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A Longitudinal Study of the Effects of Cognitive Awareness Training on Transaction Processing Accuracy: An Introduction to the ACE Theoretical Construct

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A LONGITUDINAL STUDY OF THE EFFECTS OF COGNITIVE AWARENESS TRAINING ON TRANSACTION PROCESSING ACCURACY

AN INTRODUCTION TO THE ACE THEORETICAL CONSTRUCT

by

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ABSTRACT

This study examines the impact of Cognitive Awareness training on transaction processing accuracy rates within the US Financial Services Industry. Grounded in the theories of Inattentional Blindness and Error Management Culture, this paper supports and extends both theories through the development of a new theoretical construct. The ACE Construct is a novel approach that combines cognitive science, organizational development, and operational efficiency practices into a single approach designed to improve transaction processing accuracy. The study involved the design and implementation of a novel training program, with performance data observations sampled over seven months, to evaluate the impact of Cognitive Awareness training on accuracy.

The researcher was able to partner with a global financial services firm to conduct experiments within three of their US based locations. It involved over 150 agents as they processed live-client transactions requests in real time. The similarities between agent populations, training practices, systems and procedures, and work types, allowed for analysis and interpretation of independent variables related to gender, proficiency/experience of the agent, and location.

As expected, analysis of pre-treatment conditions suggest that accuracy is largely dependent on experience. Analysis of post-treatment accuracy results favor improvement in both accuracy measures and organization climate and culture dynamics as a result of Cognitive Awareness Training. Statistically significant improvements to

both accuracy and organizational climate, related to type of Cognitive Awareness treatment introduced, and tenure, were discovered in the agent populations who were present during the entirety of the study.

However, there was an absence of statistical support for a direct relationship between Cognitive Awareness Training as an independent variable and accuracy improvement. Furthermore, I was unable to detect a correlation between improvements in Error Management Culture and transaction processing accuracy.

The results suggest the possibility of positive effects on transaction processing accuracy in practice, and open the door for continued research in this field.

CHAPTER ONE:

INTRODUCTION

The fundamental motivation for my research stems from two-plus decades of practitioner experience in the US financial services industry. Established industry practice suggests that increased post-production sampling is the only way to monitor and improve transaction processing accuracy. However, my direct observation of these practices led me to the conclusion that post-production sampling rates are decidedly uncorrelated to accuracy outcomes. If post-production sampling practices are not an effective practice for improving transaction processing accuracy, what is?

A thorough review of the available academic literature on quality management practices such as TQM, Six Sigma, Lean, and others, did not provide sufficient answers to the primary research question. Though ample research exits on these theories, their application remains focused on mechanical and processes oriented approaches to accuracy. While these certainly have relevance in practice, and are important for transaction processing activity in financial services, they fail to address the central actor in this process, the transaction processing agent.

I then began to investigate the social sciences in an effort to identify other possible explanations that targeted the human agent and their abilities related to transaction processing. In so doing, I discovered a wealth of research covering a variety of distinct and independent fields ranging from neuroscience and cognitive

theories, to organizational and management oversight theories, to evaluation and sampling frequency theories.

However, none of the research looked at the entire process and the combined effects of each. The effects of these theories would certainly be present simultaneously throughout the act of completing a financial transaction. Could then, a new theory emerge that would tie these disciplines together in a manner that informs and advances both academia and practice? This question led to the development of the ACE construct for improving transaction accuracy performance.

ACE stands for "Awareness, Culture and Evaluation" and the construct derived from the literature review suggests that transaction processing accuracy will be positively influenced by the adaptation of all three phases in a coordinated, holistic approach to managing transaction processing agents.

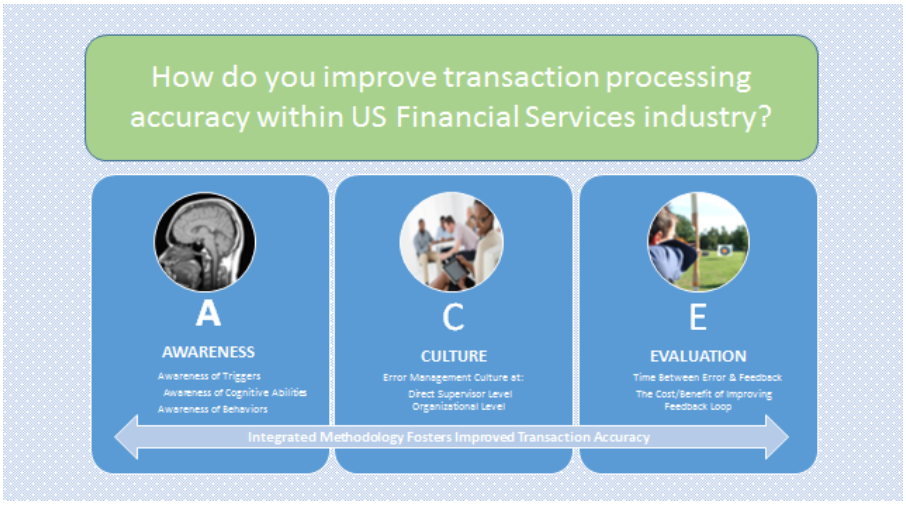


Figure 1: The ACE Theoretical Construct

In the spring of 2016, I developed a qualitative survey to evaluate the current state of ACE practices in the US financial services industry. The survey was sent to

operational managers of 12 US based financial services organizations and complete responses were received from 6 firms. The results were analyzed and the conclusion was that “Evaluation” practices were well developed and extensively used across the industry. Furthermore, about half of the respondents indicated that they were aware of and attempting to create cultures consistent with Error Management Culture, though none indicated proficiency of completeness of these practices.

The survey further indicated the absence of Cognitive Awareness training, as well as the possible positive impact of such on performance, in any of these organizations. As a result of this industry wide survey, the methodology of my research program became more clearly defined. My research would focus exclusively on the impact of Cognitive Awareness training as a means of contributing to the broader question of, “What drives transaction processing accuracy in US financial services firms?”

The research question led to the design of three hypotheses:

H^1: A targeted treatment of cognitive awareness training programs will have a positive effect on transaction processing accuracy.

H^2: A targeted treatment of cognitive awareness training programs will increase the Error Orientation of transaction processing agents.

H^3: Improved accuracy and increased Error Orientation are positively correlated.

Chapter 8 is included as an Appendix. For those unfamiliar with the problem space of financial services transaction processing, this section provides additional detail into the nature of the work and its dependence on human agents and cognition.

CHAPTER TWO:

LITERATURE REVIEW

There is significant depth in the social sciences literature covering various dimensions of human psychology and the influencers of accurate task performance. However, there is an absence of literature focusing specifically on the Financial Services industry and the accuracy of transaction processing groups.

So what drives quality in a processing environment? The research literature tends to be very consistent and focused on three key themes; (A) Awareness, (C) Culture, and (E) Evaluation, or the "ACE" Construct. Academic literature is spread across a variety of industries and the research covers many dynamics of performance. But with very minor exceptions, the consensus of researchers is centered on the principles of ACE. That is not to say there aren't subtle nuances in the literature for each subject – there are. In fact, each component of ACE is multi-faceted with each sub-genre representing its own branch of research.

To better understand the literature, I systematically reviewed each component of ACE in attempt to create an overall narrative in response to the main research question. I then investigated and reviewed the literature behind the Cognitive Awareness Training experiment. The Cognitive Awareness training is grounded in the Awareness literature, but the scientific underpinnings that describe brain functions and neuroscience are central to the training design.

To properly assess the impact of Cognitive Awareness training on performance, we must first explore the literature on cognitive awareness and how it relates to transaction processing.

Awareness, simply stated, is the general state of mind of mental capabilities of the agent/processor. There are three Awareness themes, or pillars, emerging from the literature; Awareness of Triggers (A^T), Awareness of Cognitive Process or Abilities (A^c), and Awareness of Behavior (A^B). The research suggests that firms who focus on all three elements can vastly improve quality output and performance among its agents.

The Awareness of Triggers (A^T) pillar is described in three papers located in the research. Specifically, A^T refers to an agent's ability to develop and sense errors as they are happening or immediately after they have happened (but before the transaction is completed). Have you ever driven away from your house and turned back because you weren't sure if you unplugged the iron before leaving? This is an example of a trigger. We learn these triggers very early on as a means of insuring personal safety and overall fitness. To some extent, the process is embedded deep within our genetic makeup as we long ago developed adaptations that kept us alert and vigilant against people, places, things or activities that could harm us. The key is tapping into that ability to help agents sense when they are in danger of making an error. Ohlsson's (1996) research concludes that agents must be equipped with these triggers to learn from and improve their own performance. Allwood's (1984) research draws the same conclusions, stressing that agents must be equipped with the ability to diagnose and correct their own errors through well-developed triggers. This practice is supported by organizations who create environments where information is readily accessible, thereby

reducing the agent's information-anxiety and allowing them to synthesize information to better detect errors as they are about to happen (Turner and Makhija 2012).

The literature on Awareness-Triggers seems to suggest that firms would benefit from including triggering mechanisms in their training and development programs. They can also help by providing readily available sensory feedback and information so that the alert agent can identify clues to a potential error and fix it before the transaction is complete. Therefore, the practice of quality review and sampling post-production, does little if anything to support the development of an agent's triggers. This must be embedded in the training process.

But how do you train "triggers?" This question isn't directly answered by the literature, but there are clues in the second aspect of this pillar, Cognitive Awareness (A^C). My literature review suggests there are levels of awareness and attentiveness that agents must possess in order for their triggers to be effective. It begins with a knowledge of the states of awareness and the way errors can happen at each stage. After all, processing accuracy is in its simplest terms, reading information from an input source and typing or keying the transcribed information into a record keeping system. It's a task that's not beyond the capabilities of agents. Understanding the cognitive process helps agents refine their trigger mechanisms to avoid mistakes in processing.

Bell and Kozlowski (2011) describe four stages of cognitive awareness in completing a task: (1) Sensorimotor Level, (2) Conscious or Intellectual Level or Regulation, (3) Level of Flexible Action Patterns, and (4) Overarching Heuristic Level of regulation. Think of it as a playbook for each transaction. The agent must be aware of the sensorimotor actions involved with executing a transaction; namely their eyes, ears

and hands. Next, there needs to be awareness of their own cognitive state. Are they blocking out distractions and clearing their mind so that full attention can be leveraged on the transaction at hand? Third, are they familiar with the playbook? Have they processed this type of transaction before and do they understand what needs to happen to complete the transaction accurately? Lastly, there's the overall awareness of all three of the prior phases operating concurrently to produce an accurate transaction; almost an omniscient point of view of the entire process.

There's also the awareness of the forces working against cognitive awareness. Automation of data feeds and transactions can lead agents to become spectators in their own transactions, slowing down and dulling awareness of triggers (Hollenbeck, et al, 1995). In today's computer driven world, many actions of a processor are semi-automated and thus can create a false sense of security. One way to counter this phenomenon is to create an environment where agents enjoy their work and feel safe in their environment (Leonard & Weitz 1971). This leads us to the third and final Awareness pillar, Awareness of Behaviors (A^B). Behavioral awareness speaks to how firms equip agents to be aware of and respond positively to their processing environment, and in many ways, serves as a bridge to our second theme of "Culture" in responding to the research question of what actually drives quality.

A^B is an awareness of how humans are given to behave in the context of completing their transactions and how they respond psychologically to errors when they occur. Agents who are confident in their work environment feel as though the task at hand is well within their proverbial wheelhouse. They feel as though they are in control of their environment and that they have the ability to dictate the outcomes of their work

(Rotter 1996). This also means that agents must have autonomy to conduct their activities in the manner which they see fit. By keeping agents focused on work that's within their realm of mastery, they tend to be more aware of their abilities and limitations and thus are more willing to learn from mistakes when they inevitably occur, and feel confident that they can correct them going forward (Feather 1969).

In summary, each of the pillars of Awareness are well covered in the literature. When assembled together, they create a powerful reference for practitioners who seek improved transaction processing accuracy. The literature favors the argument that firms who focus on developing awareness among their agents will improve accuracy and performance.

CHAPTER THREE:

STUDY DESIGN

Longitudinal Study Design Using Quantitative Data

Given the lessons learned from the literature review, the goal was to design a cognitive awareness training program and find a practitioner partner who would permit the training to be administered. Additionally, quantitative measures for gathering data related to the training would need to be developed. Lastly, methods for analysis of the data would need to be identified and applied.

However, in developing the training, I discovered multiple studies on the relative ineffectiveness of "brain training" games or programs on sustained learning. Simons, et al, conducted extensive research of commercially available "brain training" games and applications and conclude that while the trainings appear to have a direct effect on improving performance in the targeted area of brain cognition, there was no evidence to support this learning could generalize to other areas. (Simons, et al, 2016) (Kreitz, et al, 2015).

It's important to note that my experiment design targets awareness of cognitive functions, and is not intended to mimic a Brain training program. By design, my intervention seeks to measure the impact of increased awareness of brain functions, coupled with a self-guided and intentional program for developing one's own unique and targeted brain training design that they can practice and apply to the transaction

processing task. In summary, my experiment is unique and will provide new information to the existing knowledge base related to cognitive abilities related to successful task performance.

Thus, a study was devised whereby a host firm would allow for a controlled experiment involving the introduction of a Cognitive Awareness training program to a treatment group, with a representatively equivalent control group who would not receive the training. Transaction processing outcomes (accuracy rates) would then be observed Pre- and Post-experiment to create data sets for further observation. Transaction processing as a function, yields a rich repository of qualitative data. Businesses regularly measure the number of transactions processed per hour, the rate at which items are selected for secondary review, and the resulting error/accuracy rates at an individual, group, and department level.

I presented the idea to a large US-based financial services firm (which we will refer to as CAT or CAT Financial) in January of 2017 and they granted permission to conduct my experiment within their organization. CAT agreed to provide the researcher with transaction processing data sets for both Pre- and Post-experiment. Given the richness and availability of CAT Financial's data, I decided to create a longitudinal study of the effectiveness of Cognitive Awareness training on transaction processing accuracy. CAT would provide the researcher with anonymized transaction process accuracy over a seven-month period including four months' worth of pre-treatment performance data, and three months of post-treatment data. These data sets would provide for quantitative analysis of the impact of Cognitive Awareness training on transaction processing accuracy, thereby addressing the first hypothesis:

H^1: A targeted treatment of cognitive awareness training programs will have a positive effect on transaction processing accuracy.

Additionally, the literature review had revealed the existence of a quantitative survey methodology, known as an Error Orientation Questionnaire or EOQ (Rybowiak, Garst, et al., 1999). EOQ was discovered as part of the "Cultural" pillar of the ACE construct, but was relevant to the "Awareness" pillar due to the behavioral dynamics associated with cognitive functions. EOQ measures agents' perceptions and feelings towards errors that occur in the workplace. Measuring these perceptions and any changes over time, would be directly relevant to the assessment of cognitive awareness training. Analysis of these data would also address the second hypothesis:

H^2: A targeted treatment of cognitive awareness training programs will increase the Error Orientation of transaction processing agents.

CAT Financial also adopted EOQ as a means of measuring the overall health of their quality (accuracy) environment. They further agreed to provide the researcher with the data sets from four distinct applications of the EOQ survey; one pre-Cognitive Awareness training treatment, one at the end of the 90-day post-treatment cycle, and two more at 30 and 60 days post-treatment. The data sets would be coded in such a way as to protect the identities of the individual agents, but in such a way that they could be cross-referenced at the individual agent level with quantitative data sets from transaction processing accuracy.

Lastly, both quantitative and qualitative data sets would be utilized to address the third hypothesis:

H^3: Improved accuracy and increased Error Orientation are positively correlated.

Cognitive Awareness Training Protocol Design

As there are no existing models for training Cognitive Awareness in financial services transaction processing groups, new materials needed to be constructed. As a practitioner, I have over 25 years' worth of professional experience in leading, coaching, training, and developing practitioners in the financial services industry. I therefore began designing an original training program based on my knowledge and experience with similar practice in related subject matters.

First, I knew that all training programs needed to be engaging and interactive to be successful with adult professional learners. There needed to be clear relevance to the lessons from training; trainees need to know that the material is portable; which is to say that it can be easily translated from theory into practice; that it's obtainable, meaning that the knowledge will be easy for them to grasp and understand; and that there are low barriers to entry, meaning that the material will have an immediate impact on their performance.

The first barrier would be creating content that was true and accurate to the existing academic literature, but was presented in a manner that would be readily received and consumed by the target audience. However, words and phrases associated with these material present immediate barriers to learning in the practitioner context. Terms like "Neuroplasticity," "Overarching Levels of Heuristic Regulation," and "Behavioral Mechanisms," are all well suited to science, medicine, and academic research, but are an anathema to most agents in transactions processing groups.

The literature for the "Awareness" pillar suggests that there are three distinct sub-concepts associated with Cognitive Awareness: Awareness of Triggers (A^T), Awareness of Cognitive Functions (A^C), and Awareness of Behavioral Mechanisms (A^B). The training materials would therefore need to consist of three distinct learning modules dedicated to each of the sub-concepts. The training program would also need an introduction providing context around the learning concepts in such a way that it would answer the following questions:

1. WHO is administering this training? (Is it credible? Is the instructor credible?)
2. WHAT is Cognitive Awareness? (What does it mean to practice?)
3. WHY are we learning about this when we have so many other things to do? (What's the relevance to my job and my performance? What's in it for me?)
4. WHEN will I use it? (Will I see immediate results? How will it take for me to see results? Will the results last?)
5. WHERE will I use it? (Does this help me process better, faster? Will it work for some transactions but not others?)
6. HOW will I apply this to improve my performance? (How do I easily translate the learning into practice? How will I know it's working?)

Lastly, the training program would need a conclusion and call to action. Exposure to the materials is only the first part of learning new behaviors. Cognitive Awareness training would need a conclusion that provided some prescriptive method for carrying forth the lessons learned and turning them into practice. The training program would therefore be developed with the following structure:

1. Introduction to Cognitive Awareness
2. Learning Module I: Awareness of Triggers
3. Learning Module II: Awareness of Cognitive Functions
4. Learning Module III: Awareness of Behavioral Mechanisms
5. Review and Conclusion

As an experienced trainer and facilitator, I knew the training program would need to be comprehensive, yet concise. My original training design called for a 60-minute learning program that could easily fit into the busy schedules of CAT Financial, or any other firm that would leverage the training in practice. As development of the training materials began, it was readily evident that the scope and content of the materials could not effectively be addressed in a 60-minute window. The program design was altered to allow for a 90-minute training delivery time.

Constructing the Introduction Section

The introduction section of Cognitive Awareness Training ultimately consisted of 7 slides, including a title slide and agenda slide. The remaining five slides were dedicated to answering the six questions referenced in the previous section. In them, the learning objectives are introduced to the audience; they are told that the purpose of the training is to help improve their transaction processing accuracy. Credibility is established by briefly exposing the audience to the academic theories behind ACE, and how the industry already supports, in varying degrees, advanced evaluation techniques and fundamental error management cultures.

Audience expectations related to “what” the content is, “why” it’s important to their work and performance, and “where” they will use it to improve performance are also addressed. Lastly, the audience is informed that they will receive both a Job-Aid for quick reference of key aspects of Cognitive Awareness training, and a performance improvement plan that will be used after training to embed the learning into practice. This addresses the “how” question.

With the primary needs of the audience met, the training program turns to content and learning modules sections. At this stage, the audience has a clear understanding of what information will be coming their way over the 90-minute program, why it’s important, and how it will be used for their benefit. They are primed for exposure to new learning content.

Constructing Learning Module I: Awareness of Triggers

In the first of three learning modules, the goal is to orient the audience to the fundamental workings of the brain, and how the brain’s features contribute to and detract from seeing and performing with perfect attention to detail. After all, transaction processing in practice involves reading and sense-making of written instructions provided by a customer, applying business and industry rules to interpret the client’s request and determine a course of action, then taking action (normally by keying a transaction request into a trading or recordkeeping system). All of these steps take place multiple times a day and thousands of times a year in financial services transaction processing groups.

Additionally, being the first learning module and the introduction to the entire learning suite, it is important to capture the audience’s attention and interest, to help

them relate to the problem space at an individual and personal level, so that they are motivated to learn and pay closer attention to the content. Learning Module I's attention to Triggers needed to do just that.

Learning Module I consists of six slides. In order to bring the lessons alive in an easy to grasp and engaging manner, I chose to leverage brain-teaser exercises and videos. Through an internet search using Google, I discovered two quick and easy exercises. The goal of both is to spot a minute detail – or outlier – in an image. The image would flash for only ten seconds, then disappear. The purpose of these slides is to start energizing the audience with a simple and fun exercise. Regardless of the results, the intent is to make them aware that seeing detail is hard and can be missed or overlooked (just like detail in a financial services transaction request). Everyone has Triggers that enable them to see anomalies, but only some of the time. Why?

From there, the training program introduces the term, "Triggers" as a general reference to the ability to sense and interpret detail in our environment. Ohlsson's (1996) research suggests that agents who are not equipped with "mechanisms" to detect their own errors are unable to learn from their actions and improve performance. Allwood's (1984) research suggests that agents need to be equipped with the ability to identify their own errors before they occur, and that a greater emphasis needs to be placed on developing error detection triggers. Therefore, the motivation of Learning Module I needs to build on the agent's ability to detect triggers. In order to do that, they must first understand how errors can occur.

To that end, the next slide playfully illustrates the concept of the human's "old brain" which developed earlier in our evolutionary cycle to protect us from danger and

increase chances for survival. Next, I found three videos on YouTube that further develop the dichotomy of the Old Brain/New Brain. The first video from AsapScience entitled, “Brain Tricks – this is how your brain works.” In just four minutes, this illustrative video covers the separate functions of the Old/Fast brain and the New/Slow brain, and how their functions can lead to being either too hyper focused on a specific detail and thereby missing other equally important details, or being too focused on problem solving to miss anomalies in the environment.

Next, there’s a video called the “Monkey Business Illusion” where the viewer gets further exposure to the cognitive challenges presented by Old/Fast and New/Slow brain thinking. (Simons 2010). This video is intended to get the audience to further consider the impact of old and new brain functions so that they are primed to discover their own triggers.

Lastly, there’s another video from Dr. Simons called, “Seeing the World as It Isn’t” that goes a bit deeper into explaining how we often get the impression that we’re seeing the entire picture in complete detail, when in fact we are not. (Simons 2011). Again, the purpose of this video is to further convince the audience that they are aware of the gaps in their cognitive process and the need to develop triggers to help identify illusions and mistakes as they are happening. They now are aware of the need for triggers, but have not yet been equipped with the methodology of how to do so. That will come in Modules II & III.

With the videos chosen, I then proceeded to search the academic literature for evidence of existing studies that would support and validate the use of these videos in the given context. First, I searched for the works of Daniel Simons and found extensive

references to a term called Inattentional Blindness or IB, which is described as, “When people attend to objects or events is a visual display, they often fail to notice an additional, unexpected, but fully visible object of event in the same display.” (Most, et al. 2001)

Both of the videos from Dan Simons are grounded further in academic publishings on inattentional blindness. In them, the research concludes that our visual system can work against our ability to see the full picture in detail, the extent of this impact being dependent on the type and frequency of visual stimulation related to task. (Simons & Levin 1997; Krietz, et al, 2017; Stothart, et al, 2016; Simons, 2010).

Additional support for the training content regarding interactions between Old/Fast and New/Slow brain functions is evident in the works of several researchers, most notably in the works of Nillie Lavie (Lavie 2005; Cartwright-Finch & Lavie, 2006; Milner & Goodale, 1998; New & German, 2015).

Learning Module I concludes with a brief review of the key terms discussed in the section and an acknowledgement that this new awareness may be unsettling for the audience. They now have awareness of basic cognitive functions and the ways they can negatively impact performance, but don’t yet have the knowledge or ability to behave differently.

Ohlsson and Allwood posit that agents must be equipped with their own triggers to better learn from and avoid errors. To learn, one must first have awareness of the problem space and develop a sense of urgency for addressing the problem space with new solutions. The concepts introduced in Learning Module I are designed to prime them for tackling the more complex concepts introduced in Learning Module II so that

they will be inclined to pay full attention. The concepts in Learning Module II are the foundation for building knowledge and capabilities to produce and master one's own Triggers.

Constructing Learning Module II: Awareness of Cognitive Functions

Hollenbeck, et al, describe how modern advances in automation have dulled the senses and perhaps the ability to effectively leverage triggers to avoid errors. (Hollenbeck, et al. 1995). Certainly, today's financial services organizations have adopted a myriad of technology all aimed at improving speed and accuracy among their transaction processing agents. While most of these advances are effective, they come with the unintended consequence of dulling the agent's senses to the point where triggers are no longer active. To rebuild these triggers, one must reconstruct them from the ground up. Agents will also need to learning plan to sustain the development of triggers in the future.

With this in mind, Learning Module II introduces two related concepts to the audience. First, there exists a need to convince the audience that their brains, in fact all brains – regardless of past performance or current state, have the ability to learn, evolve and grow. Once must believe that they have the ability and capacity to change if they are to embark on a course of action that will lead to that change.

Upon an extensive search on Google using terms like, "brain change," "brain growth" and "cognitive function growth," I discovered a fourteen-minute video from Dr. Lara Boyd on the concept of "Neuroplasticity." (Boyd 2015). Neuroplasticity did not emerge directly from the literature review, however, for the purposes of encouraging the learning audience that they could master their brain's development to build their own

triggers, it has been included in Learning Module I. In addition to playing the video, there is a slide that covers seven key themes from the video in easy to understand and apply terms.

Next, drawing from Bell and Kozlowski's (2011) research, the audience is exposed to the four levels of cognitive function:

1. Sensorimotor Level
2. Conscious or Intellectual of Regulation
3. Level of Flexible Action Patterns
4. Overarching Heuristic Level of Regulation

This research provides a taxonomy for mastering complex tasks. Understanding each stage, and the opportunity for errors in the part of the agent at each particular level, may lead to a better understanding of how to prevent such errors in the future. In short, this research provides the initial basis for rebuilding a set of triggers. However, given the practitioner audience, these terms need to be introduced in more digestible and relatable terms. To that end, for the purposes of Cognitive Awareness training, they have been relabeled as:

1. The Engine
2. The Thinking Brain
3. The Playbook
4. The Director

Learning Module II discusses the four stages of cognitive function using these simplistic terms as a reference or anchor. The stages are translated into functions that are more accessible to the practitioner audience. For example, the fourth cognitive

function is described by Bell and Kozlowski as “Overarching Heuristic Level of Regulation,” but for the training, we use more familiar imagery of a movie-set director who sits back and observes the actors, the action, and the set as a whole, offering guidance and input to all three systems so that the scene is perfected.

Similar to the approach taken with Learning Module 1, I conducted additional literature reviews to support the learning concepts related to Neuroplasticity and the multiple levels of brain function and their contribution to learning. Dr. Boyd’s assertions in the video are grounded in a literature that supports the notion that the brain is capable of continuous learning and restructuring. Additionally, there is sufficient evidence to support that intentional practice can lead to changes in brain function and composition to support improved performance. (Stothart, et al, 2015) (Voss, et al, 2011) (Most, et al, 2005) (Boyd, et al, 2010) (Boyd, et al, 2003).

This module concludes with a summary of the two themes; Neuroplasticity and the Four Stages of Cognitive Function. They are introduced as the formation of building cognitive awareness and triggers to improve performance. Before the module concludes, the audience is reminded that they will be supplied with learning tools that will help them construct their own improved performance. Before they can begin however, they must also learn about behavioral mechanisms and their impact on performance.

Constructing Learning Module III: Awareness of Behavioral Mechanisms

The third and final Learning Module is dedicated to the Awareness of Behavioral Mechanisms. Leonard and Weitz’s research speaks to the importance of feeling safe and confident in one’s environment to perform at optimal levels. (Leonard & Weitz 1971)

Rotter contributes to this by describing the importance of task confidence in performing at optimal levels. (Rotter 1996). Feather's work introduces that agents can further benefit from both mastery and confidence in their operating environment, balanced with a healthy respect for their own limitations, as a means of learning from errors and improving performance. (Feather 1969)

Following the more strenuous and complex information presented in the previous module, Learning Module III is constructed simply. It introduces common emotions and behaviors such as "confidence," "fear," and "anger" as easily identifiable emotional states. These emotions are tied back to the lessons from Module I where we remember that old/fast brain systems are happening automatically. They are only controlled or inhibited by our new/slow brain functions who consciously determine whether the perceived stimulus and corresponding emotion is justified and to what extent.

Agents are then exposed to the positive and negative ways that emotions can impact performance before concluding that both positive and negative emotions are useful to understanding and controlling the functions of the brain. In doing so, we are addressing the key themes uncovered from the academic literature review. Learning Module III concludes with a brief overview of the impact of behavioral mechanisms on performance, tying them directly to the learnings from the prior two modules. (Pessoa, et al, 2002)

Constructing the Conclusion and Review of Cognitive Awareness Training

The conclusion of training begins with a review of the basic learning themes from each of the three modules. The themes are presented in a manner consistent with a Job Aid that learners will take away from the training. Job Aids have proven useful in

my past training experience because they provide a readily accessible, and visible reinforcement of the learning content. For Cognitive Awareness Training, I designed a 1-page, laminated Job Aid that is intended to be displayed at the agents' cubicle when they return to their work station.

Agents are also provided with a recommended strategy for enabling ongoing learning and the formation of their own unique triggers. In Learning Module II, they learned about the concepts of Neuroplasticity and how one can intentionally work to build a better, more effective brain. To that end, I also designed a Cognitive Awareness Personal Action Plan. This two-page document provide a page for the associate to commit to by writing down the specific steps they will take to support a lasting development of Triggers. There is also a page with recommendations on how to leverage this plan in coaching sessions with their Supervisors to maintain learning and development.

Additionally, knowing that adult learning takes place over time and is optimized through collaboration with a trusted partner, I designed a Supervisor Job aid that discusses how Supervisors can coach their agents through the development and mastery of their own individual Triggers. As a prerequisite to Cognitive Awareness training, all Supervisors must also complete the training program in advance of their agents' participation so that they are prepared to coach and reinforce the lessons immediately upon their conclusion of training. The Supervisor Job Aid provides them with the necessary reminders of the learning content, along with suggestions on how to implement coaching programs to better assist the long-term development of triggers among their agents.

I then designed a five-question learning assessment survey. The survey was administered by the training facilitator at the conclusion of Cognitive Awareness training or immediately upon returning to the agent workstation. The results of this survey provided immediate feedback as to the effectiveness of the training content and delivery by identifying retention of several key terms and concepts. Variations on performance on the learning assessment may have pointed to opportunities to improve training delivery.

Lastly, I designed a Facilitator's guide. The facilitator's guide describes the talking points associated with each slide of the Cognitive Awareness Training presentation deck. It has been designed so that professional trainers can quickly come up to speed on the learning content, and effectively deliver Cognitive Awareness Training, without any prior knowledge or experience with the material.

These materials are essential to the total design of the Cognitive Awareness training program. They address the key learning terms, provide agent and Supervisor with action plans designed to embed the learning into performance, and a facilitator's guide to insure consistent and effective delivery of the training content.

Experiment Design & Implementation

My primary research question is, "Will the interjection of cognitive awareness training have a positive effect on transaction processing accuracy?" By obtaining approval from CAT Financial to conduct my research with their transaction processing organization, I have the opportunity conduct a controlled experiment in practice, and obtain relevant data sets for analysis.

CAT Financial has transaction processing duties spread across multiple locations in the US. They apply consistent measures across all locations which helps ensure that geographic location are the only discernable differences between the different locations. Agents are hired using the same recruiting tactics, and have identical job profiles. They have a consistent on-boarding process, use the same training materials, have the same operating systems and share a consistent environmental design. They also process identical types of work, share the same performance expectations and coaching programs, and are subject to identical sampling and quality review practices.

CAT Financial agreed to allow data collection from agents operating in three of their US locations. Given the overall similarities in the populations across all three geographic locations, my treatment protocol calls for a targeted treatment location that received training on specific aspects of cognitive awareness, while the other two sites did not receive the treatment and served as control groups.

As the researcher, I had access to the accuracy performance data of everyone in the study parameters; both the treatment and control groups. I established a 120-day Pre-treatment measurement of performance data as a benchmark, and observed the treatment group for 90 days Post-treatment. The results of both the treatment and control groups were analyzed to determine the likelihood of a positive effect from the treatment protocol.

Simultaneously, I administered a survey to the entire study population. The survey was designed to measure the respondents' Error Orientation, using a scale proposed by Rybowiak, Garst, Frese, and Batinic. The survey was given at the onset of the experiment to both control and treatment populations to establish a baseline for how

they felt about errors that occur in the workplace. The survey was then administered at 30, 60 and again at 90-days Post-treatment. The results of the surveys were analyzed to determine if the treatment protocol had a measurable impact on participants relative to their error orientation; i.e., does the treatment of Cognitive Awareness Training reflect changes in the error orientation of the respondents, or more simply, were we able to positively increase “awareness”?

Lastly, CAT Financial conducted post-training learning assessments as part of their standard operating procedures. The results of the post-training learning assessments for the treatment group were anonymized and provided to the researcher and used as a measure of the effectiveness of the training intervention (in other words, did the training intervention have an immediate result on increasing awareness of Cognitive states.)

These measures were necessary because it is possible the results could have been equally confirmatory of the treatment protocol, equally dismissive of the treatment protocol, or mixed. If the results are mixed, the difference between the two may indicate whether an increase in awareness can exist, even when the treatment plan is ineffective. Or, conversely, it may indicate that a successful treatment protocol can improve performance, even when awareness is unchanged. Either way, the two studies provided ample data sets which were of interest and relevance.

There would be great value to practice if a learning protocol can definitively improve transaction processing accuracy without improving costs. Existing training protocols are already embedded in the onboarding and continuing education programs of financial services firms, but none have indicated that they are employing cognitive

awareness training. Should the results of my study indicate positive effect, and the results are further replicatable across CAT Financial, the Financial Services industry, and the investing public they serve, will reap significant benefits.

CHAPTER FOUR:

METHODOLOGY

Baseline

CAT Financial provided 120-days' worth of performance data for all agents located in the three targeted sites. The dependent variable for this study was the agent accuracy rates over the entire 120-day Pre-experiment timeframe. Though anonymized, the data set was coded such that each unique operator could be identified by an individual 3-digit code randomly assigned by CAT Financial. Additionally, the data set was encoded to identify location, tenure, and gender.

Location / Site Key	Tenure Key	Gender Key
1 – Site A / Treatment Site	1 – Apprentice (0-12 months)	1 - Female
2 – Site B / Modified Control Site	2 – Novice (13-36 months)	2 - Male
3 – Site C / Control Site	3 – Expert (37+ months)	

Table 1: Example of Data Coding

CAT Financial also provided total transactions processed, total selected for post-production accuracy review, total errors identified from post-production sample set, and the Accuracy Rate (percentage of transactions sampled without error, divided by total transactions selected for sampling review). For example:

Agent ID	Total Processed	Total Sampled	Errors Detected	Accuracy Rate %
001	1,000	30	02	93.3%

Table 2: Example of Accuracy Data Sample

Accuracy data sets – for both Pre-treatment 120-day samples and Post-treatment 90-day samples – used two criteria for inclusion in the analyzed data sets. First, agents must have completed at least 100 items during the Pre-treatment period. Second, agents needed to have a minimum of 1.5% of their completed work sampled for review. One hundred thirty-seven agents met these criteria.

The Error Orientation Questionnaire (EOQ) was developed from the work of Rybowiak, et al. (1999) and implemented at 30-day intervals during the study. EOQ measures how people feel about errors in the workplace. The 37 questions breakdown into 8 dimensions of feeling or attitudes; 5 are positive attributes while 3 are negative attributes:

Positive EOQ Dimensions:

1. Error Competence: Do I feel confident in my skills and abilities
2. Learning from Errors: My ability and openness to learning from my mistakes
3. Error Anticipation: Level of alertness, watchfulness, and ability to sense danger
4. Communication about Errors: Level of comfort discussing my mistakes with others
5. Thinking about Errors: Reflective state where we internally process mistakes

Negative EOQ Dimensions:

1. Error Risk Taking: Overconfidence – taking risks and acting while uncertain
2. Error Strain: Overly concerned with the possibility of making an error
3. Error Cover-up: Seeking to hide or obscure the errors you make

Responses for each of the 37 questions were assigned a numerical value from 1-5 and the values of these answers were summed and averaged for each of the eight dimensions. Scores for the three negative dimensions were reversed for scoring, such that any survey response of “5” would receive a value of “1”, responses of “4” would receive value of “2” and so on. This allows for total scores to be calculated with Positive and Negative dimensions contributing to the final EOQ score consistently. The total sum of scores for the eight dimensions represents the cumulative EOQ score where the highest possible overall score was 40 and the lowest was 8. The 50% mark would therefore be a score of 24.

CHAPTER FIVE:

RESULTS

Data gathered throughout the experiment is used to test the validity of the three hypotheses proposed in this study. The first dependent variable is accuracy, where differences in Pre- and Post-treatment transaction processing rates will be evaluated. The second dependent variable will be Error Orientation Questionnaire (EOQ) cumulative scores which indicate how agents feel about errors in the workplace.

Additionally, three independent variables are evaluated to identify their influence on dependent variables; gender, tenure and location. I tracked differences between male and female throughout the experiment, and CAT Financial provided access to their transaction processing agents in three locations that were geographically separated by a minimum of 1,000 miles:

1. Site-1: Received full Cognitive Awareness Training treatment protocol
2. Site-2: Received only a one-page hand-out reinforcing CAT Financial's accuracy coaching principles
3. Site-3: Control group – received no treatment of any kind.

Tenure, or time in role, served as a proxy for task proficiency and is divided into three groups:

1. Apprentice: 0-12 months tenure at the beginning of the experiment
2. Novice: 13-36 months tenure at the beginning of the experiment

3. Expert: 37+ months tenure at the beginning of the experiment

Location	Tenure	Mean Accuracy	Standard Deviation
All Sites	**ALL**	**89.31%**	**12.71%**
	Apprentice	83.54%	17.36%
	Novice	89.42%	8.07%
	Expert	94.30%	6.34%
Site-1	**ALL**	**90.02%**	**9.70%**
	Apprentice	81.49%	8.83%
	Novice	87.44%	10.94%
	Expert	95.67%	4.71%
Site-2	**ALL**	**87.40%**	**16.59%**
	Apprentice	79.28%	27.80%
	Novice	88.74%	6.83%
	Expert	92.22%	6.70%
Site-3	**ALL**	**91.07%**	**8.53%**
	Apprentice	88.17%	8.17%
	Novice	91.74%	8.45%
	Expert	95.07%	7.34%

Table 3: Pre-Treatment Measures of Accuracy

Pre-Treatment Analysis

Overall, Site-3 had the highest overall accuracy during the pre-treatment period, with Site-2 the lowest, and Site-1 in between.

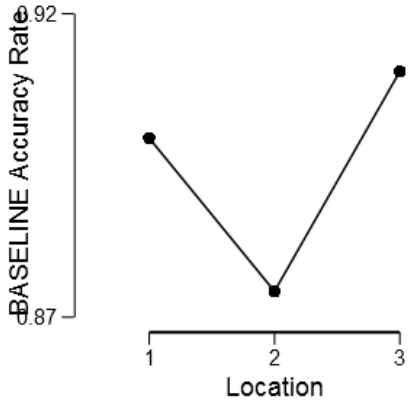


Figure 2: Pre-Treatment Accuracy Rate by Tenure

Using JASP software, I performed a series of ANOVA tests to observe the pre-treatment state among the three targeted locations for CAT Financial and found that only Tenure had a significant relationship with accuracy rates. In Figure 3, baseline performance data for transaction processing accuracy increased with each group with respect to tenure; Apprentice groups had the lowest accuracy, Expert groups had the highest accuracy, and Novice groups fell in between. This suggests a linear relation and that without treatment, accuracy may be dependent on experience.

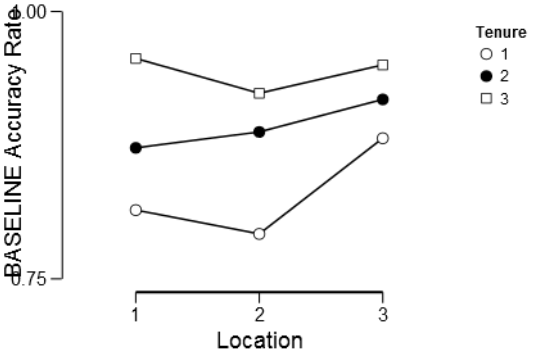


Figure 3: Pre-Treatment Accuracy Rate by Location & Tenure

1= Apprentice, 2= Novice, 3= Expert

Next, I observed differences relating to gender (Figure 4). In all three sites, Female agents had a higher mean performance than their male counterparts, but this difference was not statistically significant.

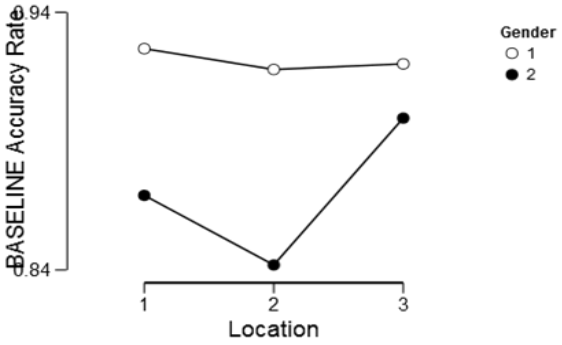


Figure 4: Pre-Treatment Accuracy Rate by Location & Gender

1 = Female, 2 = Male

Cases	Sum of Squares	df	Mean Square	F	p
Location	0.019	2	0.01	0.674	0.512
Tenure	0.201	2	0.1	7.008	0.001
Gender	0.026	1	0.026	1.83	0.179
Location ✻Tenure	0.021	4	0.005	0.367	0.832
Location ✻Gender	0.01	2	0.005	0.357	0.701
Tenure ✻Gender	0.055	2	0.027	1.921	0.151
Location ✻Tenure ✻Gender	0.03	4	0.007	0.523	0.719
Residual	1.703	119	0.014		

Table 4: Pre-Treatment Accuracy ANOVA Results by Location, Gender, and Tenure

Lastly, I compared the results of the baseline EOQ survey, issued at the beginning of March prior to treatment initiation. There were 81 valid and complete responses. Interestingly, I found an inverse relationship to pre-treatment accuracy levels (Figure 5). At this juncture, Site-2 had the highest EOQ scores, with Site-3 the lowest, and Site-1 in the middle.

Figure 5: Pre-Treatment EOQ cumulative scores by Location

Running ANOVA tests on pre-treatment EOQ survey results, I also found no significant differences by location, tenure, or any interactions. Figures 6 shows wide variation in EOQ scores when observing the relationship between of tenure and location. Table 5 shows the ANOVA results where none of the independent variables have a relationship to EOQ.

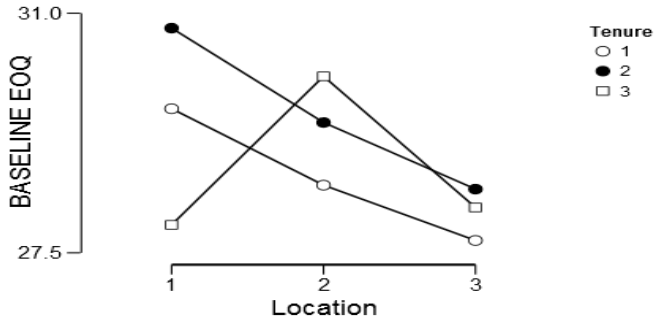


Figure 6: Pre-Treatment EOQ cumulative scores by Location & Tenure

1 = Apprentice, 2= Novice, 3= Expert

Cases	Sum of Squares	df	Mean Square	F	p
Location	28.55	2	14.274	1.599	0.211
Gender	18.96	1	18.962	2.124	0.151
Tenure	21.22	2	10.611	1.189	0.312
Location ✻Gender	18.41	2	9.205	1.031	0.363
Location ✻Tenure	63.78	4	15.945	1.786	0.145
Gender ✻Tenure	15.85	2	7.924	0.888	0.417
Location ✻Gender ✻Tenure	27.29	2	13.645	1.528	0.226
Residual	499.97	56	8.928		

Table 5: Pre-Treatment EOQ ANOVA Results by Location, Gender, and Tenure

Post-Treatment Analysis

For the post-treatment data sets, I applied the same criteria for accuracy data set inclusion. Agents needed to have a minimum of 100 transactions processed and 1.5% of work sampled to be qualified for inclusion. There were 128 agents who met these criteria during the post-treatment evaluation period (Table 6).

Location	Tenure	Mean Accuracy	Standard Deviation
All Sites	**ALL**	**90.01%**	**9.35%**
	Apprentice	85.80%	9.71%
	Novice	87.93%	7.56%
	Expert	93.26%	8.73%
Site-1	**ALL**	**91.47%**	**8.27%**
	Apprentice	84.90%	8.76%
	Novice	84.03%	5.06%
	Expert	95.48%	5.51%
Site-2	**ALL**	**90.24%**	**9.19%**
	Apprentice	86.16%	11.64%
	Novice	89.09%	7.53%
	Expert	94.53%	5.33%
Site-3	**ALL**	**88.62%**	**10.23%**
	Apprentice	86.08%	5.52%
	Novice	88.22%	7.96%
	Expert	89.74%	12.19%

Table 6: Post-Treatment Accuracy Results by Location and Tenure

Mean accuracy across all three locations was 90.01%, a minimal overall change from the Pre-Treatment mark of 89.31%. At this juncture, Site-1 had the highest overall accuracy, followed by Site-2 and Site-3. Similar to the Pre-Treatment analysis, there appears to be a relationship between the dependent variable of accuracy and independent variables of location and tenure. Sites 1 & 2 continued to have the highest overall accuracy present in their Expert populations, however the relationships between tenure and accuracy changed during the Post-Treatment period.

In the Pre-Treatment state, accuracy had a linear relationship with tenure across all locations; Apprentice had the lowest accuracy, Novice were better, and Experts were

the best. In the Post-Treatment state, only Site-2 retained this linear relationship. In Site-1, Experts continued to have the highest accuracy, but Apprentice accuracy was slightly better than Novice accuracy. In Site-3, the Novice population had the highest overall accuracy, followed by Expert, and lastly, the Apprentice population. (Figure 7)

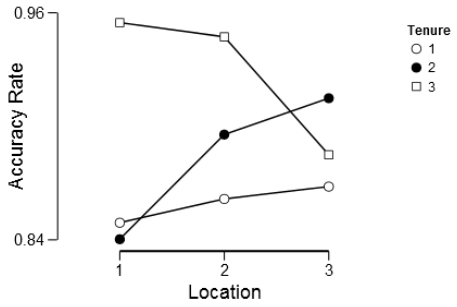


Figure 7: Post-Treatment Accuracy Results by Location and Tenure

I performed ANOVA test to evaluate the statistical significance and found that tenure appears to have a relationship with accuracy. Location alone has no interaction. While the combination between tenure and location is not statistically significant for the total population, the improved p-values offer the possibility of an interaction that may be worth further exploration and evaluation. (Table 7)

Cases	Sum of Squares	df	Mean Square	F	p
Location	0.014	2	0.007	0.911	0.405
Tenure	0.075	2	0.038	4.778	0.010
Gender	0.006	1	0.006	0.701	0.404
Location ✻Tenure	0.060	4	0.015	1.902	0.115
Location ✻Gender	0.029	2	0.014	1.825	0.166
Tenure ✻Gender	0.003	2	0.001	0.166	0.847
Location ✻Tenure ✻Gender	0.015	4	0.004	0.490	0.743
Residual	0.864	110	0.008		

Table 7: Post-Treatment Accuracy ANOVA results

Given these results, I also performed a 1-way ANOVA test for interaction between tenure and accuracy within each independent location. I found that Site-1 had a statistically significant relationship between tenure and accuracy. Site-2 had a weaker but still significant relationship, while Site-3 had no relationship. (Table 8)

ANOVA – Post-Treatment Accuracy Rate for SITE-1					
Cases	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
Tenure	0.105	2	0.053	11.87	< .001
Residual	0.155	35	0.004		

ANOVA – Post-Treatment Accuracy Rate for SITE-2					
Cases	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
Tenure	0.062	2	0.031	4.028	0.024
Residual	0.352	46	0.008		

ANOVA – Post-Treatment Accuracy Rate for SITE-3					
Cases	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
Tenure	0.012	2	0.006	0.531	0.592
Residual	0.417	38	0.011		

Table 8: Post-Treatment Accuracy ANOVA results for SITE-1, SITE-2 and SITE-3

Next, I reviewed the EOQ results for the Post-Treatment period. Response rates were low for the April (n=59) and May (n=23), so they were not included in the study. The final survey, conducted in June, had 76 valid responses and was used as the Post-Treatment EOQ result basis for EOQ. The mean EOQ score was 29.47 which was similar to Pre-Treatment EOQ baseline. I performed ANOVA test to determine if any of the independent variables had a relationship with EOQ scores and found no interaction for location, tenure, or gender. (Table 9)

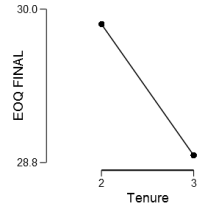
Cases	Sum of Squares	df	Mean Square	F	p
Location	0.705	2	0.352	0.044	0.957
Tenure	14.041	2	7.021	0.868	0.425
Gender	10.162	1	10.162	1.257	0.267
Location ✻Tenure	2.883	3	0.961	0.119	0.949
Location ✻Gender	4.61	2	2.305	0.285	0.753
Tenure ✻Gender	18.785	2	9.392	1.162	0.32
Location ✻Tenure ✻Gender	1.345	2	0.673	0.083	0.92
Residual	493.135	61	8.084		

Table 9: Post-Treatment EOQ ANOVA results by location, tenure, and gender

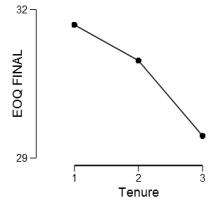
I also observed that when evaluating EOQ results by each independent location, EOQ scores decreased in a linear fashion with tenure. Site-1's Apprentice population was absent from the Tenure analysis of EOQ as they had been rotated to a different assignment by CAT Financial prior to the administration of the final EOQ survey.

TENURE Populations: 1= Apprentice, 2= Novice, 3=Expert

SITE-1 POST-TREATMENT EOQ BY TENURE



SITE-2 POST-TREATMENT EOQ BY TENURE



SITE-3 POST-TREATMENT EOQ BY TENURE

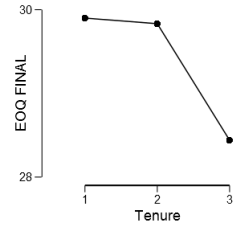


Figure 8: Post-Treatment EOQ ANOVA results for SITE-1, SITE-2, and SITE-3

Analysis of Change Between Pre- and Post-Treatment States and the Relationship Between Accuracy and EOQ

In calculating the differences between Pre- and Post-Treatment periods for accuracy, I observed only the populations who had met the minimum criteria of 100+ items processed and a minimum 1.5% sample rate for both Pre- and Post-Treatment periods. In terms of accuracy, there were 114 agents who met these criteria.

Upon comparing changes in Pre- and Post-treatment accuracy, there was improvement in overall accuracy in both Sites 1 & 2, which had both received some form of treatment. Site-1 received the complete treatment while Site 2 only received a simplistic job aid and no formal classroom training on cognitive awareness. Site-3, which served as the control group and received no treatment, saw an overall reduction in accuracy during the post-treatment measurement period. (Table 10)

Location	Tenure	Change in Mean Accuracy
All Sites	**ALL**	**0.70%**
	Apprentice	**2.26%**
	Novice	**-1.49%**
	Expert	**-1.04%**
Site-1	**ALL**	**1.45%**
	Apprentice	**3.41%**
	Novice	**-3.41%**
	Expert	**-0.19%**
Site-2	**ALL**	**2.84%**
	Apprentice	**6.88%**
	Novice	**0.35%**
	Expert	**2.31%**
Site-3	**ALL**	**-2.45%**
	Apprentice	**-2.09%**
	Novice	**-3.52%**
	Expert	**-5.33%**

Table 10: Differences between Pre- and Post-Treatment Means for Accuracy

During the baseline observation of accuracy, the Expert population had the highest overall accuracy, followed by Novice population, and lastly, the Apprentice population across all sites.

Site-2, which received the minimal treatment protocol, and which had the highest EOQ scores for both Pre- and Post-Treatment periods, saw improvement across all tenure populations. The coaching form they were provided with was based off of CAT-Financial's core training and served as a reinforcement of commonly discussed accuracy principles. Site-1, who received the full Cognitive Awareness Training protocol, saw an increase in the Apprentice population's accuracy, but decreases in the Novice and Expert population's accuracy.

I performed ANOVA tests to observe the strength of the relationship between the dependent variable of accuracy and the independent variables of location, tenure and gender and found no relationship between changes in accuracy and location, tenure or gender. (Table 11)

ANOVA – Changes in Accuracy Rate by Location, Tenure and Gender

Cases	Sum of Squares	df	Mean Square	F	p
Location	0.002	2	9.714e -4	0.112	0.894
Tenure	0.005	2	0.003	0.296	0.744
Gender	0.017	1	0.017	1.963	0.164
Location ✻Tenure	0.039	4	0.010	1.130	0.347
Location ✻Gender	0.003	2	0.002	0.191	0.827
Tenure ✻Gender	0.047	2	0.024	2.718	0.071
Location ✻Tenure ✻Gender	0.002	4	5.570e -4	0.064	0.992
Residual	0.826	95	0.009		

Table 11: Differences between Pre- and Post-Treatment Accuracy Means by Location, Tenure, and Gender

In calculating the differences between Pre- and Post-Treatment EOQ samples, I observed only the populations who had completed the survey at both intervals. There were 49 agents who met this criterion. Overall, there was a net decrease in overall EOQ scores during the treatment period among this population.

Site-1, who received the full Cognitive Awareness Training, was the only location where an overall increase in EOQ scores between Pre- and Post-Treatment populations. Site-2, who received the minimal treatment, had the largest decrease in scores, while Site-3, the control for this experiment, had a small decrease in scores. (Table 12 and Figure 9)

Location	Change in Mean EOQ Score	Standard Deviation
All Sites	**-0.068**	**2.331**
Site-1	**0.297**	**2.285**
Site-2	**-0.456**	**1.864**
Site-3	**-0.017**	**3.104**

Table 12: Differences between Pre- and Post-Treatment EOQ Scores

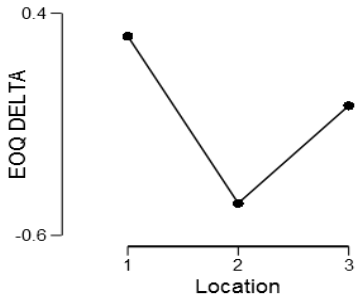


Figure 9: Differences between Pre- and Post-Treatment EOQ Scores

I then performed an ANOVA test of these variables and found significant effects for location, gender, location by tenure, and location by gender. (Table 13) Population samples were limited due to staff attrition throughout the life of the survey. It is therefore impractical to perform additional analysis of the sub-populations to determine the nature and direction of the effects of EOQ surveys on the populations. With that said, the impact of error management culture as measured by EOQ surveys points toward a general effect, which is of interest.

Cases	**Sum of Squares**	**df**	**Mean Square**	**F**	
Location	28.4	2	14.2	3.499	0.041
Tenure	10.396	2	5.198	1.281	0.29
Gender	23.101	1	23.101	5.693	0.022
Location ✻Tenure	36.29	3	12.097	2.981	0.044
Location ✻Gender	27.852	2	13.926	3.432	0.043
Tenure ✻Gender	6.607	1	6.607	1.628	0.210
Location ✻Tenure ✻Gender	0.618	1	0.618	0.152	0.699
Residual	146.084	36	4.058		

Table 13: ANOVA of EOQ Score Change by Location, Tenure, and Gender for Population Available in Both Pre- and Post-Treatment States

I looked for correlation between changes in accuracy rates and EOQ scores using Pearson Correlation analysis. In all, there were 40 CAT Financial agents who met the criteria of having 100+ items processed and a minimum of 1.5% of their work sampled during both Pre- and Post-treatment evaluations, and who had complete Pre- and Post-EOQ surveys. There was a negative correlation between accuracy rates and

EOQ scores for the entire sample but the relationship was not statistically significant. (Table 14)

		Accuracy Delta	EOQ DELTA
Accuracy	Pearson's r	—	-0.166
Delta	p-value	—	0.269
EOQ	Pearson's r		—
DELTA	p-value		—

Table 14: Pearson Correlation Analysis of Accuracy and EOQ Scores for CAT Financial

I also tested sub populations by location, tenure and gender and found no relationship between accuracy and EOQ. (Table 15).

		Accuracy Delta	EOQ DELTA
Accuracy	Pearson's r	—	-0.355
Delta	p-value	—	0.075
EOQ	Pearson's r		—
DELTA	p-value		—

Table 15: Pearson Correlation Analysis of Accuracy and EOQ Scores

I also observed the data sets from Site-1's population. There were 18 agents from Site-1 who met the following criteria; 100+ transactions processed in both Pre- and Post-Treatment periods, EOQ Survey responses from both Pre- and Post-treatment periods, and completion of the Post-Training Learning Assessment (PTLA) issued by

the trainer immediately upon completion of Cognitive Awareness Training. The data suggests an interaction between independent variables of Gender and PTLA with the dependent variable of change in accuracy rates, but no interaction between the same and EOQ change. (Table 16)

ANOVA - Accuracy Delta

Cases	Sum of Squares	df	Mean Square	F	p
Tenure	1.185e -4	1	1.185e -4	0.046	0.835
Gender	0.064	1	0.064	24.732	< .001
PTLA	0.052	3	0.017	6.761	0.011
Tenure ✻Gender	0.022	1	0.022	8.479	0.017
Tenure ✻PTLA	0	0			
Gender ✻PTLA	0.045	2	0.023	8.756	0.008
Tenure ✻Gender ✻PTLA	0	0			
Residual	0.023	9	0.003		

Table 16: Pearson Correlation Analysis of Accuracy and EOQ Scores for Female Population

Cases	Sum of Squares	df	Mean Square	F	p
Tenure	10.207	1	10.207	1.926	0.199
Gender	4.179	1	4.179	0.789	0.398
PTLA	3.821	3	1.274	0.240	0.866
Tenure ✻Gender	0.084	1	0.084	0.016	0.903
Tenure ✻PTLA	0	0			
Gender ✻PTLA	1.610	2	0.805	0.152	0.861
Tenure ✻Gender ✻PTLA	0	0			
Residual	47.692	9	5.299		

ANOVA - EOQ Delta

Lastly, I evaluated the qualitative data obtained from interviews with CAT Financial's Transaction Processing Group's management team. Two consistent themes of these interviews were "Overtime" and "Busy Season." The volume and complexity of CAT Financial's transaction work increased dramatically in the first two months of the Post-Treatment evaluation period (March and April) before falling off sharply in the final month (May). This resulted in increased overtime and stress among all agents, but particularly so amongst the Expert population.

CHAPTER SIX:

DISCUSSION

The purpose of this experiment was to determine if a targeted treatment of Cognitive Awareness training could improve agents' ability to process transactions accurately and to determine if Error Management Culture had a mitigating effect on the success of that training. The experiment collected baseline data from a large US-based financial services firm for 120 days prior to the commencement of the experiment. After treatment protocols were introduced, 90-days' worth of accuracy data and measures of Error Management Culture were gathered and analyzed.

H^1: A Targeted Treatment of Cognitive Awareness Training Programs Will Have a Positive Effect on Transaction Processing Accuracy.

Regarding the first hypothesis, that data does not support the hypothesis. In the Pre-Treatment analysis of accuracy, there was a linear relationship between the dependent variable of accuracy and tenure. That relationship was consistent across all locations. Although the results are not statistically significant with respect to changes in accuracy, the Post-Treatment analysis of accuracy favors improvements in the two locations that received some form of Cognitive Awareness Training.

Site-1 received the complete training protocol, consisting of a 90-minute cognitive awareness training program, a cognitive awareness job aid, and coaching guides for

both manager and agent. They had the highest overall accuracy in the Post-Treatment period. The Apprentice population of Site-1 had an increase between Pre- and Post-Treatment accuracy rates, while Novice and Expert populations saw a decrease. The results of the experiment were, however, not significant to imply cause.

In Site-2, where the population only received a reinforcing coaching guide that mirrored CAT Financial's common coaching principles for accuracy, all populations had an increase in accuracy rates during the experiment, with the largest overall increase of any population during the study coming from Site-2's Apprentice population.

Site-3, who served as a control, posted the lowest overall accuracy rate during the Post-Treatment period. All three tenure groups experienced a decrease in their accuracy rates with the largest coming from the Expert population, followed by Novice.

Although the ANOVA results of the change in accuracy don't indicate a relationship between location and accuracy, and thus Cognitive Awareness Training and accuracy, the results are directionally aligned with the expected outcome. Qualitative follow-up after the study indicated that the experiment took place during a rather turbulent time for CAT Financial, where complexity of task and volume peaked. Absent of any form of Cognitive Awareness Training, Site-3 experienced declines in accuracy across all tenure groups and went from having the highest overall accuracy across CAT Financial's locations to the lowest overall accuracy. Conversely, Sites 1 & 2 saw improvement in their overall accuracy rates.

One possible explanation is that Cognitive Awareness Training may have overcome the otherwise complex and intense environments experienced during the Treatment period, allowing Sites 1 and 2 to maintain or improve their overall fitness

while Site 3, absent of any cognitive reinforcement, saw across the board declines in accuracy.

Additionally, ANOVA tests of Post-Treatment accuracy data of all three locations indicates that Tenure and Accuracy have the strongest interaction in Site-1, the location of the full Cognitive Awareness Training, followed by Site-2, the location that received only a modest treatment. In Site-3, the control location, there is no evidence to support an interaction between tenure and accuracy during the Post-Treatment period. This finding poses new questions as to whether or not Cognitive Awareness Training may have a positive impact on maintaining the linear relationship between experience and accuracy during periods of increased activity and complexity among the agents.

Apprentice populations in both treatment locations saw the largest overall increase in accuracy during the experiment, while the same group in the Control location saw a decrease in accuracy. Although Apprentice populations in all three locations had the lowest accuracy both before and after Treatments, only the Apprentice populations exposed to some form of Cognitive Awareness Training saw an increase in accuracy. If accuracy alone is linearly dependent on tenure and experience, we would expect to see similar results across the entirety of the Apprentice populations. The differences in accuracy by location suggest that there is an additional variable interacting with Tenure on overall Accuracy.

One limitation of this study was the variability of agents over the 5 months of observation. The turnover in agent population left sub-optimal data sets for comparing Pre- and Post-Treatment populations. Future studies should account for this by either conducting the experiment within organizations with less variation and turnover among

their employee population, or by expanding the sample set to allow for sufficient analysis of the populations throughout the duration of the study period.

Further research should be conducted to determine if Cognitive Awareness Training programs, adjusted to match the agent's level of task proficiency, produce similar results.

H^2: A targeted treatment of cognitive awareness training programs will increase the Error Orientation of transaction processing agents.

The results of this experiment support H^2. The Error Orientation Questionnaire (EOQ) is a validated scientific instrument for measuring the overall health of the Error Management Culture (EMC) within a population. With that said, there's not a broad enough body of evidence in the literature to compare CAT Financial's results to and determine if their existing ECM was healthy or not. This is a limitation of the experiment design.

I did observe modest improvements in EOQ across all three locations during the experiment. Site-1, the recipient of the full cognitive awareness training protocols certainly had a positive increase in EOQ scores during the experiment, suggesting that cognitive awareness training may have a positive effect on EMC dynamics. They also were the only site who had positive gains in EOQ scores among agents who were present throughout the experiment.

While serving as the control group, Site-3 had the largest improvement in EOQ scores across its' entire population at the time of the final sampling. However, Site-3's population of EOQ respondents who were present in the data throughout the life of the experiment actually demonstrated a modest decrease in overall EOQ. This suggests

that changes in ECM are influenced by something other than the introduction of cognitive awareness training, regardless of the level or intensity or presence of Cognitive Awareness training.

The EOQ samples used as the basis of this experiment were not large enough or consistent enough to allow for tabulation and analysis at the sub-category by gender, tenure, and location dynamics. There were only 42 individual agents who voluntarily participated in both Pre- and Post-treatment EOQ exercises. Additional surveys should be offered to build a large enough sampling of Pre- and Post-treatment changes in EOQ. This should be done to better determine the key influencers of ECM by breaking down the eight sub-components of the EOQ model; Error Competence, Learning from Errors, Error Risk Taking, Error Strain, Error Anticipation, Covering up Errors, Communication about Errors, and Thinking about Errors.

H^3: Improved Accuracy and Increased Error Orientation Are Positively Correlated

H^3 is also not supported by the results of this experiment. Pearson Correlation analysis indicates an absence of a relationship between improvements in accuracy and EOQ scores.

Site-1, the primary recipient of cognitive awareness training had improvements in both accuracy and EOQ during the experiment. However, underlying changes in the population dynamics of Site-1 during the experiment failed to produce sufficient data for analysis. Site-1's Apprentice population had rotated to a new business area before the final EOQ measurement was administered, and thus were not available for final analysis.

Interestingly, the site with the highest Pre-Treatment EOQ score, Site-2, is also the only location where an increase in accuracy across all three populations of tenure. They also experienced the highest overall increase in accuracy across all three tenure populations.

Though the data obtained from this experiment does not yield statistical significance for this correlation, the study findings suggest that the direction of the outcomes may yield more statistically significant values that support the hypothesis.

The data sets vary greatly across locations and thus fail to support the premise that changes in transaction processing accuracy are affected by are not correlated to the presence or absence of cognitive awareness training. The sample size for this population was relatively small at 40 participants, and sub groups based on independent variables of location, gender, and tenure do not bear significance. Continued research and measurements are required to gain a large enough sample size that would allow for meaningful interpretation of the correlation between populations who received Cognitive Awareness Training and those who do not.

CHAPTER SEVEN:

CONCLUSIONS

The results of this research offer intriguing possibilities for both academics and practitioners. While there was greater improvement in transaction accuracy among the target group who received cognitive awareness training, the results were in fact, not statistically significant. The experiment was hampered by the longitudinal design because of the turnover within the total population over the seven months of the program. This created smaller samples sizes of the sub-populations than expected. Future experiments should account for this by either expanding the population sample size, shortening the duration of the study, or both. A larger sample size may offer stronger statistical significance that more clearly supports or refutes the hypotheses offered in this study.

Practitioners should continue to explore ways where they can advance their agent populations' awareness of cognitive abilities and the positive impact of these behaviors on performance.

This research contributes to the growing body of work of two existing research domains; inattentional blindness and error management culture. Researchers should continue to investigate the impact of cognitive awareness training protocols on performance, along with the interrelated effects of error management culture and evaluation techniques as proposed by the ACE construct.

CHAPTER EIGHT:

APPENDIX: DEFINITION OF A TRANSACTION

For readers who are unfamiliar with the world of transaction processing in financial services, the key concept to understand is “variability.” While the nature of the work may seem like a simplistic data entry process, it’s not. The realm of financial services is dictated by multiple federal, state, and industry regulations, in addition to each financial institution’s proprietary business rules.

What is permissible for one client, may not be permissible for another, given their state of residence. Additionally, different account registrations require the application of different rules. A transaction for an individually owned account will be different than a joint ownership established under Joint Tenants with Rights of Survivorship, which is different than Joint Tenants in Common, which is different for assets owned by a Trust registration, Corporate Registration, Qualified Retirement Plan and Non-Qualified Retirement Plan registration, and so on. Add in an additional layer of complexity due to the nature of the assets being transacted (i.e., an open-end Mutual Fund, Exchange Traded Mutual Fund, a Closed-End Mutual Fund, and individual corporate stock, a municipal, government, foreign, or corporate bond, etc.) and the degrees of variability are astounding.

For the purposes of this study and experiment, a transaction is defined as;

“The act of an agent interpreting written instructions from a client, evaluating the instructions for accuracy and authenticity, applying appropriate business rules, entering data into a system of record such that the client’s transaction is processed.”

Examples of the types of transactions are generally divided into two primary categories; Financial and Non-Financial. Regulations require that most Financial transactions must be completed same-day of receipt (due to the constant movement of valuations in the open markets), while Non-Financial transactions may be completed within several days of receipt.

Examples of Financial transactions include, but are not limited to; purchase of asset shares, redemption or sales of asset shares, permissible contributions into qualified retirement plans, permissible distributions from qualified retirement plans, transfer of ownership of assets between two distinct registrations, exchange of assets between identically registered accounts, transfer of assets between two distinct financial services institutions, establishing or modifying systematic reoccurring financial transactions (such as automatic purchase of sale of a specific dollar amount into/from the same asset, or the systematic rebalancing of an entire portfolio to maintain a specific ratio of portfolio asset composition), and tax-efficient transactions (transactions designed to minimize the tax consequences of certain portfolio holdings.)

Examples of Non-Financial transactions include, but are not limited to; account set-up, addition or maintenance of personal information (such as name, address, beneficiary changes, etc.), establishing services (such as on-line trading authorization, trading privileges, linking of bank accounts to facilitate money movement, etc.), various demographic information (such as on-line passwords and User Names, phone numbers,

e-mail addresses, etc.), and regulatory oversight requirements (such as Patriot Act, Anti-Money Laundering checks, Abandon Property rights and escheatment).

Lastly, there's the transaction processing environment. For my experiment, I was able to observe CAT Financial's operating environment – the environment used by agents in their daily work – but I have also been able to observe the same environment in four other US Financial Services firms. In general, agent work queues are driven by one system. Work queue systems generally image and categorize work requests so that agents can access them on their desktop across multiple locations. Certainly, this was also the case with CAT Financial.

Additionally, there are recordkeeping systems where the transactions are completed and where the associated client account and portfolio records reside. Depending on the type of registration or security being processed, agents may need to navigate between one and three different systems to complete certain transactions. Then, there's the application of a set knowledge base. Firms like CAT Financial have automated their knowledge base so that agents can more easily access procedure guides and business rules to help them navigate the complex landscape of financial services. Other firms still rely on paper manuals, notes and memos to maintain compliance with appropriate business rules and regulations.

Throughout all of this, agents must seamlessly tie these various input sources together (work image, system of record, knowledge base) to complete each transaction. While some transactions "look" identical to one another, there are often minute differences that need to be accounted for in each and every transaction. To that end,

agents who assume they know what they're doing are more at risk of missing important details that could mean the difference between getting it right and getting it wrong.

Given the complexity of this landscape, its easy to understand why human agents are still required for processing many financial service transactions. Although companies, like CAT Financial, have automated upwards of 90% of their transaction volume, there still remains a critical and complex maze of transactions that require human intervention. As computing technology advances, and artificial intelligence becomes more accessible, transactions will continue to become more automated and less dependent on humans. For the immediate and foreseeable future, firms will continue to be reliant on talented human agents to complete the daily volume of financial services transactions that their clients depend on.

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