2012

Improving Dynamic Decision Making Through Training and Self-Reflection

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IMPROVING DYNAMIC DECISION MAKING

THROUGH TRAINING AND SELF-REFLECTION

by

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A thesis submitted to the Department of Psychology
in partial fulfillment of the requirements for the degree of

Master of Arts in Psychology

UNIVERSITY OF NORTH FLORIDA

COLLEGE OF ARTS and SCIENCES

April, 2012

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Dr. Len Roberson
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Acknowledgements

It is my pleasure to esteem the many people who were instrumental in the successful completion of this thesis. First and foremost, I want to sincerely thank my thesis advisor, Dr. Dominik Güss, who inspired me to write on the subject of Dynamic Decision Making and mentored me with expert guidance, patience, and understanding. I am indebted to Dr. Güss for his significant contribution to the quality of this work. I also want to express my gratitude to Dr. Paul Thoreck for serving on my committee and providing excellent recommendations. I would like to express my appreciation to professors Dr. Dag Naslund, Dr. Paul Fadil, and Dr. Cheryl Van Deusen in the Coggin College of Business, for enabling me to collect data for my thesis and for the preliminary and follow-up studies. I want to offer my heartfelt thanks to my research team (Samantha Winsky, Alexandra Foust, Junior Badibanga and Smit Shah) for providing valuable assistance in a number of ways, such as helping with data collection and editing. Lastly, I want to thank God, my family, and all my friends for being a constant source of motivation and providing emotional and financial support. I owe much of my success to my mother, Bonnie Donovan, and my father, Dr. John Donovan.

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Abstract

The modern business environment requires managers to make decisions in a dynamic and uncertain world. In the current study, experimenters investigated the effects of a brief training aimed at improving dynamic decision making (DDM) skills on individual performance in a virtual DDM task. During the training, experimenters explained the DDM process, stressed the importance of self-reflection in DDM, and provided 3 self-reflective questions to guide participants during the task. Additionally, experimenters explored whether participants low or high in self-reflection would perform better in the task and whether participants low or high in self-reflection would benefit more from the training. Participants were 68 graduate business students. They individually managed a computer-simulated chocolate production company called CHOCO FINE and answered surveys to assess self-reflection and demographics. Results showed that students trained in DDM made decisions leading to better management performance in CHOCO FINE compared to untrained students. Self-reflection scores also predicted performance in this virtual business, and participants low in self-reflection benefitted the most from training. Organizations could use DDM training to establish and promote a culture that values self-reflective decision making.

Keywords: dynamic decision making, complex problem solving, training, self-reflection, microworlds

Improving Dynamic Decision Making Through Training and Self-Reflection

Many professions and situations require people to make time-pressured decisions for novel problems with vague or competing goals. An army unit commander, a juror, and a CEO are similar in that they all make highly consequential decisions under these circumstances. Dynamic decision-making (DDM) skills should help problem solvers process information, formulate flexible action plans, and balance multiple objectives in many real world problems (BIBB, 2005).

The importance of understanding and improving DDM is evident in various research domains including economics, education, engineering, ergonomics, human-computer interaction, management, and psychology (Osman, 2010). Within psychology, DDM has been studied in the real world in the naturalistic decision-making (NDM) paradigm (e.g., Klein, 1998) and in computer-simulated task environments, or microworlds, in the complex problem-solving (CPS) paradigm (e.g., Frensch & Funke, 1993; Güss & Dörner, 2011). The practices within each of these two paradigms complement each other: NDM makes observations during field research and develops models, while CPS forms and tests hypotheses in a laboratory. Hypothesis testing generally uses the individual differences approach and tests for correlations between cognitive (e.g. intelligence) or personality variables (e.g. openness, extraversion) and performance in DDM tasks (Brehmer & Dörner, 1993; Schaub, 2001). An ongoing challenge for researchers is to uncover the underlying factors that differentiate performance in DDM tasks.

Adult problem solvers have the cognitive ability to work through complex and dynamic problems, but often show cognitive biases and errors (Dörner, 1996;

Ramnarayan et al., 1997). Research associates self-reflection with a reduction in these common biases and errors (Güss, Evans, Murray, & Schaub, 2009; Locke and Latham, 2002; Osman, 2010). Self-reflection is "the introspection and evaluation of one"s thoughts, feelings, and behaviors" (Grant et al., 2002, p. 821). Self-reflective problem solving requires problem solvers to consciously and continuously self-reflect on oneself and the situation (Locke & Latham, 2006; Sanders & McKeown, 2008). It facilitates problem solvers" ability to relate new information to prior knowledge and understand ideas and feelings (Sanders & McKeown, 2008). Self-reflection should also help problem-solvers adapt to different environments and situations (Campitelli & Labollita, 2010).

The ability and motivation of problem solvers to use self-reflection varies between individuals and tasks (Güss et al., 2009; Sanders & McKeown, 2008). Güss et al. (2010) used think-aloud protocols to analyze DDM in two virtual environments and found only a few self-reflective statements. Telling individuals to self-reflect may or may not lead to self-reflection, and training-induced self-reflection may or may not help participants in a DDM task. Putz-Osterloh (1985) used think-aloud protocols to investigate the effects of training-induced self-reflection processes and did not find an effect for self-reflection on performance. Güss et al. (2009) gave three reflective questions to participants acting as firefighters with the responsibility of extinguishing flames in the microworld FIRE. They found that participants who received aids performed better than the participants who did not receive aids and better than participants who worked on an unrelated task during a break. The questions were: Which aspects of the game do I understand well? Which aspects of the game do I not understand well? When I go back to the game, what will I do differently to increase my performance? According to Kirkpatrick‟s model of training evaluation (2006), if participants react positively to a training program and learn the material, they are generally motivated and able to apply the training material to their jobs.

It seems reasonable to claim that increasing self-reflection would aid all problem solvers in DDM and that DDM training should reinforce self-reflection. However, it is also possible that extensive self-reflection impedes performance because it consumes time and overloads a limited working memory (Xu, 2011). It remains to be seen whether individuals high or low in self-reflection benefit more from a DDM training that promotes self-reflection.

The Advantages of Self-Reflection Related to DDM Steps

Self-reflection has specific roles within each step of the DDM process. Researchers (Güss et al., 2009, Güss & Dörner, 2011; Klein, 1998) agree on the steps (although sometimes using different terminology): 1) Problem identification; 2) Goal Definition; 3) Information Gathering; 4) Elaboration and Prediction (Forecasting); 5) Strategic and tactical planning; 6) Decision making and action; 7) Evaluation of outcome with possible modification of strategy. The frequency and duration of each subsequent phase depends on task characteristics and problem solver preferences (Güss et al., 2010).

Once problem solvers identify a problem, they define adequate goals. Goals like “do your best” or “learn the system” facilitate learning as they reduce performance anxiety and enhance self-regulatory behaviors (Locke & Latham, 2006; Osman, 2011). Through goal-focused self-reflection, problem solvers should come to understand the strengths and weaknesses of their decision making and gain insight and control (Grant et al., 2002; Sanders & McKeown, 2008).

Problem solvers in DDM tasks gather situational information relevant to their goals in order to see if and how causal relationships change over time (Ramnarayan et al., 1997). Self-reflection should reduce error caused by bias, because when problem solvers engage in self-reflection, they slow down and think about their knowledge of the situation and the relevance of their knowledge (Güss et al., 2009).

In elaboration and prediction, problem solvers infer some aspects of the problem environment and predict how nonlinear variables will interact (Brehmer & Dörner, 1993; Güss et al., 2011). Self-reflective problem solvers are more likely to question the accuracy of heuristics and their inferences. They are also more likely to recognize limitations of what they know.

Problem solvers formulate a strategy within the scope of their ability and knowledge base and adjust their strategy as they work through a DDM task. Problem solvers may err if they take aggressive actions without developing a proper strategy, or if they do not recognize and then correct for the system‟s dynamics (e.g., cyclic changes such as those seen in business cycles, Grobler, Milling, & Thun, 2008). Self-reflective and strategic questioning promotes awareness and strategic flexibility because it forces problem solvers to evaluate their decisions in light of their learning and alternate strategies.

Evaluation of outcome equates with error management. Self-reflection in this step is pivotal to success in a DDM task. Self-reflection forces problem solvers to differentiate the effects of their actions from the autonomous development of the system

(Schaub, 2007). Self-reflection also clarifies how the effects of the implemented decisions propagate through the system over time. Problem solvers who regularly self-reflect on feedback should have an accurate idea of progress in relation to their goals, a comprehensive understanding regarding the appropriateness of their strategies, and strategic control in pursuit of their goals (Locke and Latham, 2002; Osman, 2010). Trainings in DDM should stress the importance of error management and encourage problem solvers to ask reflective questions, gather additional information, and elaborate before formulating and acting on an alternate plan.

From our discussions on the importance of training to stimulate self-reflection during DDM, and considering individual differences in self-reflection, we make the following hypotheses:

Hypothesis 1: Students trained in DDM will make decisions leading to better management performance in a virtual company compared to untrained students.

Hypothesis 2: High self-reflection students will make decisions leading to better management performance in a virtual company compared to low self-reflection students.

Hypothesis 3: Low self-reflection students will benefit more from a DDM training that promotes self-reflection compared to high self-reflection students.

Method

Participants

Participants were 69 students recruited from graduate business courses in the College of Business at a university in the southeastern United States. Graduate business students were selected because they have necessary background knowledge to perform well in a highly complex business simulation. Participants" ages ranged from 22 to 58 years (*M* = 29.47, *SD* = 6.68). Participants were 43% female and 57% male. The sample‟s ethnic and gender distribution was similar to the distribution of the university‟s graduate population, with 87% Caucasian. The experimental group consisted of 38 students who received DDM training. The control group consisted of 31 participants, who did not receive training. Participants were assigned to either the experimental group or the control group based on their enrollment in one of two sections of an MBA course. Participants did not differ significantly between the two groups with regards demographics or computer experience. Two participants from each group were excluded from the analyses because they were not following instructions.

Instruments

Training. Approximately half of the participants partook in a brief, experimenter-led training. The time for training was 10 minutes. The training used a PowerPoint presentation displayed on an overhead projector to educate students in the DDM process. The training explained DDM by breaking the DDM process down into its steps: Goal Identification; Information Gathering; Forecasting; Planning, Decision Making and Action; Effect Control and Self-evaluation. In addition to defining each step, the experimenter also provided one business application for each step. Using a familiar business context should have helped business students incorporate the DDM steps into existing schemas. However, the experimenter used caution to ensure that the examples did not suggest specific actions that could influence trained participants when managing a virtual company in the second-half of the experiment. The experimenter informed participants that although listing the DDM process as linear progression of steps makes for easier comprehension, the DDM process is cyclic, and self-reflection occurs not only during „evaluation of outcome,‟ but during the other phases as well. The experimenter informed participants that self-reflection increases situational awareness and may lead to insight, which can then be applied to redefine goals, gather more information, and so forth. Additionally, the experimenter gave participants a handout of the DDM process and three self-reflective questions similar to those used by Güss et al. (2009): What did I do well? What can I do better? How can I use the Decision-Making steps more effectively? These aids were expected to increase participants‟ self-reflection while they worked on a complex and dynamic business simulation.

CHOCO FINE. CHOCO FINE can be described as a top management game or complex simulation. It was originally developed in 1993 at Universität Bamberg in Germany through collaboration of Dietrich Dörner and experts within the business field (Dörner & Gerdes, 2001); it has also been used in Germany by other researchers (e.g., Ulrike Starker or Ruediger von der Weth). The current study used a revised version (2003) of the simulation, which contains more than 1,000 simulated variables. The European Center for the Development of Vocational Training (Cedefop) and the Federal Institute for Vocational Education and Training - Germany (BIBB) endorsed CHOCO FINE as a valid training system for complex and dynamic work-related situations that require decision making and action. Preliminary studies in the United States (n = 160) were conducted to determine whether CHOCO FINE is a valid instrument in the US. Even though overall profit declined for all groups, results validated CHOCO FINE as an instrument because performance followed the expected trend: performance operationalized as account balance was highest for business owners, followed by graduate business students, followed by undergraduate business students, and lastly undergraduate psychology students.

In CHOCO FINE, each participant takes the role of CEO and manages production, marketing, and sales for a period of months within the simulation. The participant‟s task is to increase profit for the company. Participants have complete strategic freedom because CHOCO FINE does not require any actions in order to progress through the months. If participants decide to progress to a subsequent month without making changes to the system (e.g., they cannot decide what to do), implemented decisions will remain in effect. Participants automatically receive feedback regarding financial gains and losses. They pursue information that is not conveyed automatically (e.g., monthly expenditures on raw materials, whole sale prices for the different types of chocolate). The program stores every decision each participant makes in an external file and thus allows for analysis of DDM results and strategy.

The Self-Reflection and Insight Scale. Grant et al. (2002) developed the Self-Reflection and Insight Scale (SRIS), which incorporates the three factors in the self-regulation cycle: need for self-reflection (e.g., “It is important to me to try to understand what my feelings mean”), engagement in self-reflection (e.g., “I frequently take time to reflect on my thoughts”), and insight (e.g., “I usually know why I feel the way I do”). In the current study, the inter-item reliability was high for the 20-item measure and each of the 3 subscales (after reverse-scoring the appropriate items): SRIS (20 items; cronbach‟s alpha = 0.85); need for self-reflection (6 items; cronbach‟s alpha = .79); engagement in self-reflection (6 items; cronbach‟s alpha = .76); insight (8 items; cronbach‟s alpha = .75). Additionally, need for self-reflection correlated positively with engagement in self-reflection ($r = .75$, $p = .000$), and the two self-reflection subscales correlated positively with the insight subscale ($r = .30$, $p = .02$). Insight is "the clarity of understanding one"s thoughts feelings and behaviors" (Grant et al., 2002, p. 821). The significant but weaker correlation is due to the fact that while people achieve insight through self-reflection, self-reflection does not always lead to insight. Higher scores on the SRIS reflect purposeful, self-regulatory behaviors directed towards goal attainment (Grant et al., 2001).

Demographic Survey. A brief demographic survey was also administered to assess age, gender, major, and computer experience.

Procedure

In the experimental condition, 38 of the 69 participants participated in a 10-minute experimenter-led training in DDM. Trained participants also received a handout outlining the decision-making process and 3 self-reflective questions to help them self-reflect in a DDM task. The remaining 31 participants served as controls and did not receive training or training materials. All 69 participants received a 3-page overview of the simulation. It outlined the locations of specific information, the costs associated with various actions, and the interpretation of graphs and other visuals. Participants individually managed CHOCO FINE for a minimum of 45 minutes and completed at least 8 months within the simulation. Most participants completed 8 months within a range of 45 to 70 minutes. Participants in the two groups did not differ significantly in the time used for the simulation (control group, $M = 45.18$, $SD = 12.19$; experimental group, $M = 51.21$ $SD = 12.46$, $t(59) = 1.89$, $p = .06$). After ending the simulation, participants took 5 to 10 minutes to complete the SRIS (Grant et al., 2002) and answer questions regarding demographics and computer experience.

Results

A 2 x 2 x 8 mixed between-within subjects analysis of variance was conducted to explore the impact of an intervention (training, between-groups variable) and an individual difference variable (self-reflection, between-groups variable) over the time of eight assessment points (months in the simulation, within-groups variable) on the dependent variable participants‟ account balance. Training had 2 levels, training (n = 36) vs. no training (n = 29). Self-reflection score had 2 levels, high (n = 34) vs. low (n = 31). Mauchly‟s test indicated a violation in the assumption of sphericity ($\chi^2(27) = 606.24$, $p < .001$); therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = .23) for the with-in subjects effects.

The 3-way interaction of training, self-reflection, and months was not statistically significant $F(1.57, 427) = 2.94$, $p = .07$, $\eta p^2 = .05$. There was a significant interaction of months and training, $F(1.57, 427) = 17.93$, $p < .001$, $\eta p^2 = .23$, and a significant interaction of months and self-reflection, $F(1.57, 427) = 5.32$, $p = .01$, $\eta p^2 = .08$. Most importantly, the interaction of training and self-reflection was significant, $F(1, 61) = 6.81$, $p = .011$, $\eta p^2 = .10$). The training increased performance more for the low self-reflection group than for the high self-reflection group. The significant interactions qualify the significant main effect of months, $F(1.57, 427) = 93.27$, $p < .001$, $\eta p^2 = .61$, training, $F(1,61) = 20.84$, $p < .001$, $\eta p^2 = .26$, and self-reflection, $F(1,61) = 7.39$, $p = .009$, $\eta p^2 = .11$.

To compare more specific mean differences, we conducted a 4 x 8 mixed between-within analysis of variance, combining training and self-reflection into one independent variable (group) with 4 levels (see Figure 1): Trained and high in self-reflection (n = 17); Trained and low in self-reflection (n = 19); Untrained and high in self-reflection (n = 17); Untrained and low in self-reflection (n =12). As expected, the trained, high self-reflection group performed the best and the untrained, low self-reflection group performed the poorest. Using the Greenhouse-Geisser correction, there was a significant interaction of months and group, $F(4.72, 427) = 7.60$, $p < .001$, $\eta p^2 = .27$. The significant interaction of months and group qualified the main effect of months, $F(1.57, 427) = 93.27$, $p < .001$, $\eta p^2 = .61$. Post-hoc comparisons using the Bonferroni correction indicated that the untrained, low self-reflection (UTLR) group had significantly lower account balances at month 8 compared to each of the other 3 groups (THR, $p = .000$; TLR, $p = .000$; UTHR, $p = .03$). No other groups significantly differed from each other.

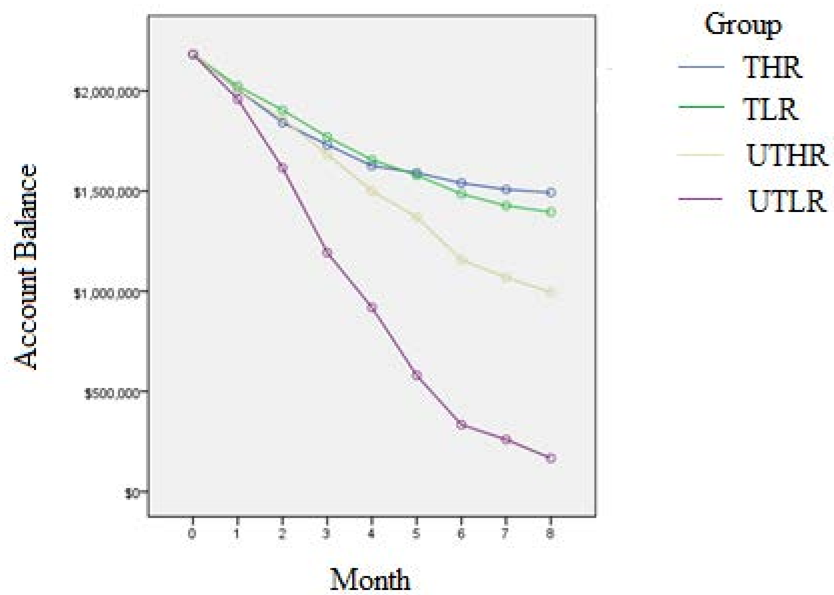

Figure 1: Performance in CHOCO FINE. This figure illustrates the mean account balance in the eight months of CHOCO FINE for the trained and high self-reflection participants (THR), trained and low self-reflection participants (TLR), untrained and high self-reflection participants (UTHR), and the untrained and low self-reflection participants (UTLR).

The profile plot from the ANOVA comparing all four groups in CHOCO FINE performance suggests that the trained groups began to learn the simulation much more quickly than the untrained participants. To investigate an emerging trend of training having an increasingly large effect on performance across months, we calculated a quadratic contrast of months by group interaction using the same four groups and the orthogonal polynomial contrast coefficients (1, -1, -1, 1). This contrast determines the relationship between x and y (slope) for each group and then compares groups by contrasting their slopes. The results show that the mean difference between the trained and untrained groups increases as participants progress through months in the simulation (p = .021).

The results of a linear regression of SRIS scores on account balance at month 8 indicated that SRIS scores explained 4% of the variance, R^2= .04, F(1,64) = 2.87 , p = .10, but predicted account balance at month 8 only marginally, β =.21, t(65) = 1.70, p = .10).

Discussion

For the current study, experimenters predicted that both training and self-reflection would increase participants‟ DDM in a virtual company (Hypotheses 1 and 2), and that training would benefit low self-reflection participants more than high self-reflection participants (Hypothesis 3). The results support all three hypotheses. Experimenters found an interaction of training and self-reflection on participants‟ account balance in CHOCO FINE. Trained participants completed the simulation with a larger account balance than untrained, low self-reflection participants. High self-reflection participants also ended the simulation with more money than untrained, low self-reflection participants.

The training was designed to improve DDM. Since previous studies (Campitelli & Labollita, 2010; Grant et al., 2002; Locke & Latham, 2006; Sanders & McKeown, 2008) suggested self-reflection plays a fundamental role in DDM, we also measured individual differences in self-reflection. Additionally, similar top management games (e.g. Ramnarayan et al., 1997) associate poor performance with errors negatively related to self-reflection (e.g. inadequate effect control). The results of this experiment extend previous research and show that training and self-reflection interact to improve DDM performance.

Noting existing research on self-reflection, one aspect of the training focused on increasing the ability and motivation of participants to self-reflect during DDM tasks. As in previous studies (e.g., Güss et al., 2009), the training gave self-reflective aids to participants. The aids were designed to motivate participants to use self-reflection, increase self-efficacy for using self-reflection, and increase self-efficacy in DDM task. Participants were also provided with blank paper for note taking, but they were not instructed to use it. The participants" notes consisted of mostly numerical expressions, and none of papers appeared to hold self-reflective statements. This training had at least one of the intended effects because trained, low self-reflection (self-report) participants performed better in the DDM task than untrained, low self-reflection participants (Hypothesis 3).

Due to the complexity and novelty of CHOCO FINE, account balance decreased for all groups. The challenges presented in CHOCO FINE were difficult for participants to overcome and losing money was certainly frustrating for participants. However, all the necessary information for participants to perform well in CHOCO FINE was available, and 11% of all participants ended the simulation with an account balance of more than two million dollars. The graphs look skewed because some participants lost a lot of money. Previous research in DDM using similar participant populations and comparable simulations associates poor performance with cognitive errors and biases in decision-making strategy, not insufficient managerial knowledge or cognitive limitations (Dörner, 1996; Ramnarayan et al, 1997). For example, Güss and Dörner (2011) expected and found that participants reached the goal and performed well (reached the target temperature) only 20% of the time in another simulation called COLDSTORE, a much less complex than CHOCO FINE.

The results of this experiment are notable because they provide evidence that a brief and low-cost training can improve management performance (Dörner, 1996). The training was designed to aid participants throughout the DDM process and reduce some of the challenges and frustrations associated with the DDM task. Results suggest that the training served this intended purpose. The differences in account balance between trained and untrained participants increased as trained participants lost less money than untrained participants each subsequent month. This trend in the data implies that the trained participants increased their understanding of the simulation more than the untrained participants as they progressed through months in the simulation.

One limitation of this study is that self-reflection was assessed via self-report. However, while self-report was used to classify participants into high and low self-reflection groups, we measured performance by account balance, an observable variable. We found the expected relationship between account balance and self-reflection score, as both high self-reflection groups (trained and untrained) outperformed the untrained, low self-reflection group. These results indicate the validity of participants‟ self-evaluations of their own mental processes. Moreover, this demonstrates the validity of the SRIS as a self-report measure and makes it reasonable to relate differences in performance to differences in self-reflective behaviors (Xu, 2011).

Another possible limitation is that participants were non-randomized. Participants were selected to participate in the training based on course enrollment. It is plausible that the sections of the course differed in some way that created a difference between groups. However, it is not likely that this created any confounds. Both sections were night classes taught by the same professor. Sections did not differ in age, gender, SES, or computer experience.

A student population limits generalizability. However, demographic survey results showed that approximately 80 % of participants have worked above an entry-level position in their company. Still, student data may not reflect the decisions managers make in organizational contexts where they are held accountable for the outcomes of their decisions. Student participants may take more risks or may not be motivated to utilize their cognitive resources in a simulation where they are not as responsible for their performance as in real world settings. However, as experimenters, we observed participants and noted that they played CHOCO FINE in earnest.

The training explained that breaking a main goal down into sub-goals might facilitate progress toward the main goal. The training also encouraged participants to self-reflect on their progress in relation to their goals. However, the training did not explain how to define adequate sub-goals. Performance feedback in CHOCO FINE informed participants on progress toward their main goal of obtaining a profit, but not how individually determined sub-goals affected profit (e.g., how a marketing campaign affects profit). Future DDM trainings could provide problem solvers with meta-cognitive aids that help them define appropriate sub-goals, and ultimately make decisions that bring them closer to achieving their main performance goals (Locke & Latham, 2002; Osman, 2010).

The field of DDM would benefit from continued research on the influence of self-reflection. One avenue for future research could be to assess these constructs in thinking-aloud or verbal protocols while participants work in such virtual environments. Güss et al. (2010), for example, found self-reflection statements in their analyses of thinking-aloud protocols in two virtual DDM environments, although not very often. Future research should also explore the effectiveness of similar DDM trainings in different business simulations and for other types of DDM tasks.

The results of the present study carry practical applications for managers who make decisions in stressful, complex, and dynamic work environments. Organizations may benefit if they encourage self-regulatory decision making. Training in DDM that reinforces self-reflection may lead to more successful decision making, especially for people low in self-reflection. Organizations could establish and promote a culture that values time set aside for self-reflection. Self-reflection can occur in a very short break, and its influence on behavior should ultimately have a positive impact at the organizational level.

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PRESENTATIONS

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