LEARNING BY THINKING:
OVERCOMING THE BIAS FOR ACTION THROUGH REFLECTION

Giada Di Stefano
HEC Paris
Department of Strategy and Business Policy
1, rue de la Libération
78351 Jouy-en-Josas, France
Phone: ++33 (0)1 3967-9615
Email: di-stefano@hec.fr

Francesca Gino
Harvard University
Negotiation, Organizations & Markets Unit
Baker Library, Bloomberg Center 447
Boston, MA 02163, USA
Phone: ++1 617 495-0875
E-mail: fgino@hbs.edu

Gary Pisano
Harvard University
Technology and Operations Management Unit
Morgan Hall 417
Boston, MA 02163, USA
Phone: ++1 617 495-6562
Email: gpisano@hbs.edu

Bradley Staats
University of North Carolina
Kenan-Flagler Business School
CB #3490
Chapel Hill, NC 27599, USA
Phone: ++1 919 962-7343
Email: bstaats@unc.edu

Keywords: learning by thinking; reflection; knowledge creation; learning; self-efficacy.

Acknowledgements: We thank Ella Miron-Spektor, Frederik Anseel, Lamar Pierce, Michaéla Schippers, and Saverio Dave Favaron, as well as participants in seminars at Cornell University, INSEAD, and the Wharton School of Business, for their insightful comments on earlier drafts. We are grateful to Devender Malhotra, Amit Rastogi, Rajesh Sehgal, Kartik Kamdar, Eben Samuel, and others at Wipro BPO for their substantial investment of time and attention in this study, without which the work would not have been possible. We appreciate the financial support of Harvard Business School and of UNC Kenan-Flagler.

Electronic copy available at: http://ssrn.com/abstract=2414478

LEARNING BY THINKING:
OVERCOMING THE BIAS FOR ACTION THROUGH REFLECTION

ABSTRACT

Research on learning has primarily focused on the role of doing (experience) in fostering progress over time. Drawing on literature in cognitive psychology and neuroscience, we propose that one of the critical components of learning is reflection, or the intentional attempt to synthesize, abstract, and articulate the key lessons taught by experience. In particular, we argue that purposeful reflection on one's accumulated experience leads to greater learning than the accumulation of additional experience. We explain this boost in learning through self-efficacy: reflection builds confidence in the ability to achieve a goal, which in turn translates into higher rates of learning. We test the resulting model experimentally, using a mixed-method design that combines two laboratory experiments with a field experiment conducted in a large business-process outsourcing company in India. We find that individuals who are given time to reflect on a task improve their performance at a greater rate than those who are given the same amount of time to practice with the same task. Our results also show that if individuals themselves are given the choice to either reflect or practice, they prefer to allocate their time to gaining more experience with the task– to the detriment of their learning.

INTRODUCTION

By three methods we may learn wisdom: First, by reflection, which is noblest; Second, by imitation, which is easiest; and third, by experience, which is the bitterest.
Confucius

It is well recognized today that knowledge plays an important role in the productivity and prosperity of economies, organizations, and individuals. Not surprisingly, then, the concept of learning has captured the attention of scholars across a wide range of fields and disciplines. In management, most research on learning has focused on its active dimension, namely the role of "doing" in explaining progress along the learning curve. This tendency is most clearly exemplified by the definition of learning as a lasting change in knowledge *generated by experience* (e.g., Argote & Miron-Spektor, 2011; Fiol & Lyles, 1985). Research on learning has mostly examined the role that different sources of experience play in the accumulation of knowledge (e.g., Darr, Argote, & Epple, 1995; Pisano, Bohmer, & Edmondson, 2001; Nadler, Thompson, & van Boven, 2003; Huckman & Pisano 2004; Gino, Argote, Miron-Spektor, & Todorova, 2010; KC, Staats, & Gino, 2013). Having focused on changes generated by experience, researchers thus have equated experience with action; hence, the notion of "learning by doing." Doing plays a

Electronic copy available at: http://ssrn.com/abstract=2414478

central role in conventional wisdom and practitioner-focused literature as well. For example, from the former comes the idea of "practice makes perfect"; from the latter, one of the best-selling management books of all time, *In Search of Excellence* (Peters & Waterman, 1982), exalted managers with a "bias for action."

The popularity of this approach rests, at least in part, on the existence of a natural bias for action. Research in psychology, economics, and management shows that when we are faced with a problem or uncertainty, we prefer to do something rather than nothing (e.g., Pieters & Zeelenberg, 2005). This is also true for cases in which doing nothing may actually be optimal. Consider, for instance, Bar-Eli *et al.*'s (2007) study examining goalkeepers' behavior in soccer games when faced with trying to save a penalty. The researchers found that over one-third of the time, penalty kickers shoot for the middle; less than two-thirds of the time, they aim for either the left or right corner. Nonetheless, almost all goalkeepers prefer to leap either to the left or the right rather than standing in the middle, where, on average, they are marginally more likely to save more goals. According to the study, the thinking behind such a decision is that it looks and feels better to have missed the ball by diving (action) in the wrong direction than to have the ignominy of watching the ball go sailing past and never to have moved (inaction).

Our natural bias for action also has implications for how we approach learning new tasks. Consider that learning a new task requires not only practice, but also thought. To learn, we must assess and interpret our performance, analyze actions, search for patterns, figure out our mistakes, and develop hypotheses about what we might do differently the next time. This bundle of cognitive activities can be summed up as reflection (Argyris & Schön, 1978; Schön, 1983). Both practice and reflection are costly—each takes time, resources, and effort. And each extracts time, resources, and energy from the other. In this paper, we argue that the bias for action likely influences how we allocate our time and effort to practice versus reflection, and it may do so in ways that are ultimately detrimental to our learning.

Electronic copy available at: http://ssrn.com/abstract=2414478

In particular, we theorize that, once a person has accumulated a certain amount of experience with a task, the benefit of additional practice is inferior to the benefit of reflecting upon the accumulated experience. In other words, the intentional attempt to synthesize, abstract, and articulate the key lessons learned from experience generates higher learning outcomes as compared to those generated by the accumulation of additional experience. To explain the boost in learning generated by reflection, we focus on psychological mechanisms. We seek to understand whether intentional reflection on experience with a task affects the way one approaches that task afterwards. In particular, we suggest that reflection results in an increase in perceived self-efficacy, defined as "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995: 2). Reflection builds one's confidence in the ability to achieve a goal (i.e., self-efficacy), which in turn translates into higher rates of learning.

We test our learning model using a mixed-method experimental design that combines the precision of laboratory experiments with the reach and relevance of a field experiment. We first test for the effect of reflection on learning (what we will refer to as "learning by thinking") and the underlying psychological mechanism driving it in two laboratory experiments. To conceptually replicate our key findings and externally validate their relevance, we then turn to a field experiment that we carried out in a large business-process outsourcing company in India. Our findings suggest that reflection is a powerful mechanism by which experience is translated into learning. Results from our experiments show that individuals who are given time to reflect on a task improve their performance more than those who are given the same amount of time to practice with the same task. Results of mediation analyses confirm that the improvement in performance observed when individuals are learning by thinking is explained, at least in part, by the increased self-efficacy generated by reflection.

Our research makes a novel contribution to the literature in several ways. First, we build on the insights generated by literature in cognitive psychology and neurosciences to explicitly incorporate the reflective dimension of learning and to provide, to the best of our knowledge, the first empirical test of the claim that the capacity to reflect on action improves learning (Schön, 1983; Kolb, 1984). Second, by uncovering the role of self-efficacy as one of the key mechanisms behind the actual process of accumulating new knowledge (Cook & Brown, 1999; Orlikowski, 2002), we provide a first attempt at unpacking the psychological drivers behind the process of learning, thus answering the call for more research on knowledge creation as a fundamental step in the learning process (Argote, 2011). Finally, we contribute to literature on the codification of tacit knowledge (Cowan, David, & Foray, 2000; Nonaka, 1994; Nonaka & Von Krogh, 2009) by providing empirical evidence of the benefits associated with knowledge codification and uncovering the psychological mechanisms behind them.

SOURCES OF LEARNING AND THE ROLE OF REFLECTION

The tendency to equate learning with learning by doing seems in stark contrast with a number of studies in cognitive psychology and neuroscience pointing to a reflective, rather than experiential, path to learning. Cognitive psychologists have shown that learning is a positive function of efforts to reflect on objectives, strategies, and processes, as in the case of metacognition (Flavell, 1979), systematic reflection (Ellis, Carette, Anseel, & Lievens, 2014), and team reflexivity (Schippers, Edmondson, & West, 2014). For instance, this line of research has documented that metacognition – that is, the monitoring of one's own cognitive phenomena – plays an important role in attention, memory, comprehension, and problem solving (Flavell, 1979). More recently, drawing on empirical findings across different psychological domains, scholars have documented how people can learn from both their successes and their failures through systematic reflection (Anseel, Lievens, & Schollaert, 2009; Ellis, Carette, Anseel, & Lievens, 2014). The same processes seem to replicate in the context of team learning, where research has shown that performance is a positive function of team effort in reflecting on and communicating about objectives, strategies, and processes (Schippers, Homan, & van Knippenberg, 2013; Schippers, Edmondson, & West, 2014).

Similar results have been found in the neurosciences, where researchers have used fMRIs[1] to investigate the possible neurobiological mechanisms behind learning and the role of reflection in the development of cognitive abilities (Nyberg, Eriksson, Larsson, & Marklund, 2006; Olsson, Jonsson & Nyberg, 2008; Immordino-Yang, Christodoulou, & Singh, 2012). For instance, research in this domain has shown that motor skill tasks may improve as a result of either motor training (as in learning by doing) or mental training (as in learning by thinking), with distinct neuroplastic changes in the brain being responsible for the different types of learning (Nyberg *et al.*, 2006; Olsson, Jonsson & Nyberg, 2008). "Rest is not idleness," suggest Immordino-Yang, Christodoulou, and Singh (2012): that is, the brain's default mode, activated by wakeful rest and by what the authors call "constructive internal reflection," may be crucial for the development of cognitive abilities.

Despite the abundance of disciplinary studies explicitly addressing the reflective dimension of learning, the management literature has tended to focus on learning's factual dimension, namely the role of "doing" in explaining progress along the learning curve. Arguably, experience may involve some degree of reflection. For instance, Nadler, Thompson, and Van Boven (2003) have shown that people learn negotiation skills through a variety of methods (i.e. didactic learning, learning via information revelation, analogical learning, and observational learning), which involve at least some reflection. The very idea of categorizing learning into autonomous and induced learning (Dutton & Thomas, 1984) makes room for the accumulation of learning through purposeful efforts (as could be in the case of reflection) rather than implicit, automatic processes (Lapré & van Wassenhove, 2001). We argue here, however, that the reflective dimension of learning has been overlooked by previous studies, which have looked at

[1] Functional magnetic resonance imaging or functional MRI (fMRI) is a magnetic resonance imaging used to detect physical changes in the brain resulting from increased neuronal activity.

action as measured through experience as the main stimulus of learning (Mishina, 1999). In this view, thinking has been treated primarily as an automatic component of learning, and as such has been relegated to explain why individuals accumulate learning over time, even without conscious effort (e.g., Fellner, 1969; Mishina, 1999).

Some notable exceptions do exist. The pioneering work of Donald Schön advocated the central role of reflection in learning from failures (Argyris & Schön, 1978). In his book *The Reflective Practitioner*, Schön (1983) argues that practitioners constantly engage in the effort to reflect in action (that is, to think on their feet) and on action (that is, to critically examine a situation and craft the optimal strategy to deal with it if it occurs again). The capacity to reflect on action, Schön argued, is necessary for practitioners to learn. Similarly, Kolb (1984) argues that effective learning is the result of progress through a cycle of four stages: (1) having a concrete experience, (2) observing and reflecting on that experience, (3) forming abstract concepts (analysis) and generalizations (conclusions), and (4) using them to test hypotheses in future situations, resulting in new experiences. Accordingly, learning is an integrated process, with each stage being mutually supportive of and feeding into the next (see Kolb & Fry, 1974). No single stage, this work suggests, is effective for learning on its own.

Along similar lines, research on the codification of tacit knowledge (Polanyi, 1962) argues that the cognitive investment necessary for codification enables codification efforts to give individuals and organizations a deeper understanding of their tacit knowledge (Cowan, David, & Foray, 2000). Despite the difficulties of codifying tacit knowledge into an explicit form (Berman, Down, & Hill, 2002; Nonaka & Takeuchi, 1995; Zollo & Winter, 2002), research in this domain consistently suggests that individuals and organizations can benefit from such an effort, as in the standardized work practices of the Toyota Production System (Adler, Goldoftas, & Levine, 1999; Staats, Brunner, & Upton 2011). The reflective dimension of learning is also present in work focusing on the process of knowing (e.g., Cook & Brown, 1999; Orlikowski, 2002). This line of research highlights the essential role of human action and cognition in the actual act of apprehending and creating knowledge. By emphasizing the individual contribution in the day-to-day practice of knowing, "from such a perspective, people learn to know differently as they use whatever means, motivation, and opportunity they have at hand to reflect on, experiment with, and improvise their practices." (Orlikowski, 2002: 253)

We build on these antecedents to advance understanding of the role of reflection in learning. In particular, we aim to compare the learning effects of reflection and experience and to enhance understanding of the psychological mechanisms behind the effect of reflection on learning. In doing so, we attempt to answer the following questions: What happens to learning outcomes when individuals purposefully engage in reflection efforts as compared to when individuals accumulate additional experience? What explains the relationship between reflection and learning? In particular, do reflection efforts affect learning by affecting how individuals approach a task once they have purposefully reflected upon it?

We define reflection as the intentional attempt to synthesize, abstract, and articulate the key lessons learned from experience. Reflection is a *purposeful* action, requiring intentional efforts on the part of the individual. In this respect, it represents a deliberative, conscious, Type II process (Evans & Stanovich, 2013), and it generates induced (Hayes, Pisano, & Upton, 1996) rather than autonomous learning (Adler & Clark, 1991). Reflection involves *interpretation* and critical examination of experience. From a cognitive standpoint, it "involves the absorption and evaluation of new concepts into personal knowledge structures, relating these concepts to the person's other forms of knowledge and experience" (Anseel, Lievens, & Schollaert, 2009: 23). Despite the fact that we define the learning generated by reflection as "learning by thinking," it should be noted that reflection operates in the domain of meta-cognition – analysis of one's own thinking (Serra & Metcalfe, 2009) – and thus represents a higher-order concept than simple thinking. Finally, to be exercised, reflection requires *experiential data* as the basis to understand, process, and derive patterns from (Ellis & Davidi, 2005).

In the present study, given our interest in comparing the effectiveness of different sources of learning, we focus on individual learning, which allows us to most precisely capture our phenomenon of interest. In addition, given the increasing atomization of work, the individual is the level at which much of the learning within organizations occurs (Clark, Huckman, & Staats, 2013). Individuals learn by acquiring and interpreting knowledge (Lindsay & Norman, 1977), even if not necessarily in an intentional manner (Bower & Hilgard, 1981). As explained by Fiol (1994: 404), "a person learns through developing different interpretations of new or existing information, that is, through developing (consciously or unconsciously) a new understanding of surrounding events." To understand this process in more detail, we compare the benefits of learning by thinking and learning by doing.

Learning by Thinking vs. Learning by Doing

Imagine you are an avid tennis player who has twenty minutes left at the end of your weekly class. You would like to improve your serve, and you see two ways of doing so. You could either hit as many serves as possible in the next 20 minutes, or you could hit just a few serves, and then pause to analyze your stroke. Every minute you spend reflecting on how to get better is costly in terms of lost practice time. Conversely, every minute you spend hitting serves consumes time you could have spent reflecting on how to get better. What would be the optimal choice for you to maximize learning? In other words, which learning activity provides the highest benefits in terms of future performance: learning by doing alone, or learning by doing coupled with learning by thinking?

Our first hypothesis provides an answer to this question by comparing the learning generated by purposeful reflection efforts to the accumulation of additional practice. Endogenous to the definition of reflection itself, which requires the accumulation of some experience in order to be exercised, our arguments are conditional on having performed a minimum threshold of practice. We explore the amount of practice needed to start observing this effect in our empirical analysis in addition to comparing practice coupled with more practice to practice coupled with reflection.

As discussed above, previous studies have found that the accumulation of learning is the result of both autonomous and induced efforts (Dutton & Thomas, 1984), thus making room for both a learning-by-doing and a learning-by-thinking effect. Here, we argue that reflection and practice as two sources of learning complement one another, making learning generated by the combination of reflection and practice superior to learning generated by the sole accumulation of additional practice. This follows from the notion of complementarity, according to which adding an activity while already performing another activity will result in higher performance than adding the activity in isolation (Milgrom & Roberts, 1990; Cassiman & Veugelers, 2006).

We think of learning by doing and learning by thinking as complementary in many respects. First, the process of learning generated by experience and repetition with a task can be thought of as an automatic, unconscious process. By contrast, attempts to learn by thinking through purposeful reflection efforts are controlled and conscious by nature. This fundamental difference corresponds to the claims of dual process theory that two different systems of thought underlie intuitive and reflective processing (Kahneman, 2011; Evans & Stanovich, 2013). In particular, System 1 thinking does not require working memory and is typically described as fast, non-conscious, intuitive, automatic, associative, and independent of cognitive ability. It is associated with experience-based decision making and implicit learning; think of the learning processes activated by a tennis player who tries to hit as many serves as possible in 20 minutes. System 2 thinking, by contrast, is defined as a reflective process that requires working memory and that is typically described as slow, conscious, controlled, rule-based, and correlated with cognitive ability. System 2 thinking is associated with consequential decision-making and explicit learning, as in the case of the learning process activated by the tennis player if he were to spend 20 minutes alternating between hitting serves and analyzing them.

Not only do practice and reflection represent different approaches to processing but they are also based on different neurobiological mechanisms. Research in neuroscience demonstrates that distinct neuroplastic changes in the brain are associated with the different types of learning (Nyberg *et al.*, 2006). We also know from this research that individuals can improve their performance on a task (i.e., motor ability) as a function of actual repetition of the task (i.e., motor training) as well as by simply projecting themselves in the act of executing the task (i.e., mental training using motor imagery). Interestingly, however, there is mixed evidence of the effectiveness of the combination of the two types of training, with Nyberg *et al.* (2006) suggesting that combined motor and mental training might result in interference effects, and Olsson, Johnson, and Nyberg (2008) find that adding mental training to motor training was more effective than motor training alone.

Using a complementarity argument, we argue the following: consider a time T, a sufficiently large fraction of which, called t, has been spent accumulating practice with a task. Learning generated by devoting (T-t) to reflecting upon the practice cumulated in t will be superior to learning generated by devoting (T-t) to accumulating additional practice. In other words, once a certain amount of practice with a task has been cumulated, the benefits of additional practice are inferior to the benefits of reflecting upon the cumulated practice. Thus, we hypothesize:

> **Hypothesis 1**: Learning generated by the coupling of practice with reflection will be greater than learning generated by the accumulation of additional practice alone.

Unpacking Learning by Thinking: The Role of Self-Efficacy

We have hypothesized that individuals will learn more effectively when they are given the chance to reflect on and articulate the key lessons learned from experience. Why might reflection efforts generate such a superior improvement in learning outcomes? In particular, does reflection impact our disposition toward a task? Can we explain the boost in learning in the light of the effect that reflection exerts on our attitudes and beliefs about our ability to deal with the task we have been reflecting upon?

We propose that the link between learning by thinking and greater performance is explained by self-efficacy, or a personal evaluation of one's capabilities to organize and execute courses of action to attain designated goals (Bandura, 1977).[2] In particular, we claim that reflecting on one's past experience on the same or similar tasks allows individuals to reduce uncertainty about their ability to perform such tasks successfully going forward. This reduced uncertainty will translate into greater effort (Rosen, Mickler, & Collins, 1987), which in turn will drive the observed increase in the ability to perform well with the task at hand.

We base our prediction on a longstanding tradition of works in psychology emphasizing the importance of the desire to feel competent and capable as a basic human motivation (White, 1959; Ryan & Deci, 2000). Self-efficacy, it has been suggested, predicts individuals' thoughts, emotions, and actions. When people experience self-efficacy in an activity, they devote more time and energy to it because they believe that their effort will translate into success (Bandura, 1977; Ryan & Deci, 2000). Self-efficacy is also "an essential motive to learn" (Zimmerman, 2000: 82). For instance, prior research has demonstrated that self-efficacious students select more challenging tasks (Bandura & Schunk, 1981), exert more effort (Schunk & Hanson, 1985; Schunk, Hanson, & Cox, 1987), and have less adverse reactions when faced with difficulties (Bandura, 1997). As a result, self-efficacious students consistently show higher academic achievement as compared to inefficacious ones (Multon, Brown, & Lent, 1991).

Information that shapes one's self-efficacy beliefs comes from various sources (Bandura, 1986, 1997). The main and most reliable source is one's own prior experiences with the tasks in question (Bandura, 1986, 1997). Reflection, we suggest, strengthens one's self-efficacy by

---

[2] Self-efficacy refers to confidence in one's ability to achieve a goal and represents people's expectations and convictions of what they can accomplish in given situations. For example, the expectation that a person can high-jump six feet is a judgment about perceived efficacy (Bandura, 1986). It is not a judgment of whether the person is competent in high-jumping in general but a judgment of how strongly the individual believes she can successfully jump that particular height under the given circumstances.

reducing a person's experience of uncertainty about being capable to complete such tasks competently and effectively. Though it is often the case that one's past experience includes ambiguities and errors, individuals tend to focus on their strengths and positive aspects when evaluating past experiences so that they can maintain a positive view of themselves (e.g., Taylor, 1991). As a result of their decreased uncertainty of their ability to complete the task they have reflected on, individuals will exert more effort on the task when returning to it, thus ending up performing better with the task at hand.[3]

In short, we expect self-efficacy to mediate the relationship between reflection efforts and learning outcomes. That is, we expect reflection to increase one's perceived self-efficacy, which in turn will lead to superior learning outcomes. Accordingly, we hypothesize:

> **Hypothesis 2**: Individuals' perceptions of their self-efficacy will mediate the effect of reflection coupled with practice on learning.

Overview of the Present Research

Our hypotheses suggest that when individuals reflect on experience accumulated from repeating one task, they perform better on subsequent tasks as compared to individuals who do not reflect, even when they have had more time to practice on the first task. This occurs because reflection increases their self-efficacy—i.e., their belief about their ability to successfully perform the task at hand. As such, it is important to both: (a) test whether outcomes are differentially affected by alternative ways of learning (i.e., practice coupled with additional practice vs. practice coupled with reflection) and then (b) demonstrate why such effects occur (i.e., heightened perceived self-efficacy).

To test our hypotheses, we collected data from both the laboratory and the field. In Studies 1 and 2, we tested our hypotheses using two laboratory experiments. In Study 3, we conducted a field experiment with employees at a large business-process outsourcing firm to

[3] Here we should recognize that experience is also likely to increase self-efficacy. However, in light of our first hypothesis, and sticking to our complementary argument, we suggest that by combining reflection with previous experience it is possible to raise self-efficacy even further than with experience alone.

constructively replicate the tests of our hypotheses in a real-world context and provide further evidence for our proposed mechanism. The use of laboratory and field experiments offers us complementary strengths and weaknesses. The laboratory experiments allow us to identify causality in a controlled setting and precisely measure our proposed mechanism. The field experiment provides a platform to not only identify causality but also to establish external validity. Together, this approach allows us to more confidently evaluate our research model.

STUDY 1: MISTAKEN BELIEFS ABOUT THE BENEFITS OF REFLECTION

In our first study, we examine people's beliefs regarding the benefits of practice versus reflection. We do so by giving participants a choice regarding how to allocate their time after gaining some experience on a task and before working on it some more. Participants could choose between practicing more on the task in question and reflecting on the experience they accumulated so far.

Method

Participants. We recruited 256 adults on Amazon Mechanical Turk (56.3% male, M_{age}=31.67, *SD*=8.46) to participate in an online study in exchange for $1 and the potential to earn an additional bonus based on performance. Specifically, 10 percent of the participants (chosen randomly) received a bonus based on their performance in the study.

Design and procedure. Participants first received welcoming instructions and were then asked two questions used as attention checks. Participants who failed one of the attention checks were redirected to a page telling them that they could not participate in the study. Participants who answered both attention-check questions correctly moved on to a screen with instructions. We told these participants that they would complete a brainteaser under time pressure. The brainteaser was a series of five "sum-to-ten game" grids (initially developed by Mazar, Amir, & Ariely, 2008). Each grid was a 3 x 4-cell matrix of numbers (see Figure 1 for an example). We gave participants 20 seconds to find the two numbers in the grid that summed to 10. Participants would earn $1 for each correct brainteaser solved in 20 seconds or less (if they were among the 10 percent selected at the end of the study).

Insert Figure 1 about here

Participants first completed a practice round to gain familiarity with the task. They then completed the first round of the brainteaser (i.e., a set of five different grids). After each grid they were told whether the answer they selected was correct or not.

We introduced our choice variable after the first round of the brainteaser. Participants received the following instructions:

> We'll soon be asking you to engage in a second round of the MATH BRAIN TEASER (i.e., five more math puzzles). Before you start round 2, you can choose how to spend the next 3 minutes. You have two choices:
> 1) You can spend 3 minutes thinking and writing about the strategies you used in the first round, thus engaging in some reflection
> 2) You can spend 3 minutes practicing on another set of math puzzles (the same type of math puzzles as the ones you solved in the first round)
> Please choose how you want to spend the next 3 minutes, to best prepare for round 2 of the MATH BRAIN TEASER.

Participants indicated their choice. Next, depending on their choice, they were redirected to one of two different screens. Participants who chose to reflect received the following instructions:

> Please take the next few minutes to reflect on the task you just completed. Please write about what strategies if any you used as you were working on the task. Also please write about what you think one can do to be effective in solving the math problems included in this task. Please be as specific as possible.
> You will have THREE minutes to engage in this reflection. The study will advance to the next stage once the THREE minutes are over.

Participants who chose to practice received the following instructions:

> Please take the next few minutes to practice some more on the task you just completed. Below you'll see a few puzzles that you can try to solve. (You can keep track of your performance on a piece of paper if you'd like.)
> You will have THREE minutes to practice on the puzzles. The study will advance to the next stage once the THREE minutes are over.

Participants who chose to practice saw 20 different puzzles and could practice solving them for the next three minutes. Then, all participants were told:

> You will now be asked to complete the second round of the MATH BRAIN TEASER. As before, you will have 20 seconds to find the right solution in each of the five math puzzles in this round.

After the three minutes, participants completed two other rounds, each comprising five different grids. The grids from the three rounds were all different. In between the second and third rounds, participants were told:

> You have now completed the second round of the MATH BRAIN TEASER. Please click on "Next" when ready to complete the third and final round. Once again, you will be asked to solve five math puzzles, as the ones you saw in rounds 1 and 2.

After completing the third round, participants completed a short questionnaire with questions about the brainteaser they had just completed. In particular, participants answered questions about perceived self-efficacy and task enjoyment by indicating their agreement with different statements on a 7-point scale (from 1=Strongly disagree, to 7=Strongly agree). We assessed perceived self-efficacy using a four-item measure adapted from Bandura (1990); participants indicated whether they felt capable, competent, able to make good judgments, and able to solve difficult problems if they tried hard enough ($\alpha = .95$). We measured task enjoyment using seven items (e.g., "I enjoyed doing this task very much," "This task was fun to do," and "I would describe this task as very interesting;" $\alpha = .93$) from the intrinsic motivation inventory (Ryan, 1982). Finally, they answered a few demographic questions.

Our primary dependent variable of interest was participants' performance in the two rounds of the brainteaser that followed our manipulation.

Results

Table 1 summarizes the correlation and descriptive statistics of the main variables assessed in the study by condition. Eighty-two percent of the participants (210 out of 256) decided to practice, and only 18 percent of them (46 out of 256) decided to reflect, $X^2(1) = 105.6$, $p < .001$.

Insert Table 1 about here

Despite these preferences, reflection resulted in higher levels of performance over rounds 2 and 3 of the brainteaser. Table 2 reports the results from an ANOVA using participants' performance on the second and third rounds of the brain teaser as the dependent measure and choice (i.e., whether people decided to reflect or to practice) as the independent variable, controlling for performance on the first round (before the choice occurred). We found a significant effect of our manipulation on performance in the second and third rounds, $F(1, 253) = 5.24$, $p = .023$, $\eta^2_p = .02$. Participants correctly solved more grids in the second and third round when they decided to reflect ($M = 5.33$, $SD = 2.31$) than when they decided to practice ($M = 4.37$, $SD = 2.39$). As one might expect, performance in round 1 predicted performance over time 2 and 3, $F(1, 253) = 56.39$, $p < .001$, $\eta^2_p = .18$.

Insert Table 2 about here

We also conducted independent samples t-tests and found no significant difference in performance in time 1 between those who chose to reflect and those who chose to practice ($p = .37$). Examining the measures captured in the questionnaire, we found that self-efficacy was higher for those who decided to reflect rather than practice ($p = .034$); task enjoyment, instead, was higher for those who decided to practice ($p < .001$).

Discussion

In Study 1, the majority of participants decided to practice rather than taking the time to reflect. Their choice of practice over reflection was supposedly based on the premise that practice would give rise to a superior performance improvement as compared to reflection. In other words, individuals chose to practice because they expected this would enable them to perform better in subsequent rounds. However, the results of Study 1 show just the opposite: this strategy was counterproductive, as participants scored higher in the following round when they decided to reflect rather than to practice.

We recognize that practicing with a task necessarily implies some reflection, at least implicitly. Still, individuals seemed to learn more, and as a result to perform better, when they deliberately stopped practicing on the task and focused exclusively on reflection. That is, they learned more when they chose to invest in learning, thus engaging in induced rather than autonomous learning (Dutton & Thomas, 1984).

STUDY 2: REFLECTION ENHANCES SELF-EFFICACY

Our first study provides preliminary evidence for Hypothesis 1, which suggested that learning resulting from coupling experience with reflection (as in the reflection condition) is greater than learning generated by the accumulation of additional experience alone (as in our practice condition). However, in Study 1, people chose to either "do" or "think." We designed a second study in which we randomize participants into three conditions: reflection, practice, and control. To test our second hypothesis about the mediating role of self-efficacy, we also assessed participants' self-efficacy after reflecting, practicing, or engaging in a neutral activity (as in the control condition).

Method

Participants. We recruited 468 adults on MTurk (50% male, M_{age}=31.03, *SD*=7.97) to participate in an online study in exchange for $1 and the potential to earn an additional bonus based on performance. Specifically, as in our previous study, 10 percent of the participants (chosen randomly) received a bonus based on their performance in the study.

Design and procedure. Participants were randomly assigned to one of three conditions:

reflection, practice, and control. We used the same task and procedure as in Study 1, but in this study, participants were randomly assigned to one of our three experimental conditions rather than having the choice to practice or reflect after the first round of the brainteaser.

We introduced our manipulation after the first round of the brainteaser. Participants in the reflection condition were asked to take three minutes to reflect on the task they had just completed (as in Study 1). Participants in the practicing condition were given three minutes to keep practicing on the brainteaser (again, as in Study 1). Participants in the control condition were instructed to watch an unrelated video (about cooking) that lasted about three minutes and were told they would be asked questions about it afterward.

After three minutes had elapsed, participants completed a short questionnaire assessing their self-efficacy with the same four-item measure used in Study 1 ($\alpha = .95$). Next, they completed two other rounds, each comprising five different grids. Finally, they answered demographic questions about their gender and age.

Results

Performance. We conducted an ANOVA using participants' performance on the second set of rounds of the brainteaser (after our manipulation took place) as the dependent measure and condition as the independent variable, and controlling for performance on the first round (before our manipulation occurred). We found a significant effect of condition on performance in the rounds after the manipulation occurred, F (2, 464) = 10.46, $p < .001$, $\eta^2_p = .04$. Participants correctly solved more grids in the reflection condition ($M = 4.79$, $SD = 1.82$) than they did in the practice condition ($M = 4.07$, $SD = 2.29$; $p = .006$) and in the control condition ($M = 3.81$, $SD = 2.45$; $p < .001$). Performance did not differ for participants in the practice condition and those in the control condition. As one may expect, performance in round 1 predicted performance at time 2, F (2, 464) = 182, $p < .001$, $\eta^2_p = .28$.

Self-efficacy. We used participants' perceived self-efficacy in an ANOVA with condition (reflection vs. practice vs. control) as a between-subject factor. As expected, this analysis revealed a main effect for our manipulation, F (2, 465) = 6.80, p = .001, η^2_p = .03. Participants reported feeling more efficacious following the manipulation in the reflection condition (M = 5.16, SD = 1.46) and in the control condition (M = 5.12, SD = 1.50) than they did in the practice condition (M = 4.58, SD = 1.66; p = .003 and p = .006, respectively). Perceived self-efficacy did not differ for participants in the reflection condition and those in the control condition.

Mediation analyses. To examine whether self-efficacy mediated the effect of reflection on performance, we followed the steps recommended by Baron and Kenny (1986). The first and second criteria specify that the independent variable should significantly affect the dependent variable and the mediators. The prior analyses showed that these two criteria were met, as reflection had a significant effect on performance in the rounds following the manipulation and self-efficacy. To assess the third and fourth criteria, we conducted a hierarchical ordinary least-squares (OLS) regression analysis (controlling for performance in the first set of rounds and including a dummy variable for the control condition) predicting performance from the independent variable of reflection condition (Step 1) and self-efficacy (Step 2). The third criterion specifies that the mediator should significantly predict the dependent variable while controlling for the independent variable. The results met this criterion: Having dummy-controlled the reflection, we found that self-efficacy significantly predicted higher performance (β = .14, t = 3.25, p = .001).

To complete the test of mediation for self-efficacy, the fourth criterion holds that the effect of the independent variable on the dependent variable should decrease after controlling for the mediator. After controlling for self-efficacy, the effect of reflection on performance decreased significantly (from β = .12, t = 2.77, p = .006; to β = .10, t = 2.29, p = .022). To test whether the size of the indirect effect of reflection on performance through self-efficacy differed significantly from zero, we used a bootstrap procedure to construct bias-corrected confidence intervals based on 10,000 random samples with replacement from the full sample (Preacher & Hayes, 2004). The 95% bias-corrected confidence interval excluded zero (0.03, 0.22), indicating a significant indirect effect. Thus, self-efficacy mediated the effect of reflection on performance.

Discussion

Providing preliminary support of Hypothesis 1, Study 1 showed that learning resulting from coupling experience with reflection (as in the reflection condition) is greater than learning generated by the accumulation of additional experience alone (as in our practice condition). In Study 2, participants were randomly assigned to three experimental conditions: reflection, practice, and control. Results from our analysis provide further support for Hypothesis 1: participants in the reflection condition outperformed those in the practice and control condition, with no significant difference appearing between practice and control.

Results from Study 2 also support Hypothesis 2: We found that perceived self-efficacy partially mediates the effect of reflection on learning. This is consistent with our expectation that purposefully engaging in a reflection effort affects the disposition of people toward a task by increasing their personal evaluation of their ability to perform such task going forward. The fact that the mediation effect is partial suggests, however, that reflection also affects learning through a direct path, or that alternative mechanisms may play a role in explaining this relationship. This is consistent with our focus only on self-efficacy as one of the possible psychological drivers of the learning-by-thinking effect.

STUDY 3: THE POWER OF REFLECTION IN A FIELD STUDY

As our final study, we moved to the field to constructively replicate our findings. In Study 3, we compare the effects of reflection to those of practice; we also include a sharing condition in which participants not only reflected on their learning but also shared them with others. We included this condition to examine whether sharing would further increase the benefits of reflection.

Method

Sample and procedures. Our final study was completed at Wipro BPO, an India-based global leader in the business-process outsourcing industry. Wipro provides knowledge-based customer support and back-office services (e.g., data entry and data processing) for its global customer base. We conducted our field study using one customer account. The work for this account involved answering technology-related support questions via the telephone for customers of a Western technology company.

The call center provides us with an excellent setting to study learning and productivity at the individual level. Successful completion of the work requires technical knowledge on the part of Wipro employees. Questions can cover a wide range of topics; some are answered easily, while others require a great deal of problem solving. To complete the work, Wipro not only recruits well-qualified agents (college graduates) but also trains them for four weeks on the technical process they will follow once they join the firm (known as "process training"). After technical process training, workers go through two weeks of "on-the-job training" – a combination of classroom training and answering actual calls. At the end of their training, workers transition full-time into their customer service responsibilities.

Our field study sample was comprised of workers who joined Wipro BPO in the focal account between June and August 2013. Workers joined in batches of 10 to 25 workers, and each batch was assigned to one of three conditions: (1) reflection, (2) practice, and (3) sharing. Each group represents a similar profile of employees in terms of age, experience, and other background qualifications that influence performance. Each group went through the same overall technical training. The primary difference was that workers in the reflection and sharing conditions spent the last 15 minutes of their day performing the tasks associated with our experimental manipulations instead of spending the same amount of time getting additional practice in their on-the-job training.

In the reflection group, on the sixth day of training, workers were given a paper journal and asked to spend 15 minutes reflecting on the day's activities. The exact instructions provided by their Wipro trainer were:

> Please take the next 15 minutes to reflect on the training day you just completed. Please write about the main key lessons you learned as you were completing your training. Please reflect on and write about at least two key lessons. Please be as specific as possible.

Agents were given time to reflect at the end of each day for a total of 10 days. A survey was administered at the end of process training, prior to receiving final scores, to collect data on perceptual measures (i.e., self-efficacy), and operational data was collected during training (i.e., the score each individual got on the assessment test at the end of training).

Agents assigned to the sharing condition were asked to both reflect and share. In particular, they were instructed to:

> Please take the next 10 minutes to reflect on the training day you just completed. Please write about the main key lessons you learned as you were completing your training. Please reflect on and write about at least two key lessons. Please be as specific as possible. When done, you will be given another 5 minutes to explain these to another participant who is completing the training process with you.

Agents were given time to reflect and share at the end of each day for a total of 10 days. The same survey was administered, and the same data was collected as in the sharing condition.

Finally, agents assigned to the practice condition were asked to go on with their normal training activities. Instead, in the reflection and sharing interventions, trainers were asked to adjust their timing during the day to free up the last 15 minutes for the intervention. The same survey was administered and the same data collected as in the sharing and reflection conditions.

Empirical strategy. As in Study 2, we first test the performance effect of reflection as compared to practice and then look at the mediating role of self-efficacy on the relationship between reflection and performance. Our primary independent variable of interest is reflection coupled with practice, as manipulated in the reflection experimental condition described above. We also manipulate practice and sharing – the former in order to test for H1 (according to which reflection should lead to improved performance as compared to practice) and the latter to examine whether sharing would further increase the benefits of reflection.

Our dependent variable is participants' performance in the test they took at the end of their process training. This is a test administered directly by Wipro at the end of each process training in order to assess the extent to which trainees have learned the main lessons taught during the training. Scores can range from 0 to 100 and were provided to us directly by the company.

We measure individuals' perceptions of self-efficacy (self-efficacy) using a five-item scale adapted from Schwarzer and Jerusalem (1995), which asked participants to indicate the extent to which they felt: (1) able to solve difficult problems if they tried hard enough; (2) capable of sticking to their aims and accomplishing their goals; (3) confident that they could deal efficiently with unexpected events; (4) able to find several solutions when confronted with a problem; and (5) able to handle whatever would have come their way ($\alpha = .78$). We used this measure rather than the items from Study 2 since it is more specific and appropriate for a field setting. We collected this information through a survey administered to all of our participants at the end of their process training, independently of the condition to which they were allocated. Finally, in our analyses, we include a series of controls at the individual level, namely age (years), gender (male=1, female=0), and previous work experience (months). Table 3 reports descriptive statistics and correlations among the variables we collected, while Table 4 provides details on their operationalization. Finally, Table 5 reports mean comparisons across participants allocated to the three different experimental conditions. It is worth noting that participants in the different experimental groups did not differ significantly in terms of age and work experience. We do observe a lower number of female participants allocated to the reflection condition compared to both the practice condition and the sharing condition. However, gender is poorly correlated with all other variables and does not significantly predict our mediating and dependent variable.

Insert Tables 3, 4, and 5 about here

Results

Performance. To analyze the results from our field experiment, we run an ordinary least squares (OLS) regression in which we estimate the effect of reflection and sharing on performance in comparison with practice.[4] Table 6 shows three models: Model 1 includes only control variables; Model 2 includes reflection and sharing while omitting the variable practice, which acts as the baseline; and Model 3 replicates Model 2 and adds our mediating variable (self-efficacy).

The results from Model 2 show strong support for H1: participants in the reflection condition displayed a significant increase in performance as compared to participants in the practice condition. In particular, by being allocated to the reflection condition, participants improved their score on the final assessment test by 15.1 points, a 22.8% increase with respect to the average score for the entire sample (66.1). Similarly, we observe that participants allocated to the sharing condition improved their score on the final assessment test of 16.5 points – that is, a 25.0% increase with respect to the average score for the entire sample. However, the difference between sharing and reflection is not statistically significant.

Model 3 shows that the effect of reflection on performance continues to hold even when we insert our mediator, thus suggesting a partial mediation effect. We next ran a number of additional analyses aimed at testing our mediation hypothesis.

Insert Table 6 about here

[4] As a robustness test, we also used an alternative logit specification using a dichotomous dependent variable, *passed,* indicating whether our participants passed the final assessment test or not. This pass/fail evaluation was again provided directly by Wipro. Results based on this alternative specification are consistent with those presented in the paper.

Mediation analyses. According to H2, we expect self-efficacy to mediate the relationship between reflection and learning. In particular, we expect that higher reflection will increase one's self-efficacy and that this will in turn be associated with higher performance on the final assessment test.

Consistent with H2, we find that self-efficacy significantly mediates the relationship between reflection and learning. In fact, reflection significantly predicted both self-efficacy (β = 0.162, t = 1.68, p = 0.096) and performance on the final assessment test (β = 15.076, t = 5.23, $p < 0.001$), and self-efficacy predicted performance when controlling for reflection (β = 7.256, t = 2.99, p = 0.003). Finally, after controlling for self-efficacy, the effect of reflection on performance decreased (from β = 15.076, t = 5.23, *p* = 0.000; to β = 13.880, t = 4.90, *p* = 0.000). To test whether the size of the indirect effect of reflection on performance through self-efficacy differed significantly from zero, we used a bootstrap procedure to construct bias-corrected confidence intervals based on 10,000 random samples with replacement from the full sample (Preacher & Hayes, 2004). The 95% bias-corrected confidence interval excluded zero (2.09, 14.69), indicating a significant indirect effect. Thus, self-efficacy mediated the effect of reflection on improved performance.

Discussion

The results from our field experiment provide further support for our prediction that learning generated by the coupling of practice with reflection will be greater than learning generated by the accumulation of additional practice alone (H1) and that perceived self-efficacy explains this relationship (H2). In addition, these findings show that the beneficial effects of reflection endure over time, as we observed performance benefits two weeks after the manipulation occurred. Interestingly, we did not find significant differences between sharing and reflection, indicating that –at least in this context – sharing did not produce additional benefits to learning as compared to simply reflecting on one's own.

GENERAL DISCUSSION

Over the last few decades, knowledge work—that which is built around the labor of the mind—has become an increasingly important component of advanced industrialized economies (e.g., Powell & Snellman, 2004). The rise of the so-called "knowledge economy" means that individuals face growing pressure to learn new skills and hone existing ones. At the same time, intensifying competitive pressures and other social trends have increased the pace at which we live and work.[5] As Perlow (1999: 57) puts it, many "types of workers routinely work seventy- or eighty-hour weeks, putting in extra effort during particularly hectic times."

Data show that between 1973 and 2000, "the average American worker added an additional 199 hours to his or her annual schedule – or nearly five additional weeks of work per year (assuming a 40 hour workweek)" (Schor, 2003: 7). In the meanwhile, between 1969 and 2000, "the overall index of labor productivity per hour increased about 80 percent, from 65.5 to 116.6" (Schor, 2003: 10). As a result, productivity and time efficiency have become significant concerns in modern Western societies, with time being perceived as "the ultimate scarcity" (e.g., Gross, 1987)—a valuable resource to guard and protect (Gleick, 2000; Zauberman & Lynch, 2005). In our daily battle against the clock, taking time to reflect on one's work would seem to be a luxurious pursuit.

Though some organizations increasingly rely on group reflection, as in the case of after-action reviews and post-mortems (Catmull, 2014), there has been little effort to encourage individuals to reflect, and people often fail to engage in self-reflection themselves. Reflection entails the high opportunity cost of one's time, yet we argue and show that reflecting after completing tasks is no idle pursuit: It can powerfully enhance the learning process, and it does so

[5] Consider, for instance, the amount of information that we could potentially absorb nowadays, thanks to IT and the Internet. According to Eric Schmidt, executive chairman of Google, it now takes two days to generate the same amount of information generated between the dawn of civilization through 2003 (Pariser, 2011).

more than the accumulation of additional experience on the same task. Learning, we find, can be augmented if one deliberately focuses on *thinking* about what one has been doing. Results from our three studies consistently show a significant increase in the ability to successfully complete a task when individuals are given the chance to couple some practice with a purposeful reflection effort aimed at synthesizing, abstracting, and articulating the key lessons learned from such practice. In explaining the boost in learning generated by reflection, we show that the fact that one has purposefully engaged in a reflection effort on one's experience with a task affects the way in which one approaches the same task afterwards. In particular, results from our studies show that the effect of reflection on learning is mediated by greater self-efficacy. Through reflection, individuals build confidence in their ability to deal with the task in question, which in turn translates into higher performance when they return to work on it.

Theoretical and Practical Implications

We believe our research contributes to extant literature along three dimensions. First, our research builds on the insights generated by literature in cognitive psychology (Flavell, 1979; Ellis, Carette, Anseel, & Lievens, 2014; Schippers, Edmondson, & West, 2014) and neurosciences (Nyberg *et al.*, 2006; Olsson, Jonsson & Nyberg, 2008; Immordino-Yang, Christodoulou, & Singh, 2012) to explicitly incorporate the reflective dimension of learning. Our finding on the effect of reflection on learning speaks to previous studies on learning (Darr, Argote, & Epple, 1995; Gino *et al.*, 2010; KC, Staats, & Gino, 2013) by showing that individual learning can be augmented when individuals can not only "do" but also "think" about what they have been doing. In doing so, we add to previous work on learning and provide, to the best of our knowledge, the first empirical test of the claim that the capacity to reflect on action improves learning (Schön, 1983; Kolb, 1984).

Second, by showing that self-efficacy acts as the mechanism behind learning by thinking, we contribute to literature on the process behind the creation and accumulation of new knowledge (Cook & Brown, 1999; Orlikowski, 2002). Our results show that by reflecting on and articulating the key lessons learned from experience, a person boosts her self-efficacy, which in turn has a positive effect on learning. By uncovering one of the mechanisms behind the creation of new knowledge, we answer the call for more research on knowledge creation as a fundamental step in the learning process (Argote, 2011).

Third, the finding that reflection aids learning outcomes supports the argument put forward by literature on the codification of tacit knowledge (Cowan, David, & Foray, 2000; Nonaka, 1994; Nonaka & Von Krogh, 2009), according to which the process of transforming tacit into codified knowledge requires a cognitive investment that generates a deeper understanding of this knowledge. We contribute to this literature by providing empirical evidence of the benefits associated with knowledge codification and uncovering one of the psychological mechanisms behind it.

Our results also have important practical implications. In our field study, we showed that taking time away from training and reallocating that time to reflection actually improved individual performance. Companies often use tools such as learning journals as a way to encourage reflection in training and regular operations. Our personal experience is that individuals of all ages may not treat these exercises with much seriousness; however, our findings suggest that they should. We highlight that it may be possible to train and learn "smarter," not "harder." Additional work is needed to clarify how reflection can be incorporated more broadly into both training and regular operations.

Limitations and Directions for Future Work

Despite our efforts, our results are subject to several limitations. First, despite the fact that we combine the use of laboratory experiments with a field study, additional research is needed to explore these findings across a broader array of contexts and tasks. Second, our research focused on individual learning, and except for one condition in the field study, participants were removed from social interactions. Understanding how social interaction may aid or detract from reflection and learning is worth additional study. Third, the finding that self-efficacy only partially rather than fully mediates the relationship between reflection and improvements in problem-solving capacity suggests the need for additional studies to better "unpack" what reflection is, how it works, and through which avenues it influences our ability to learn.

We believe our research opens a number of avenues for future investigation. First, future work could better map the effect of time in the attempt to understand to what extent different sources of learning produce improvements that last and whether there are differences among them. In addition, reflection may produce benefits not only for the tasks one reflected on, but also for related others. Zollo and Winter (2002) argue that knowledge codification is an important element in building capabilities. Future research examining the role of reflection in building capability would deepen our understanding of the benefits of learning by thinking.

Second, future research could examine potential boundary conditions for the effects we demonstrated by focusing on individual differences that moderate the effectiveness of reflection on learning. For instance, it would be interesting to investigate whether the effects of learning by thinking are stronger or weaker for people with high rather than low self-esteem or with more rather than less task experience. Reflection may be most beneficial for people with low self-esteem, who may be unaccustomed to taking the time to codify their learning even when they do not have a lot of task experience. For these people, in fact, reflecting may point to important aspects of their prior performance that they would not naturally think about. However, the opposite may also occur if individuals with low self-esteem have a hard time finding strengths in their prior performance.

Finally, our research focused on the beneficial effects on performance of different types of learning at the individual level. A possible extension would be to see how these effects interact with group dynamics when reflection becomes a collective effort, as it is sometimes done in companies through formal after-action reviews (Goh, Goodman, & Weingart, 2013). More generally, future research could extend the study of reflection to better understand how it can impact other variables. For instance, the notion that reflection favors progress along the learning curve may inform research on employee motivation and the role of work progress as one of its key drivers (Amabile & Kramer, 2011).

Conclusion

Research on learning has primarily focused on the role of doing (experience) in fostering progress over time. Drawing on literature in cognitive psychology and neurosciences, we propose that one of the critical components of learning is reflection, or the intentional attempt to synthesize, abstract, and articulate the key lessons taught by experience. Using a mixed-method design that combines laboratory experiments with a field experiment conducted in a large business-process outsourcing company in India, we find that individuals who are given time to reflect on a task outperform those who are given the same amount of time to practice with the same task. Interestingly, we show evidence that if individuals themselves are given the choice, they prefer to allocate their time to practicing on the task rather than reflecting on it. Our findings, however, suggest that this preference is irrational given the higher benefits associated to reflection. Together, our results reveal reflection to be a powerful mechanism behind learning, confirming the words of American philosopher, psychologist, and educational reformer John Dewey (1933: 78): "We do not learn from experience...we learn from reflecting on experience."

REFERENCES

Adler, P. S. & K. B. Clark. 1991. Behind the learning curve: a sketch of the learning process. *Management Science*, 37(3): 267-281.

Adler, P. S., Goldoftas, B., & D. I. Levine. 1999. Flexibility Versus Efficiency? A Case Study of Model Changeovers in the Toyota Production System. *Organization Science*, 10(1): 43–68.

Amabile, T., & S. Kramer. 2011. *The progress principle: Using small wins to ignite joy, engagement, and creativity at work*. Cambridge, MA: Harvard Business Review Press.

Anseel, F., Lievens, F., & E. Schollaert. 2009. Reflection as a strategy for enhancing the effect of feedback on task performance. *Organizational Behavior and Human Decision Processes*, 110: 23-35.

Argote, L. 2011. Organizational learning research: Past, present and future. *Management Learning*, 42: 439–446.

Argote, L. & E. Miron-Spektor. 2011. Organizational learning: From experience to knowledge. *Organization Science*, 22(5): 1123–1137.

Argyris, C. & D. A. Schön. 1978. *Organizational learning: A theory of action perspective*. Reading, MA: Addison-Wesley.

Bandura, A. 1977. Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review*, 84: 191–215.

Bandura, A. 1986. *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. 1990. *Multidimensional scales of perceived academic efficacy*. Stanford, CA: Stanford University Press.

Bandura, A. 1995. *Self-efficacy in changing societies*. Cambridge, MA: Cambridge University Press.

Bandura, A. 1997. *Self-efficacy: The exercise of control*. New York, NY: Freeman.

Bandura, A., & D. H. Schunk. 1981. Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology*, 41: 586–598.

Bar-Eli, M., Azar, O.H., Ritov, I., Keidar-Levin, Y., & G. Schein. 2007. Action bias among elite soccer goalkeepers: The case of penalty kicks. *Journal of Economic Psychology*, 28(5): 606-621.

Baron, R. M, & D. A. Kenny. 1986. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51: 1173–1182.

Berman, S. L., Down, J., & C. W. H. Hill. 2002. Tacit knowledge as a source of competitive advantage in the National Basketball Association. *Academy of Management Journal*, 45: 13–31.

Bower, G. H., & E. R. Hilgard. 1981. *Theories of learning*. Englewood Cliffs, NJ: Prentice-Hall.

Cassiman B. & R. Veugelers. 2006. In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science*, 52(1): 68-82

Catmull, E. 2014. *Creativity, Inc*. New York, NY: Random House.

Clark, J., Huckman, R. S. & B. R. Staats. 2013. Customer specificity and learning: Individual and organizational effects in outsourced radiological services. *Organization Science*, 24(5): 1539–1557.

Cook, S. D. N. & J. S. Brown. 1999. Bridging epistemologies: Between organizational knowledge and organizational knowing. *Organization Science*, 10(4): 381–400.

Cowan, R., David, P. A. & D. Foray. 2000. The explicit economics of knowledge codification and tacitness. *Industrial and Corporate Change*, 9(2): 211–253.

Darr, E. P., Argote, L., & D. Epple. 1995. The acquisition, transfer and depreciation of knowledge in service organizations: Productivity in franchises. ***Management Science***, 41(11): 1750–1762.

Dewey, J. 1933. ***How We Think***. Boston, MA: D. C. Heath & Co.

Dutton, J. M., & A. Thomas. Treating progress functions as a managerial opportunity. ***Academy of Management Review***, 9(2): 235-247.

Ellis, S., Carette, B., Anseel, F. & Lievens, F. 2014. Systematic reflection: Implications for learning from failures and successes. ***Current Directions in Psychological Science***, 23: 67-72.

Ellis, S., & I. Davidi. 2005. After-event reviews: Drawing lessons from successful and failed experience. ***Journal of Applied Psychology***, 90: 857–871.

Evans, J. St. B. T. & K. E. Stanovich. 2013. Dual-process theories of higher cognition: Advancing the debate. ***Perspectives on Psychological Science***, 8: 223–241.

Fellner, W. 1969. Specific interpretations of learning by doing. ***Journal of Economic Theory***, 1: 119–140.

Fiol, C. M. 1994. Consensus, diversity, and learning in organizations. ***Organization Science***, 5(3): 403–420.

Fiol, C. M., & M. A. Lyles. 1985. Organizational learning. ***Academy of Management Review***, 10(4): 803–813.

Flavell, J.H. 1979. Metacognition and cognitive monitoring. A new area of cognitive-development inquiry. ***American Psychologist***, 34(10): 906–911

Gino, F., Argote, L., Miron-Spektor E., & G. Todorova. 2010. First, get your feet wet: The effects of learning from direct and indirect experience on team creativity. ***Organizational Behavior and Human Decision Processes***, 111: 102–115.

Gleick, J. 2000. ***Faster: The acceleration of just about everything***. New York, NY: Vintage Press.

Goh, K. T., Goodman, P. S., & L. R. Weingart. 2013. Team innovation processes: An examination of activity cycles in creative project teams. ***Small Group Research***, 44: 159-194.

Gross, B. L. 1987. Time scarcity: Interdisciplinary perspective and implications for consumer behavior. ***Research in Consumer Behavior***, 2: 1–54.

Hayes, R. H., Pisano, G. P., & D. M. Upton. 1996. ***Strategic operations: Competing through capabilities***. New York, NY: The Free Press.

Huckman, R. & G. P. Pisano. 2003. The firm specificity of individual performance: Evidence from cardiac surgery. ***Management Science***, 52(2): 473-488.

Immordino-Yang, M. H., Christodoulou, J. A., & V. Singh. 2012. Rest is not idleness: Implications of the brain's default mode for human development and education. ***Perspectives on Psychological Science***, *7*(4): 352-365.

Kahneman, D. 2011. ***Thinking, fast and slow***. New York, NY: Farrar, Straus and Giroux.

KC, D., Staats, B. R., & F. Gino. 2013. Learning from my successes and others' failure: Evidence from minimally invasive cardiac surgery. ***Management Science***, 59(11): 2435-2449.

Kolb, D. A. 1984. **Experiential learning: Experience as the source of learning and development** (Vol. 1). Englewood Cliffs, NJ: Prentice-Hall.

Kolb, D. A., & Fry, R. E. 1974. **Toward an applied theory of experiential learning**. Cambridge, MA: MIT Alfred P. Sloan School of Management.

Lapré, M. A., & L. N. van Wassenhove. 2001. Creating and transferring knowledge for productivity improvement in factories. ***Management Science***, 47(10): 1311-1325

Lindsay, P. & D. A. Norman. 1977. Human information processing: An introduction to psychology, 2nd edition. New York, NY: Academic Press.

Mazar, N., Amir, O. & D. Ariely. 2008. The dishonesty of honest people: A theory of self-concept maintenance. ***Journal of Marketing Research***, 45: 633-644.

Milgrom, P., & J. Roberts. 1990. The economics of modern manufacturing: Technology, strategy, and organization. ***American Economic Review***, 80: 511-528.

Mishina, K. 1999. Learning by new experiences: Revisiting the flying fortress learning curve. In N. R. Lamoreaux, D. M. G. Raff & P. Temin (eds.), ***Learning by doing in markets, firms, and countries***. Chicago, IL: University of Chicago Press; 145-184.

Multon, K. D., Brown, S. D., & R. W. Lent. 1991. Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. ***Journal of Counseling Psychology***, 18: 30–38.

Nadler, J., Thompson, L., & L. Van Boven. 2003. Learning negotiation skills: Four models of knowledge creation and transfer. ***Management Science***, 49(4): 529–540.

Nonaka, I. 1994. A dynamic theory of organizational knowledge creation. ***Organization Science***, 5(1): 14-37.

Nonaka, I. and H. Takeuchi. 1995. ***The knowledge creating company: How Japanese companies foster creativity and innovation for competitive advantage.*** New York, NY: Oxford University Press.

Nonaka, I. & G. von Krogh. 2009. Perspective–Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory. ***Organization Science***, 20(3): 635–652.

Nyberg, L., Eriksson, J., Larsson, A., & P. Marklund. 2006. Learning by doing versus learning by thinking: an fMRI study of motor and mental training. ***Neuropsychologia***, 44: 711–717.

Olsson, C. J., Jonsson B., & L. Nyberg. 2008. Learning by doing and learning by thinking: An fMRI study of combining motor and mental training. ***Frontiers in Human Neurosciences***, 2: 5.

Orlikowski, W. J. 2002. Knowing in practice: Enacting a collective capability in distributed organizing. ***Organization Science***, 13(4): 249-273

Pariser, E. 2011. ***The filter bubble***. London, UK: Viking, Penguin Books.

Perlow, L. A. 1999. The time famine: Towards a sociology of work time. ***Administrative Science Quarterly***, 44: 57-81.

Peters T. J., & R. H. Waterman. 1982. ***In search of excellence***. New York, NY: Harper & Row

Pieters, R., & M. Zeelenberg. 2005. On bad decisions and deciding badly: When intention-behavior inconsistency is regrettable. ***Organizational Behavior and Human Decision Processes***, 97: 18–30.

Pisano, G. P., Bohmer, R., & A. Edmondson. 2001. Organizational differences in rates of learning: Evidence from the adoption of minimally invasive cardiac surgery. ***Management Science***, 47(6): 752-768.

Polanyi, M. 1962. ***Personal knowledge***. Chicago, IL: University of Chicago Press.

Powell, W. W., & K. Snellman. 2004. The knowledge economy. ***Annual Review of Sociology***, 30: 199-220.

Preacher, K. J., & A. F. Hayes. 2004. SPSS and SAS procedures for estimating indirect effects in simple mediation models. ***Behavior Research Methods, Instruments, & Computers***, 36: 717–731.

Rosen, S., Mickler, E. & J. E. Collins. 1987 Reactions of would-be helpers whose offer of help is spurned. ***Journal of Personality and Social Psychology***, 53: 288-297.

Ryan, R. M. 1982. Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. ***Journal of Personality and Social Psychology***, 43, 450-461.

Ryan, R. M., & E. L. Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. ***American Psychologist***, 55: 68-78.

Schippers, M. C., Edmondson, A. E., & West, M. A. 2014. Team reflexivity as an antidote to information processing failures. ***Small Group Research***, 5:731-769.

Schippers, M. C., Homan, A. C., & van Knippenberg, D. 2013. To reflect or not to reflect: Prior team performance as a boundary condition of the effects of reflexivity on learning and final team performance. ***Journal of Organizational Behavior***, 34, 6-23.

Schön, D. 1983. ***The reflective practitioner: How professionals think in action***. New York, NY: Basic Books.

Schor, J. 2003. The (even more) overworked American. In J. de Graaf (ed.), ***Take back your time: Fighting overwork and time poverty in America***. San Francisco, CA: Berrett-Koehler Publishers; 6-11.

Schunk, D. H., & A. R. Hanson. 1985. Peer models: Influence on children's self-efficacy and achievement behaviors. ***Journal of Educational Psychology***, 77: 313–322.

Schunk, D. H., Hanson, A. R., & P. D. Cox. 1987. Peer model attributes and children's achievement behaviors. ***Journal of Educational Psychology***, 79, 54–61.

Schwarzer, R., & M. Jerusalem. 1995. Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston (eds.), ***Measures in health psychology: A user's portfolio. Causal and control beliefs***. Windsor, UK: NFER-NELSON; 35-37.

Serra, M. J., & J. Metcalfe. 2009. Effective implementation of metacognition. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (eds.), ***Handbook of Metacognition and Education***. New York, NY: Routledge; 278-298.

Staats, B. R., Brunner, D. J. & D. M. Upton. 2011. Lean principles, learning, and knowledge work: Evidence from a software services provider. ***Journal of Operations Management***, 29(5): 376-390.

Taylor, S.E. 1991. Asymmetrical effects of positive and negative events: The mobilization-minimization hypothesis. ***Psychological Bulletin***, 110: 67-85.

White, R. 1959. Motivation reconsidered: The concept of competence. ***Psychological review***, 66: 297–333.

Zauberman, G. & J. G. Lynch. 2005. Resource slack and discounting of future time versus money. ***Journal of Experimental Psychology: General***, 134(1): 23–37.

Zimmerman, B. J. 2000. Self-efficacy: An essential motive to learn. ***Contemporary Educational Psychology***, 25: 82–91.

Zollo, M. & S. G. Winter. 2002. Deliberate learning and the evolution of dynamic capabilities. ***Organization Science***, 13(3): 339–351.

Table 1.
Descriptive statistics and correlations, Study 1[a]

	Mean	SD	1.	2.	3.	4.	5.	6.
1. Chose Practice	.82	.39	1.00					
2. Correct Round 1	2.05	1.34	-0.06	1.00				
3. Correct Round 2	2.39	1.46	-0.13*	0.38**	1.00			
4. Correct Round 3	2.15	1.36	-0.14*	0.35**	0.46**	1.00		
5. Self-efficacy	4.73	1.66	-0.13*	0.43**	0.52**	0.48**	1.00	
6. Task enjoyment	4.99	1.46	0.22**	0.21**	0.23**	0.30**	0.38**	1.00

[a] ** p<0.01, * p<0.05

Table 2.
Means (and standard deviations) of performance scores across rounds by condition, Study 1

	Performance Round 1	**Performance Rounds 2 and 3**	**Self-efficacy**	**Task enjoyment**
Practice	2.22	4.37	4.63	5.14
	(1.59)	(2.39)	(1.68)	(1.36)
Reflection	2.02	5.33	5.20	4.31
	(1.28)	(2.31)	(1.45)	(1.70)

Table 3.
Descriptive statistics and correlations, Study 3

Variable	Mean	Std. Dev.	1.	2.	3.	4.	5.	6.	7.	8.
1. Performance	66.097	16.193	1.000							
2. Reflection	0.389	0.489	0.269	1.000						
3. Sharing	0.299	0.459	0.208	-0.521	1.000					
4. Practice	0.313	0.465	-0.488	-0.538	-0.440	1.000				
5. Age	25.201	3.613	-0.131	-0.096	-0.003	0.104	1.000			
6. Gender	0.833	0.374	-0.101	-0.217	0.170	0.060	0.030	1.000		
7. Experience	28.824	28.658	0.107	0.068	-0.042	-0.030	0.605	0.063	1.000	
8. Self Efficacy	6.242	0.481	0.272	0.151	-0.050	-0.109	-0.017	0.093	0.118	1.000

Table 4.
Variables and measures, Study 3

Variable	Measure	Operationalization
	Dependent Variable	
Performance	Score on the final assessment test administered by Wipro at the end of the process training.	*Assessed by Wipro* Integer from 0 to 100
	Mediating Variable	
Self Efficacy	Question on the survey administered at the end of process training, asking participants to indicate the extent to which they felt: (1) able to solve difficult problems if they tried hard enough; (2) capable of sticking to their aims and accomplishing their goals; (3) confident that they could deal efficiently with unexpected events; (4) able to find several solutions when confronted with a problem; and (5) able to handle whatever would have come their way.	*7-point scale, where 1 is strongly disagree and 7 is strongly agree* Five-item scale adapted from Schwarzer & Jerusalem (1995) (α=.78)
	Independent Variables	
Practice	Participants used the last 15 minutes of their day to gain additional practice with their activities	*Manipulated* Dummy variable: 1 if practice, 0 otherwise
Reflection	Participants used the last 15 minutes of their day to reflect based on the following intervention (starting from day 6): "Please take the next 15 minutes to reflect on the training day you just completed. Please write about the main key lessons you learned as you were completing your training. Please reflect on and write about at least two key lessons. Please be as specific as possible."	*Manipulated* Dummy variable: 1 if reflection, 0 otherwise
Sharing	Participants used the last 15 minutes of their day to share based on the following intervention (starting from day 6): "Please take the next 10 minutes to reflect on the training day you just completed. Please write about the main key lessons you learned as you were completing your training. Please reflect on and write about at least two key lessons. Please be as specific as possible. When done, you will be given another 5 minutes to explain these to another participant who is completing the training process with you."	*Manipulated* Dummy variable: 1 if sharing, 0 otherwise
	Control Variables	
Age	Age of trainee in years	Integer count in years
Gender	Gender of trainee	Dummy variable: 1 if male, 0 if female
Experience	Previous work experience (outside Wipro) of trainee in months	Integer count in months

Table 5.
Univariate Tests across Conditions, Study 3

	Reflection (n=56)		Practice (n=45)		T-test		Sharing (n=44)		T-test	
	Mean	S.D.	Mean	S.D.	t	Sig	Mean	S.D.	t	Sig
Control Variables										
Age	24.768	0.483	25.787	0.560	1.385	0.169	25.341	0.512	0.808	0.421
Gender	0.752	0.060	0.872	0.049	1.769	0.080	0.932	0.038	2.643	0.010
Experience	31.245	4.483	26.930	4.053	-0.702	0.484	29.118	3.887	-0.347	0.729
Mediating Variable										
Self Efficacy	6.332	0.048	6.166	0.082	-1.811	0.073	6.205	0.075	-1.482	0.142
Dependent Variable										
Performance	71.536	1.308	54.422	3.088	-5.474	0.000	71.233	1.565	-0.150	0.881

Table 6.
Results from OLS Regressions, Study 3[a]

	Model 1		**Model 2**		**Model 3**	
	coef	**Se**	**coef**	**Se**	**Coef**	**se**
Age	-1.392**	0.455	-1.024*	0.413	-0.925*	0.403
Gender	-4.795	3.509	-3.910	3.214	-5.017	3.147
Experience	0.171**	0.057	0.135**	0.052	0.116*	0.051
Reflection			15.076***	2.882	13.880***	2.831
Sharing			16.549***	2.987	16.373***	2.905
Self Efficacy					7.256**	2.425
_cons	100.259***	11.033	80.459***	10.505	34.687†	18.392
N	144		144		144	
F	4.296		10.985		11.175	
Adjusted R2	0.065		0.259		0.299	

[a] *** p<0.001, ** p<0.01, * p<0.05, †<0.10

Figure 1.
An example of the type of grid participants were asked to solve, Study 1

8.18	9.01	3.97
5.2	4.56	9.12
0.28	2.92	6.59
1.12	6.93	9.72