessarily imply the inferiority of growth-based interventions, it does suggest that focus on accountability provides a powerful organizational lever for learning from errors.

6.4 Strengths and Limitations

The present study has a number of strengths. The developed measurement instrument is a result of both rigorous theoretical integration and empirical work across four samples. While there is room for refinement, the LFE inventory demonstrates a consistent and invariant structure with good psychometric properties.

The choice of settings for data collection is another strength of this thesis. Contributing to the literature that argues for the benefits of error management over error prevention, the empirical component of this thesis relied on occupational contexts where errors are frequent, expected, and an integral part of the work itself. The entrepreneurs’ quotes showed that inevitability of errors in some settings can co-exist with high error costs, while the qualitative accounts of the service workers also illuminated a variety of learning reactions that become possible when errors are considered a norm. These settings are in contrast with high reliability organizations, where the severity of error costs dictates the emphasis on error prevention. At the same time, the chosen samples did not come from a student population or a laboratory experiment, where errors may be easy to accept but are not always associated with meaningful work outcomes. Therefore, use of full-time employees representing service delivery work, knowledge work, and entrepreneurship is an important methodological and substantive contribution to the domain of error management.

Another strength of this study is in the introduction of regulatory focus theory to the scholarship on errors. One of the original postulates of the regulatory focus theory is that not all failures are experienced in the same way (Higgins, 1997, 1998), i.e. behavioral, cognitive and affective responses to failure may vary depending on the particular kind of failure. This property of regulatory focus strongly resonates with experiential learning scholarship that traditionally
deems learning as a product of cognitions, emotions, and motivations (Kolb, Boyatzis, & Mainemelis, 2001). Consequently, regulatory focus theory provides a comprehensive framework of self-regulation with respect to errors, a considerable advantage compared to other motivation theories applied to the studies of errors. Recognizing these advantages, some scholars called for exploring the role of regulatory focus perspective in learning from errors (Frese & Keith, 2015). To my knowledge, this is the first study that addresses these calls and proves regulatory focus perspective fruitful for theorizing the emergence of various learning types.

The present study also has some limitations. First, the construct validation efforts are largely based on online panel samples, and so replications in samples with alternative recruitment methods are necessary. Also, inclusion of additional variables in new studies may help further test the distinctiveness in the nomological networks of the five error learning scales. Specifically, this study examined only individual variables, such as covering up and error strain. A number of contextual variables appear logical candidates for the nomological network that so far remained untested. For example, psychological safety, learning climate, error management and error aversion cultures should be examined as predictors of the five types of learning from error. Additionally, the previously mentioned performance outcomes, reliability, innovation, and resilience, as well as other relevant criterion variables, such as occupational self-efficacy, work-related affective well-being, burnout, and turnover, should also be investigated as part of the further assessment of LFE nomological nets.

Second, across three samples, the measures of work-related regulatory focus reflected individuals’ general inclination to pursue growth aspirations and security needs at work. The use of such regulatory focus measures was justified in the present study, since learning from errors was also operationalized at the general level of one’s overall experience with mistakes at work. However, these measures give little new insight into concrete organizational and contextual origins of the reported regulatory focus, making it difficult to offer new organizational practices and interventions for stimulating learning through regulatory focus. So a logical extension of the present work would involve study designs with experimental manipulations (e.g., feedback as yet unattained growth versus falling short on a critical responsibility) or coding of organizational factors (e.g., the extent to which an incentive system or leadership rewards gains versus punishes for losses).
Third, all measures used in the Sample 1a and 3 were collected with the same instrument at one time, thereby creating a threat to internal validity of our findings. I was able to rule out the common method bias statistically in Sample 1a, thereby minimizing threats to internal validity. Additionally, I separated measures of regulatory focus and learning from errors in time in Sample 2. However, future studies should aim to further validate the observed results by using multisource data and employing experimental designs.

Additionally, the size and composition of the samples is another limitation. Specifically, I encountered attrition in Sample 2 between the two waves of the survey. Furthermore, returning participants were different on such variables as gender, management level within organization, and promotion focus. Given that respondents were a more gender-balanced group from higher management levels and with higher promotion focus (compared to non-respondents), the findings may be unrepresentative of the original sample, thereby potentially challenging generalizability to the North American workforce. Additionally, attrition made it impossible to collect error learning data from participants with low promotion focus, which potentially affects internal validity of the observed effects. Furthermore, Sample 3 findings were inconclusive, likely due to low statistical power. Accordingly, future studies validating the observed effects in large and representative samples are warranted.

Lastly, while efforts were made to aggregate results across the three samples, these efforts mainly focused on improving precision of the effect estimates. However, given the small number of samples available for this aggregation, I did not formally test for heterogeneity or include additional controls in the meta-analysis. It is my hope that new studies will test and try to replicate the observed relationships, so that future meta-analytic efforts can be more robust.

6.5 Conclusion

Encounters with errors at work commonly elicit ideas about learning, such as “errors are a stepping stone to success” or “errors are our best teachers.” This sentiment seems deeply ingrained in the discourse of errors among lay people and scholars alike. The lessons learned from errors may vary though in their nature and content, suggesting that errors may be harnessed for one’s improvement in more ways than one. From this diversity of potential lessons, what we
actually learn depends on our fundamental human needs for growth and security, whether stable or transient.

In the times when experiential and active learning are celebrated (Bell & Kozlowski, 2008; Noe, Tews, & McConnell Dachner, 2010), there is a need for more rigor in the empirical work on errors and their effects on individual and organizational learning. The present thesis can contribute to these empirical efforts by enabling researchers to investigate distinct error learning outcomes and suggesting regulatory focus theory as a potentially promising perspective. Continual attention on multidimensionality and motivational underpinnings of learning are important for truly making errors “our best teachers.”
References


Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research, 18*(3), 382-388.


Vogus, T. J., & Sutcliffe, K. M. (2007). The impact of safety organizing, trusted leadership, and care pathways on reported medication errors in hospital nursing units. *Medical Care, 45*(10), 997-1002.


Appendices

APPENDIX A: Letter of Information used with Sample 1a

Project Title: Experience of errors at work

Principal Investigator: Dr. Fernando Olivera, Professor, Ivey Business School, Western University

Co-investigator: Anna Sycheva, PhD Candidate, Ivey Business School, Western University

Letter of Information

Invitation to Participate

You are being invited to participate in a study of errors in the workplace. The purpose of this letter is to provide you with information required for you to make an informed decision regarding whether you want to participate in this research.

Purpose of this Study

The purpose of this study is to examine how individuals experience errors at work. Errors create opportunities to pause and reflect on performance, which may provide benefits for individuals and organizations. Thinking about errors can help us learn valuable skills and develop various effective practices on the job. It is these reflections that we seek to understand in this research.

To be eligible to participate in the study you must meet the following criteria:

1. You must be 18 years old or older.
2. You must work full-time as a server or bartender.

Study Procedure

If you agree to participate, you will be presented with a number of open-ended and survey questions that will ask you to reflect upon your prior error experiences on the job, as well as some other, more general, inclinations and preferences. The survey should take you approximately 20 minutes to complete.

Participation in the study is voluntary. You may refuse to participate or refuse to answer any of the questions.

Compensation

Your participation in the study will be compensated as indicated in the invitation from your panel provider.

Possible Risks and Benefits

There are no known or anticipated risks associated with participating in this study. Please know that no information communicated within this study will be traceable to you.

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APPENDIX A: Letter of Information used with Sample 1a (continued)

In terms of benefits, reflecting upon the questions in the survey may make you more aware of your approach to responding to errors and thus provide insights for future job performance.

You do not waive any legal rights by participating in this research.

Confidentiality

The responses that you provide will remain anonymous and confidential and accessible only to the researchers performing the study. In accordance with the American Psychological Association requirements, the data will be kept for five years and then destroyed. If the results are published, your name will not be used. To receive a copy of any potential study results, you can contact the project investigators using the contact information provided at the end of the survey.

Representatives of The University of Western Ontario Non-Medical Research Ethics Board may require access to your study-related records to monitor the conduct of the research.

Contacts for Further Information

If you would like any further information regarding this research project or your participation in the study you may contact either Anna Sycheva, at [redacted] or [redacted] or Fernando Olivera, at [redacted] or [redacted]. If you have any questions about your rights as a research participant or the content of this study, you may contact the Office of Research Ethics at 519.661.3036 or ethics@uwo.ca.

Consent

Completing the survey indicates that you have understood the nature of the study explained to you, that all questions have been answered to your satisfaction, and that you consent to participate in this study.

*Individual contact information has been removed to protect privacy.*
APPENDIX B: Interview protocol used with Sample 1b

Interview Protocol

Date: _______________

Time start of interview: ____________

Interviewee Code: _______________

SECTION 1: Background Information

1. We want to learn about your experiences working at ORGANIZATION. Let me begin by asking you how long have you worked for ORGANIZATION?

   Probe: Part time or full time? If part time, do you currently work at other organizations?

2. What is your current job? How long have you been doing this job?

3. As a [job position as given by the interviewee], what are your primary tasks and responsibilities?

4. We would like to get a sense of what your job is like on a day-to-day basis. Could you please describe what a typical day/shift of work is like for you?

   Probe: If we were to follow you around, what would we see you do? What interactions would you have with customers, coworkers, managers?

If the respondent says there is no typical day, ask about yesterday or what the previous workday is like.

SECTION 2: Challenging Situations at Work

5. Most jobs involve a variety of tasks and situations. Some of these situations are common and dealing with them is fairly straightforward. Others are more unique and challenging. We are interested in learning about situations that you may find challenging in doing your job. What are some of these challenges at this job for you? Can you think of an example and describe it to us?

   Probe: What kind of challenges or unexpected situations that you may have in fulfilling the responsibilities?

If we ask some of your colleagues this same question, what responses do you think we would hear?
APPENDIX B: Interview protocol used with Sample 1b (continued)

SECTION 3: Responses to Errors at Work

6. We have talked about challenging situations in your job. This has helped us learn about what you do and what can be difficult in your job. We have learned from our research that often times, when doing our jobs, we make mistakes. This is fairly common because, as human beings, we all make mistakes. We are interested in learning about your experience with mistakes. We would like you to think about a recent situation where you experienced a mistake. Please tell us about the situation.

   Probe: What happened? How did you know that you made a mistake? How did you react to it? What did you do (responses)?

7. Often times people report feeling certain emotions when they make mistakes. Going back to the example that you gave us, can you describe how you felt in that situation?

   Probe:
   (a) Feelings upon error detection: What did you think about it then?
   (b) Did you talk about it with someone else? Who? What happened?

   Do you anticipate that this situation would happen again? If so, how do you anticipate you would react to it?

8. Sometimes people describe mistakes as learning opportunities. Others say they’d rather forget about the experience. Tell us how you feel about this experience with regards to whether it served as a learning opportunity to you?

   Probe: What did you learn from the experience? What makes the learning part hard and what makes it easy? How did you feel?

   If the respondent says there is no learning, ask the respondent to “think about a most recent example where you learned something from your experience. Can you describe the experience to us? What happened? How did you feel? What are your responses? What did you learn from it?

9. If time permits, ask the interviewees to give us another example of experience of mistakes at work.

10. For the interviewees who had a previous job: We've talked about experience of mistakes in your current job. If you think about your previous job, is there any difference in how you reacted to mistakes then?

   For the interviewees who have two or more simultaneous jobs at the same time: Is there any difference in how you reacted to mistakes at [another organization’s name]?

   Thank you very much for your participation.
APPENDIX C: Comparison of LFE factor structures at Time 1 in Sample 2

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<th>Model and description</th>
<th>$\chi^2$</th>
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Note: TASK = Task Learning; PREV = Prevention Learning; RESP = Response Learning; COPE = Coping Learning; META = Meta-Learning. ‘&’ signifies that the two factors were merged for that model.

** p < .01
# Curriculum Vitae

**Name:** Anna Sycheva

**Post-secondary Education and Degrees:**

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<th>Institution</th>
<th>Location</th>
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<th>Years</th>
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<td>B.S.</td>
<td>2005–2009</td>
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<td>Bloomsburg University of Pennsylvania</td>
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<td>London, Ontario, Canada</td>
<td>M.S.</td>
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<tr>
<td>The University of Western Ontario</td>
<td>London, Ontario, Canada</td>
<td>Ph.D. (anticipated)</td>
<td>2013–2019</td>
</tr>
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</table>

**Honours and Awards:**

- Honorable Mention Award, Administrative Science Association of Canada, 2017

**Related Work Experience:**

- Lecturer, King’s College at Western University, 2016–2019