Reinforcing Upward Spiral Inspiration for Technology Acceptance: A NeuroIS Fuzzy Statistical Structured Equation Approach to Improve Software Training Results by Harnessing Natural Neuro-Physiological Steroid Performance Enhancement Hormones

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This paper addresses the problem of predicting inspiration utilizing an upward spiraling inspiration model for technology acceptance. Monitoring of cortisol levels provided feedback for a decision support system that measured errors and elapsed time for training tasks completed by end-users of a health care application. The training success was measured utilizing statistics, SEM and a Fuzzy approach. The predictive model was implemented by comparing the regression, fuzzy logic and SEM results. Data collected from 338 health care workers were used to test a proposed model that inspiration, memory, and inspirational memory affect end user intention to adopt a digitized patient record software application. Structural equation modeling showed that, as expected, inspiration affected the individual behavior of the end users. Inspiration had an interactive impact through memory on collective acceptance of the technology, thereby affecting subsequent evaluations and behavior. The proposed model was nomologically validated through the use of a portable platform loaded with software for the electronic collection of operational-level health care data. Embedded metrics measured participants' memory as operationalized by task completion time, number of errors, and completeness of the data. In order to triangulate the results, salivary cortisol levels collected from 74health care workers were used to measure whether inspiration improves memory and affects end user intention to adopt the application through reduced errors and decreased completion times. NeuroIS is a relatively new approach for studying training (Leger et al: forthcoming). To this point, most research revolving around end user beliefs have been purely behavioral (Ortiz de Guinea, Titah and Léger: forthcoming). However recent studies have begun to utilize biosignal, and neuro-physiological approaches to study these effects (Randolph, Borders and Loe: 2013). Even factors such as the impact of emotion upon training success are being reexamined from a NeuroIS perspective (Leger, Reidl & vom Broche: forthcoming). It is with this pioneering spirit that a group of end-users are examined from multiple perspectives ranging from behavioral to physiological, in this paper. Statistical, SEM and Fuzzy approaches are examined and used to triangulate the data. Charnes, Cooper, and Rhodes (1978) introduced the idea of comparing efficiencies of different decision-making units. We use three techniques in this study. The first utilizes the fuzzy technique to determine cortisol and inspiration levels as measured by time and errors. Bhaskar, Pal, and Pal (2011) used a heuristic method for a resource-constrained project scheduling problem with fuzzy activity times that we adapt to determine whether an increase in cortisol levels leads to decreases in errors and decreases in time to complete training tasks with a corresponding increase in inspiration in a reinforcing and an upward spiraling manner. The second is statistical approach utilizing regression and descriptive insights. The third is the SEM, which has been used in the past to predict behavioral perspectives. The present paper contributes to the literature by proposing a model that takes into account the roles of inspiration, physical measures of memory (i.e., time to complete a script and number of errors), and the measurement of salivary levels of Cortisol. This pilot study is exploratory and investigates the feasibility of a framework to show that the stimulus in question could actually manipulate inspiration and memory. Therefore, we conducted a study to test end user salivary Cortisol levels as a surrogate for end user acceptance of a medical software package that facilitated the digitization of electronic health records. Users evaluated their intention to use the technology based on the TAM model. TAM is often used to obtain user evaluations of information technologies. The assumption is that "users will give evaluations based on the extent to which systems meet their needs and abilities" (Davis 1989). For the purpose of our study, we define user evaluations as user perceptions of the ease of use and perceived usefulness of the medical modules based on their ability to complete tasks in a timely and reduced error environment. Our model is as follows and the hypotheses follow from the model: Inspiration → increased salivary cortisol → increased memory → decreased errors and time → better perceptions. Participants were 74 end users from around the nation. Participants' mean age was 39.61 years (SD = 1.24). They included medical doctors (46.8 percent), nurses (25.7 percent), ancillary service personnel (17.8 percent), and health care staff (9.7 percent). Participants were not biased toward either gender and were asked not to drink any fluids during the training. The participants voluntarily agreed to the training at a major international medical conference. Thirty-seven of the participants were randomly selected for the control group and 37 in the treatment group and placed in separate rooms. All 74 participants were given a baseline salivary Cortisol swab at 9:00 am as a pretest. Then the treatment group viewed the "I'm an IBMer. Let's build a smarter planet" video clip and listened to an inspirational speech on how the handheld technology could be used to improve patient care through decreased time and errors. Trainers gave sufficient training to enable participants to operate and evaluate the modules.

The training program included instruction, handouts, and hands-on training with the modules on handheld devices. A customized training application was installed on each device, and the instructors guided the users in working with it to learn how to operate the equipment and modules. Both groups were tested for salivary cortisol as a baseline and upon completion of the tasks and TAM survey. The instructors ensured that all users were thoroughly familiar with the equipment, modules, and objectives of the study before they participated in the evaluation. The instructors taught the users how to operate the device and module controls, enabling them to follow the steps of operation from startup to shut down. The users also learned the steps that they would be asked to follow during the evaluation, including entering data into the modules according to scenarios developed by us. When training concluded, the users were able to switch on the devices, open the modules, enter data according to scenario test scripts, print the form associated with the scenario, close the modules, and switch off the devices. Throughout the process, personnel familiar with the modules and scripts were on hand to provide support and answer questions. After successful completion of training, participants completed four scripts using the medical software modules. The scripts guided the users through the process of completing medical forms. Code embedded in the software captured date/time metrics regarding the length of time it took users to enter data associated with each form. After users completed a script, they printed the applicable forms using wireless printers supplied by us. Upon conclusion of the field testing a posttest salivary Cortisol sample was taken from both groups. The personnel collected the devices installed with the medical modules. We reviewed and analyzed the date/time metrics collected by the embedded code. We calculated and report here descriptive statistics for each script as well as data on the completeness and accuracy of the forms. Descriptive statistics were initially run in order to establish the distribution of the data and whether parametric or nonparametric methods are suitable for analysis. Given the limitations in the application of linear regression, it is likely that fuzzy logic approaches can be applied to the upward spiraling inspirational model to predict the error and time metrics. For example, fuzzy logic rules can be established for such continuous variables as cortisol level, time elapsed and errors made.

The current study makes several contributions to the literature. First, it is the first generalizable, national survey to attempt to experimentally manipulate inspiration and its effect on intention to use technology and on memory through measurements of salivary cortisol. Second, it reveals that when end users in the treatment group reported changes in inspiration, they also had improved memory and concentration to complete test scripts in a more timely and accurate manner than end users in the control group. Third, to our knowledge this is the first study of the impact of inspiration on memory (as measured by time to complete a script and number of errors in the script) in a sample of technology end users and the first study to measure their interaction. Also, this was the first attempt to measure intention to use technology with a method other than perceptual surveys. The model presented here is unique because it incorporates inspiration into the TAM model to measure its effect on intention to use technology. We adapted the TAM model to develop an instrument for obtaining user evaluations of medical modules used after hearing an inspiring video clip and invigorating speech. The results showed that treatment group had increased cortisol levels, improved memory, and greater intention to use with fewer errors made and a shorter task completion time relative to the control group. We postulate that inspiration was the major factor that affected overall intention to use the software modules and was responsible for participants' increased perceptions that the applications were easy to use and useful, that the applications satisfied their needs, and that they felt inspired to use the applications. The results of the survey showed that study participants were satisfied that the modules performed most data collection functions very well. Participants also indicated that the modules could be useful tools for collecting and disseminating data and would allow users to obtain, evaluate, and present information more efficiently than with previous methods. Overall, participants indicated that the medical modules had significant potential utility for digital data collection. Furthermore, the results showed that the video clip successfully inspired and motivated the end users. As expected, participants reported significant increases in inspiration and intention to use the technology after viewing the inspiring clip. What makes a stimulus inspiring is its "perceived intrinsic value" rather than its reward value. If a person perceives a stimulus as inspiring, this will increase his or her motivation to know, accomplish, or experience. In this study, participants were open to the stimulus (i.e., the inspirational speech and video clip), which increased their motivation to accept the technology in question. Based on these results, we conclude that participants found value in the stimulating video clip as reflected by the fit of inspiration into the TAM. Finally, not only did the inspirational speech increase end user inspiration, but this then facilitated increases in memory as measured by decreases in time to complete the script and number of errors in the script and increased salivary cortisol levels. This study suggests several potential avenues for future research. First, future research needs to examine populations other than medical technology end users to determine the consequences of inspiration among these populations. Moreover, individual differences due to gender or personality traits may have different effects on inspiration and motivation. Because different personality traits are correlated with inspiration, understanding individual differences can help researchers better understand inspiration. Second, researchers should examine the consequences of change in inspiration in end users to clarify the role of inspiration versus motivation in technology acceptance. Future research should also test whether the antecedents of inspiration lead to increased inspiration. Third, simple memory experiments could be performed to determine whether inspiration leads to performance gains. Fourth, the role of administrators in this area should be studied. Fifth, researchers need to determine whether inspiration leads to absorption, creativity, and optimism, constructs with which it is correlated. If inspiration can indeed increase an end user's focus (i.e., absorption) or influence the end user to be creative, then it may facilitate better performance. Social-contextual influences may also increase inspiration and affect motivation, as it is well documented that such influences help facilitate autonomy, relatedness, and competence. Sixth, the field would benefit from more robust, larger measures of salivary cortisol that include attitude, social norms, perceived behavior control, facilitating conditions, motivation, memory, inspiration, and their interactions. Studying interactions between time and errors and all of the inspiration variables may provide more insights into inspired memory. Finally, positron emission tomography and other neuroscience imaging tools could be used to study the effects of inspiration and memory on intention. Inspirational memory forms a bridge between social and cognitive psychology and paves the way to neuro-information systems. It affects intention to use both emotionally (through idea inception from the inspiration) and physically (by improving memory through reduced time to complete a training script and reduced number of errors on the script). The next step in the progression of this research should be to measure brainwaves using positron emission tomography and other imaging tools. We used fuzzy logic to develop a cortisol membership function that could be used to find the subsequent optimal inspiration level to decrease errors and elapsed time, for a task software application training exercise. We demonstrated that the cortisol levels provide a good estimate through the fuzzy system to identify inspiration feedback as an effective method of reducing errors and time. We tested our fuzzy logic system and compared the results to actual outputs from the cortisol and SEM experiments. We found that a cortisol level of 5 μg/dL corresponded with many errors and slow time to completion. Similarly, a cortisol level of 40 μg/dL demonstrated no errors and a fast time to complete the assigned task. The present research began in 2008 with the aim of exploring the use of a portable platform for the electronic collection of operational-level medical information at the point of care. We found that the use of an inspirational stimulus increased end user memory through fewer errors on the devices and less time to complete a task while enhancing intention to use the technology and increasing salivary cortisol levels. Thus, the modules used in this study show promise for improving patient care through increased accuracy of data and decreased errors resulting from transcription. The use of these modules on a handheld device would also increase flexibility in data collection during fieldwork. Our software team is currently using participant feedback and end user data to make improvements to the modules. The present results suggest that inspiration may be a particularly salient construct in the domain of technology acceptance. However, more research is necessary. Managers need to know how to increase autonomy among end users, because this will result in end users having a better experience and being more likely to adhere to tough and demanding training programs. Inspiration is a new and little known variable that warrants future research because of its link to performance gains and positive emotions both inside and out of the technology acceptance context. In addition, other salivary components, such as epinephrine, should be explored as a consequence of inspiration on memory and intention to use technology. The management information systems community needs to move away from predominantly survey-based methodologies to more scientific methods of measuring end users' true intent to adopt technology if progress is to be made in this area of research. The triangulation of the SEM model, the regression model, and the salivary cortisol model supports the TAM model. The end users perceptually rated the software application favorably in terms of its perceived ease of use, perceived usefulness, and use. The SEM model provides evidence that inspiration is a latent factor that effects use and memory. The salivary cortisol measurements lend credence to the contention that inspiration increased end user memory by decreasing errors and time to completion in training scripts. In summary, men and women from a medical conference session on a healthcare software application demonstration gave saliva samples before and after training. For both men and women, an inspirational video substantially increased saliva cortisol compared to the control group. Participants were asked to fill to a 5 ml line marked on the side. This procedure was repeated immediately after the end of the training so that samples were received within 15 min after training completion. Samples were stored at approximately -20 degrees C within 30 min after collection and the frozen samples were later sent to the lab for processing. Test volumes were 25 μl. Statistics showed that inspiration from software trainers affected individual behavior. Inspiration had an impact, through memory, on acceptance of the technology. The cortisol levels of 37 "inspired" end users were measured and compared to those of a control group (n = 37). The inspired group demonstrated a 15% increase in baseline salivary cortisol levels. Inspiration is a key driver that improves memory to affect end user intention to use.