Proceedings
Gmunden Retreat on NeuroIS 2013

Gmunden, Austria | June 1-4, 2013 | www.NeuroIS.org

Fred Davis, René Riedl, Jan vom Brocke,
Pierre-Majorique Léger, Adriane Randolph
(Eds.)

Gmunden Retreat on NeuroIS 2013
— Keynotes —

Gmunden, Austria | June 1-4, 2013 | www.NeuroIS.org

Fred Davis, René Riedl, Jan vom Brocke, Pierre-Majorique Léger, Adriane Randolph
(Organizing Committee)

June 3

11:00-12:30 **Keynote Speech I**

New Developments in NeuroIS:
The Power of the Genes

Martin Reuter

Head of Differential and Biological Psychology
Director of the Center for Economics and Neuroscience
University of Bonn, Germany

The new scientific discipline of NeuroIS enriches classical IS research by a neurobiological perspective. Frequently used imaging techniques (e.g., fMRI) are limited to experimental conditions that lack ecological validity, a shortcoming that is to a lesser extent also true for physiological measures such as GSR or ECG. The use of a genetic approach in NeuroIS research does hardly exist, although this technique allows conducting IS research in realistic environments. Moreover, genetic information disentangles environmental from hereditary influences and even provides information on central nervous mechanisms. Besides a brief introduction into the molecular genetic approach, examples from empirical genetic NeuroIS research are presented. The studies deal with technostress (i.e., stress induced by disturbed human-computer interaction), the prediction of technology acceptance by genetic markers, and the biological basis of Internet addiction. An outlook is given on the possibilities and limitations of using the genetic approach in the context of NeuroIS research.

June 4

9:00-10:30 **Keynote Speech II**

Embedding Brain-Computer Interfacing (BCI)
Research in Human-Computer Interaction
Using BCI Games

Anton Nijholt

Professor in the Human Media Interaction research group of the University of Twente, The Netherlands

Brain-computer interfacing has become a topic of interest for computer scientists and in particular human-computer interaction (HCI) researchers. They are looking for applications that add the brain-activity modality to other multi-modal ways of interacting with 'computers'. That is, a modality that can be added to the usual mouse and keyboard control of applications. But, also a modality that can be added to existing ideas about sensor-equipped environments and devices that also take as input information obtained from auditory, visual, tactile and physiological sensors. We review and discuss possibilities (and limitations) of brain-computer interfacing in HCI by looking at possibilities of on-line control of entertainment applications and on-line adaptation of an application based on a user's brain activity. In the presentation we will give some examples of our research on entertaining brain-computer interface applications and future applications that require collaborative and synchronized brain activity from several users or gamers.

Mouse vs. Finger as Input Device: Does it Influence Information Memorization?

Sylvain Sénécal, HEC Montréal, Pierre-Majorique Léger, HEC Montréal, Marc Fredette, HEC Montréal, François Courtemanche, HEC Montréal, Ann-Frances Cameron, HEC Montréal, Seyedmohammadmahdi Mirhoseini, HEC Montréal, Arnaud Paquet, HEC Montréal, René Riedl, University of Applied Sciences Upper Austria & University of Linz

Corresponding author: ss@hec.ca

The main objective of this research in-progress is to investigate how characteristics of input devices influence users' information memorization. Although the computer mouse is still a very popular input device (Taveira and Choi 2009), the growing popularity of tablets and smartphones promotes a different type of input device, namely touch screens.

Based on prior research in human-computer interaction and neuroscience, we investigate the extent to which the nature of the input device has an influence on users' experience, thereby also affecting their information encoding and memorization. According to Taveira and Choi (2009, p. 458), input devices "sense physical properties of the user (e.g., motions, touch, voice) and convert them into predefined signals to the computer." Input devices can be categorized as either direct (e.g., touch screen) or indirect (e.g., mouse) (Rogers et al. 2005). Direct input devices such as touch screens require the user to interact with the target object by virtually touching it with the finger(s).

Dijkerman and de Haan (2007) suggest that the somatosensory system is central to our understanding of touch and that different neural correlates are involved depending on the touch intention pursued (action-related vs. recognition and memory) and the stimuli (internal: body-related vs. object-related). For instance, the posterial parietal cortex (PPC) is suggested to be involved in exploratory object-related hand movement, while both the PPC and the insula are suggested to be involved in tactile object recognition (Dijkerman and de Haan, 2007). Research suggests that the brain areas used for processing different types of information are similar to the areas used for storing the information (Fiehler et al, 2007). For instance, PPC and insula are activated for retrieving the haptic information. Pasternak and Greenlee (2005) suggested that this haptic information can be used for recognition tasks.

We build upon prior research on the somatosensory system (tactile information processing) to argue that a touch input device will involve more cognitive and motor skills components than an indirect input device, leading to a richer information encoding and consequently to better information retrieval from memory. Our main hypothesis posits that there is a relationship between the type of input device used to perform a task and the information memorization of the task stimuli. Specifically, a direct input device facilitates information memorization.

In order to test this hypothesis, a one factor between-subject experimental study will be performed. Participants will be randomly assigned to either a "touch" or "mouse" input device condition. In each condition, participants will be asked to perform multiple product choices between two competing products, either using a touch screen or a mouse to interact with the products (images, characteristics, fictitious brand names, and logos). Following their product choices, participants will be asked to complete a brand recognition task. Using an Event-Related Potential (ERP) technique, participants will be randomly exposed to a set of brands to which they were exposed during their product choice task and a set of fictitious brands to which they were never exposed. Participants will be ask to indicate if they recognize the brands (yes, no). During the ERP task, neural activities will be recorded continuously from 32 electrodes using EGI's dense array electroencephalography (dEEG). A wavelet analysis of the ERP data will be done to compare the two groups. We expect that the touch condition is likely to generate a P300 with a higher amplitude and shorter peak latency due to the recognition of the somatosensory stimuli. The experiment will be conducted at HEC Montreal's Tech^{3}Lab. We plan to present preliminary results at the Gmunden Retreat.

To the best of our knowledge, no research has investigated how input devices influence information memorizarion. Thus, the proposed study contributes to theory development in information systems research and human-computer interaction. Furthermore, the proposed research sheds light on underlying neural mechanism explaining the relationship between input device and information memorization.

References

- Dijkerman, H. C., & de Haan, E. H. (2007). Somatosensory processing subserving perception and action: Dissociations, interactions, and integration. *Behavioral and Brain Sciences*, (30:2), pp. 224-230.
- Rogers, W. A., A. D. Fisk, et al. 2005. "Touch a Screen or Turn a Knob: Choosing the Best Device for the Job," *Human Factors*, (47:2), pp. 271-288.
- Taveira, A. D., & Choi, S. D. (2009). Review study of computer input devices and older users. *International Journal of Human-Computer Interaction*, (25:5), pp. 455-474.
- Fiehler, K., Engel, A., & Rosler, F. (2007). Where are somatosensory representations stored and reactivated? *Behavioral and Brain Sciences*, (30:2), 206-206.
- Pasternak, T., & Greenlee, M. W. (2005). Working memory in primate sensory systems. *Nature Reviews Neuroscience*, (6:2), 97-107.

Mobile Recommendation Agents Making Online Use of Visual Attention Information at the Point of Sale

Thies Pfeiffer, Bielefeld Univ., Jella Pfeiffer, J. G. Univ. Mainz, Martin Meißner, Bielefeld Univ.

Corresponding author: tpfeiffe@techfak.uni-bielefeld.de

We aim to utilize online information about visual attention for developing mobile recommendation agents (RAs) for use at the point of sale. Up to now, most RAs are focussed exclusively at personalization in an e-commerce setting. Very little is known, however, about mobile RAs that offer information and assistance at the point of sale based on individual-level feature based preference models (Murray and Häubl 2009).

Current attempts provide information about products at the point of sale by manually scanning barcodes or using RFID (Kowatsch et al. 2011, Heijden 2005), e.g. using specific apps for smartphones. We argue that an online access to the current visual attention of the user offers a much larger potential. Integrating mobile eye tracking into ordinary glasses would yield a direct benefit of applying neuroscience methods in the user's everyday life. First, learning from consumers' attentional processes over time and adapting recommendations based on this learning allows us to provide very accurate and relevant recommendations, potentially increasing the perceived usefulness. Second, our proposed system needs little explicit user input (no scanning or navigation on screen) making it easy to use. Thus, instead of learning from click behaviour and past customer ratings, as it is the case in the e-commerce setting, the mobile RA learns from eye movements by participating online in every day decision processes.

We argue that mobile RAs should be built based on current research in human judgment and decision making (Murray et al. 2010). In our project, we therefore follow a two-step approach: In the empirical basic research stream, we aim to understand the user's interaction with the product shelf: the actions and patterns of user's behaviour (eye movements, gestures, approaching a product closer) and their correspondence to the user's informational needs. In the empirical system development stream, we create prototypes of mobile RAs and test experimentally the factors that influence the user's adoption. For example, we suggest that a user's involvement in the process, such as a need for exact nutritional information or for assistance (e.g., reading support for elderly) will influence the user's intention to use such as system.

The experiments are conducted both in our immersive virtual reality supermarket presented in a CAVE, where we can also easily display information to the user and track the eye movement in great accuracy, as well as in real-world supermarkets (see Figure 1), so that the findings can be better generalized to natural decision situations (Gidlöf et al. 2013).

In a first pilot study with five randomly chosen participants in a supermarket, we evaluated which sort of mobile RAs consumers favour in order to get a first impression of the user's acceptance of the technology. Figure 1 shows an excerpt of one consumer's eye movements during a decision process. First results show long eye cascades and short fixations on many products in situations where users are uncertain and in need for support. Furthermore, we find a surprising acceptance of the technology itself throughout all ages (23 – 61 years). At the same time, consumers express serious fear of being manipulated by such a technology. For that reason, they strongly prefer the information to be provided by trusted third party or shared with family members and friends (see also Murray and Häubl 2009). Our pilot will be followed by a larger field experiment in March in order to learn more about factors that influence the user's acceptance as well as the eye movement patterns that reflect typical phases of decision processes and indicate the need for support by a RA.

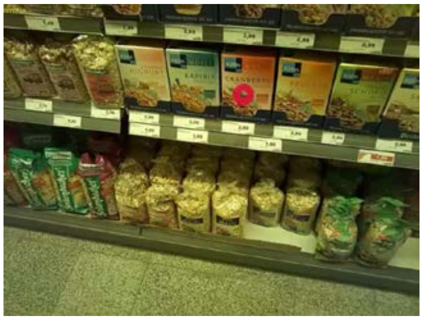

Figure 1. Real-Time Eyetracking at the Point of Sale

REFERENCES

- Gidlöf, K., Wallin, A., Dewhurst, R., and Holmqvist, K. 2013. "Using Eye Tracking to Trace a Cognitive Process: Gaze Behaviour During Decision Making in a Natural Environment," *JEMR* (6:1), pp. 1-14.
- Heijden, H. 2005. "Mobile decision support for in-store purchase decisions," *Decision Support Systems*, 42(2006), pp. 656-663.
- Kowatsch,T., Maass, W., and Fleisch, E. 2011. "The Role of Product Reviews on Mobile Devices for In-store Purchases: Consumers' Usage Intentions, Costs and Store Preferences," *International Journal of Internet Marketing and Advertising* (6:3), pp. 226-243.
- Murray, K.B., Liang, J., and Häubl, G. 2010. "ACT 2.0: The Next Generation of Assistive Consumer Technology Research," *Internet Research* (20:3), pp. 232-254.
- Murray, K.B., and Häubl, G. 2009. "Personalization without Interrogation: Towards More Effective Interactions between Consumers and Feature-based Recommendation Agents," *Journal of Interactive Marketing* (23:2), pp. 138-146.

An Evaluation of Timing and Synchronization among Tobii, Affectiva, and Emotiv Physiological Devices

Nicholas S. Lockwood, Missouri University of Science and Technology
lockwoodn@mst.edu

Timing and synchronization are crucial elements in psychophysiological research, where consecutive data samples may be separated by no more than a millisecond or two. Psychologists and neuroscientists typically combine specialized hardware and software that provide the level of precise integration needed to address their research questions. However, this hardware and software is often expensive and complex to use.

In recent years, physiological recording devices designed for clinical or consumer applications have become more widely available. These devices aim to be inexpensive, easy to use, and/or less intrusive than traditional research equipment. For example, Affectiva's Q Sensor is a wireless device used to record skin conductance, temperature, and motion. A wrist strap and dry electrodes enable the Q Sensor to be worn during normal daily activities, and the battery allows for up to 24 hours of data recording. Another example is Emotiv's EPOC headset, which is an inexpensive wireless electroencephalography (EEG) device. Both of these devices were designed for consumer and assistive applications as well as research.

Such devices may be particularly useful for business and information systems (IS) researchers. Their relative inconspicuousness allows for data collection in settings that more accurately reflect real-world situations. Devices which are less expensive and/or easier to use also increase accessibility to this area of research. For instance, smaller schools and individual researchers may be able to acquire these devices more easily.

For researchers looking to integrate data from multiple physiological recording devices, a key question is how well data from such devices can be synchronized. The purpose of this study is to answer that question with regard to three specific devices: Tobii T60 eye tracker, Affectiva Q Sensor, and Emotiv EPOC headset.

A technical report by Hairston (2012) provided an analysis of timing drift and variability (also known as jitter) among four common EEG systems (one of which was the Emotiv system). In his study, Hairston examined timing differences between a stimulus presentation computer running E-Prime and the data acquisition computer running each EEG system's native software.

The current study extends Hairston's work in three ways: 1) timing drift and jitter are evaluated simultaneously for the three physiological devices previously listed, 2) data are collected over longer periods of time to determine the impact of drift during experiments involving complex tasks or a greater number of trials, and 3) performance of the Emotiv system is compared with Hairston's results to determine whether a newer firmware version improves timing accuracy.

One challenge with testing these devices relates to event recording. While the Tobii and Emotiv systems can read event markers from external devices (e.g., through TTL signals), Q Sensor version 1.0 does not. This version of Q Sensor is self-contained and only records data locally on the device itself. It is necessary to instead simulate event markers in the data through a transistor switch connected to the stimulus computer's parallel port. Figure 1 shows how the systems are connected.

Timestamps from each device are regressed on timestamps from the stimulus computer to determine drift. Means and standard deviations of timestamp differences reflect jitter. Results of the analysis will be presented at the retreat.

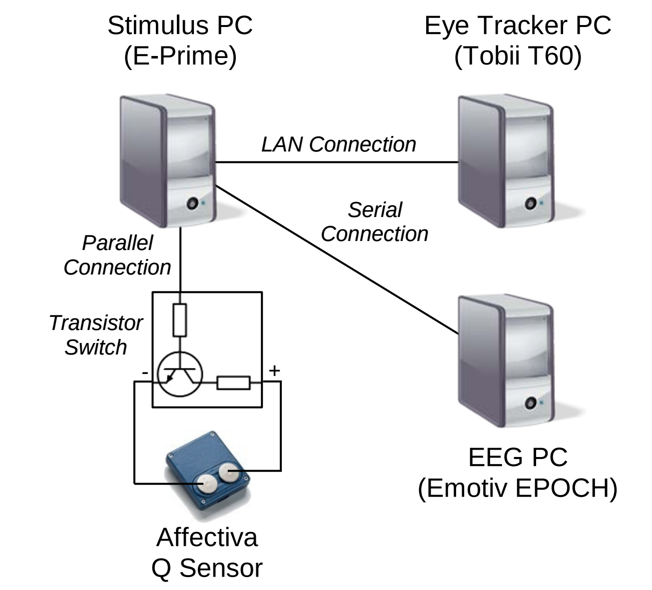

Figure 1. System Connections used for Testing

References

❖ Hairston, W. D. 2012. "Accounting for Timing Drift and Variability in Contemporary Electroencephalography (EEG) Systems," U.S. Army Research Laboratory Technical Report ARL-TR-5945, Aberdeen Proving Ground, MD.

Technostress: Current Knowledge and Directions for Future Research

René Riedl, University of Applied Sciences Upper Austria & University of Linz

rene.riedl@jku.at

Human society has significantly benefited from the adoption of information and communication technologies (ICT). Despite this fact, however, ICT use may also have a "dark side." Human interaction with ICT, but also perceptions, emotions, and thoughts regarding the implementation of enterprise systems and ICT pervasiveness in society in general, may result in considerable stress perceptions—a type of stress referred to as *technostress* (TS). Analysis of the information systems (IS) literature reveals that TS is a topic that has gained significant momentum during the past years.

Ragu-Nathan et al. (2008), for example, studied the influence of TS on job satisfaction, commitment to the organization, and intention to stay. The results of this study show that TS inhibitors (e.g., technical support provision) increase job satisfaction, as well as organizational and continuance commitment. Moreover, the results indicate that demographic variables could significantly affect TS perceptions (e.g., younger users perceive more TS than older ones). In another paper, Tarafdar et al. (2007) investigated the influence of TS on role stress and individual productivity. It was hypothesized that TS would be negatively correlated with individual productivity, role stress would be negatively correlated with individual productivity, and TS would be positively correlated with role stress. Other IS studies revealed further significant insights into the TS phenomenon; see, for example, investigations by Ayyagari et al. (2011) and Tarafdar et al. (2010, 2011).

Despite the significant value of prior IS research on TS, analysis of the corresponding literature reveals a significant research gap: The phenomenon has hardly been addressed from a biological perspective. This is problematic, because biology not only provides objective stress measurements, but also predicts human behavior toward ICT. Moreover, biological measures (e.g., levels of stress hormones such as adrenaline and cortisol) are crucial predictors of human health, making them an important complement to self-reports on stress perceptions (Riedl et al. 2012).

Against this background, and with the goal of developing a "big-picture" view of TS and biology, I recently published an article entitled "On the Biology of Technostress: Literature Review and Research Agenda" (Riedl 2013). This paper reviews the TS research based on biological approaches that has been published in various scientific disciplines (e.g., human-computer interaction, medicine, biological psychology).

In the presentation, I discuss the major findings of this study. For example, regarding the four biological levels of analysis in stress research (see Figure 1), the study found that an imbalance in research intensity exists—while the levels of the autonomic and somatic nervous systems and the endocrinological system have been examined intensively, TS research related to the genetic system and the central nervous system (in particular the brain) hardly exists. Based on this analysis, in the talk I also present important aspects of the research agenda, which was developed with the goal of providing ideas for future research projects.

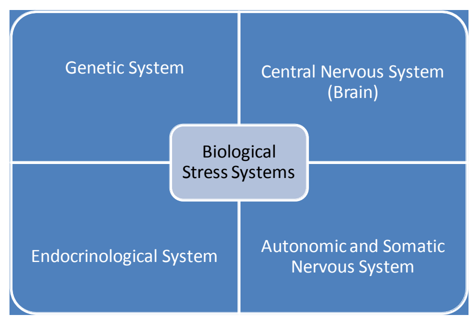

Figure 1. Biological Stress Systems

References

- Ayyagari R., Grover, V., and Purvis, R. 2011. "Technostress: Technological Antecedents and Implications," *MIS Quarterly* (35:4), pp. 831-858.
- Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan B.S., and Tu, Q. 2008. "The Consequences of Technostress for End Users in Organizations: Conceptual Development and Empirical Validation," *Information Systems Research* (19:4), pp. 417-433.
- Riedl, R. 2013. "On the Biology of Technostress: Literature Review and Research Agenda," *DATA BASE for Advances in Information Systems* (44:1), pp. 18-55.
- Riedl, R., Kindermann, H., Auinger, A., and Javor, A. 2012. "Technostress from a Neurobiological Perspective: System Breakdown Increases the Stress Hormone Cortisol in Computer Users," *Business & Information Systems Engineering* (4:2), pp. 61-69.
- Tarafdar, M., Tu, Q., and Ragu-Nathan, T.S. and Ragu-Nathan, B.S. 2007. "The Impact of Technostress on Role Stress and Productivity," *Journal of Management Information Systems* (24:1), pp. 301-328.
- Tarafdar, M., Tu, Q., and Ragu-Nathan, T.S. 2010. "Impact of Technostress on End-User Satisfaction and Performance," *Journal of Management Information Systems* (27:3), pp. 303-334.
- Tarafdar, M., Tu, Q. and Ragu-Nathan, T.S. and Ragu-Nathan, B.S. 2011. "Crossing to the Dark Side: Examining Creators, Outcomes, and Inhibitors of Technostress," *Communications of the ACM* (54:9), pp. 113-120.

NeuroIS Measures of Technostress: On the Use of α-Amylase as an Alternative to Cortisol

Stefan Tams, HEC Montréal
stefan.tams@hec.ca

Recent IS research has called for investigating the physiological factors underlying IT-related human behavior (Dimoka et al. 2011, 2012; Riedl et al. 2010). Such an investigation may be particularly useful in the context of technostress, an emerging phenomenon of strong practical significance (e.g., Dimoka et al. 2012; Riedl 2013), because stress can be found in both the human mind and the human body (Cooper et al. 2001). Yet, while the job stress literature has long recognized the potential of such biological measures as cortisol to complement psychological ones (i.e., self-reports) (Cooper et al. 2001), technostress research is slow in its adoption of biological measures. Only one published study to date (Riedl et al. 2012) has examined technostress from a biological perspective by measuring – largely consistent with the job stress literature – cortisol in saliva. This nascence of technostress research employing biological measures can perhaps be explained with the fact that the most widely known hormone in stress research (i.e., cortisol) peaks relatively late, about 20 minutes poststressor (Granger et al. 2007), a characteristic that may create logistical issues when studying stressful technological events in laboratory settings. However, besides cortisol, there are other important stress hormones such as adrenaline, which has only recently been approximated through the salivary stress enzyme α-amylase (sAA) (Granger et al. 2007). sAA is a marker of the sympathetic nervous system component of the psychobiology of stress and, as such, reflects changes in adrenaline. In contrast to cortisol, sAA peaks much faster (usually within 5 minutes poststressor), implying that its collection may entail a lower logistical burden than that of cortisol. Hence, sAA has become prominent as a cutting-edge measure of stress in biobehavioral research (Granger et al. 2007). The objective of the present paper is to explore *whether sAA may also be useful for research on technostress*.

Salivary α-amylase, which is officially classified as family 13 of the glycosyl hydrolases, reacts to both physical and psychological stressors (Granger et al. 2007). The latter characteristic renders it useful for research on technostress since such research has been informed by both biological and psychological theories to justify proposed relationships (e.g., Ayyagari et al. 2011; Riedl et al. 2012). Additionally, sAA can be collected non-invasively (Tams 2011), rendering it useful for research on technostress since the data collection itself does not create an alternative explanation for stress effects. Further, the amount of α-amylase in the saliva captured can easily be assessed by shipping the samples in a frozen condition to assay companies, such as the Center for Interdisciplinary Salivary Bioscience Research at Johns Hopkins University. These companies return a MS Excel file containing the α-amylase concentration per subject to the researcher, who can, then, directly import the data into statistical software packages. Thus, assessing the concentration of α-amylase in saliva is practical for technostress researchers, who most often do not have direct access to an assay lab.

Due to its useful properties, sAA has recently been employed successfully in technostress research. An early study by Tams (2011) used psychological theories complemented with biological concepts to hypothesize relationships among technological stressors, stress, performance, and related cognitive concepts. He evaluated his model using a lab experiment that integrated a memory task with the collection of sAA and other measures, and he found that sAA was predicted by stress-related psychological concepts and that it, in turn, predicted performance on the memory task. Hence, sAA constitutes a viable alternative to cortisol in technostress research for experiments requiring short-interval or repeated measurement points and simplified logistics.

References

- Ayyagari, R., Grover, V., and Purvis, R. L. 2011. "Technostress: Technol. antecedents and implications," *MIS Quarterly* (35:4), 831-858.
- Cooper, C. L., Dewe, P. J., and O'Driscoll, M. P. 2001. "*Organizational stress: A review and critique of theory, research, and applications*," Thousand Oaks, US: Sage Publications, Inc.
- Dimoka, A., Banker, R.D., Benbasat, I., and Davis, F.D. et al. 2012. "On the Use of Neurophysiological Tools in IS Research: Developing a Research Agenda for NeuroIS," *MIS Quarterly* (36:3), 679-702.
- Dimoka, A., Pavlou, P.A., and Davis, F. 2011. "NeuroIS: The Potential of Cognitive Neuroscience for Information Systems Research," *Information Systems Research* (22:4), 687–702.
- Granger, D. A., Kivlighan, K. T., El-Sheikh, M., Gordis, E. B., and Stroud, L. R. 2007. "Salivary alpha-amylase in biobehavioral research: Recent developments and applications," *Annals of the New York Academy of Sciences* Vol. 1098, pages 122–144.
- Riedl, R. 2013. "On the Biology of Technostress: Literature Review and Research Agenda," *DATA BASE for Advances in Information Systems* (44:1), 18-55.
- Riedl, R., Banker, R., Benbasat, I., Davis, F.D., Dennis, A., Dimoka, A., Gefen, D., Gupta, A., Ischebek, A., Kenning, P., Pavlou, P.A., Muller-Putz, G., Straub, D., van Brocke, J., and Weber, B. 2010. "On the Foundations of NeuroIS: Reflections on the Gmunden Retreat 2009," *Communications of the AIS* (27:15), 243-264.
- Riedl, R., Kindermann, H., Auinger, A., Javor, A. 2012. "Technostress from a Neurobiological Perspective," *Business & Information Systems Engineering* (4:2), pp. 61-69.
- Tams, S. 2011. "*The Role of Age in Technology-Induced Workplace Stress*," Unpublished Doctoral Dissertation, Clemson University, USA.

Emotions in Financial Decision Making: The Impact of Media and News Valance

Hong Sheng, Li Li Eng, Nicholas Lockwood, Mansoureh Fazel
Missouri University of Science and Technology

Corresponding author: hsheng@mst.edu

For many years, text-based press releases were the most common medium for publishing a company's financial news. With technological advances, other methods have become available for news announcements. With the increasing popularity of rich multimedia content on the Internet, firms have begun to use online video to explain significant financial news (Elliot et al. 2012). Although video is considered a richer medium and can be utilized to better explain the financial news of a company, it is not known precisely how video might impact investor perceptions and decisions or whether that impact differs for positive vs. negative news.

Research has shown that financial restatements can influence investors' perceptions about a company, which in turn affect their investment decisions. Elliot et al. (2012) find that announcing a financial restatement via online video will more strongly influence investors' judgments and their investment decisions than announcing it via text. While it is expected that good financial news will positively influence investors' decisions and bad news will negatively influence investors' decisions, it is unclear how the valence of the news will interact with the communication medium. Adelaar et al. (2003) suggest that customers who are exposed to video have stronger emotions toward the stimulus than customers who are exposed to plain text. Therefore we expect that the positive or negative emotions elicited by positive or negative financial news, respectively, will be intensified by the video medium. This, in turn, will lead to a relatively greater positive or negative investment decision. The research model is shown in Figure 1.

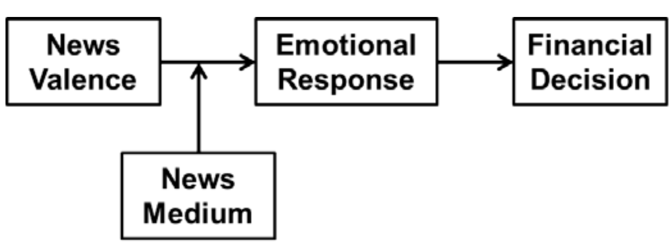

Figure 1. Research Model

In this study, we examine how positive and negative financial news can elicit differing emotional responses and, ultimately, investment decisions when delivered via text vs. video. In our experiment, we manipulated news valence (positive vs. negative) and news medium (text vs. video) in a 2x2 between-subjects design. Participants took on the role of investors and were randomly assigned to one of four conditions in which they received positive or negative financial information about a fictional handbag manufacturer through either text or video. The text news was formatted to resemble a typical corporate press release, and the video news was pre-recorded with an actor in a simulated news studio setting. In order to measure the participants' perceptions toward the company and their investment decision after viewing the news, participants were also asked to complete two sets of surveys before and after viewing the financial news.

Physiological responses were captured during the experiment to measure attention and arousal. These responses included eye gaze and pupil diameter captured using a Tobii T60 eye tracker as well as skin conductance captured using an Affectiva Q-Sensor. Skin conductance and pupil dilation reflect emotional arousal—a key construct in the current research model—and have been examined in previous decision making research (Bradley et al. 2008; Figner and Murphy 2011). Eye gaze is used to examine patterns of attentional focus across conditions. Results of the analysis shed light on the interaction between media and financial information and the impact of this interaction on investor perceptions.

References

- Adelaar, T. Chang, S. Lancendorfer, K.M. Lee, B., and Morimoto, M. 2003. "Effect of Media Formats on Emotions and Impulse Buying Intent," *Journal of Information Technology*, (18:4), pp. 274-266.
- Bradley, M. M., Miccoli, L., Escrig, M. A., and Lang, P. J. 2008. "The Pupil as a Measure of Emotional Arousal and Autonomic Activation," *Psychophysiology* (45:4), pp. 602-607.
- Elliot, W. B., Hodge, F. D., and Sedor, L. M. 2012. "Using Online Video to Announce a Restatement: Influences on Investment Decisions and the Mediating Role of Trust," *The Accounting Review* (87:2), pp. 513-535.
- Figner, B., and Murphy, R. O. 2011. "Using Skin Conductance in Judgment and Decision Making Research," in *A Handbook of Process Tracing Methods for Decision Research*, M. Schulte-Mecklenbeck, A. Kuehberger, and R. Ranyard (eds.), New York, NY: Psychology Press, pp. 163-187.

Methodologies for Analyzing Neurospatial Activation Patterns Associated with Information Retrieval Tasks Conducted on Search Engines

Vincent N. Carrasco, Laboratory of Applied Informatics Research, SILS
Kelly S. Giovanello, Cognitive Neuroscience of Memory Laboratory, Dept of Psychology
Javed Mostafa, Laboratory of Applied Informatics Research, SILS
University of North Carolina at Chapel Hill

Corresponding author: jm@unc.edu

The modern information seeking model, which is based on about 30 years of research, can best be characterized as an iterative process concentrated on fulfilling the Anomalous State of Knowledge (ASK) in which an actor (user) interacts with a resource (database or search engine). The search paradigm process is conceptualized as: ASK → QUERY FORMULATION→ SEARCH→ INTERPRET→ RESULT→ REFINE QUERY→SEARCH (REPEAT).

Information scientists study information seeking in an attempt to discern the cognitive components of this complex dynamic process mainly based on behavior-centric experimental approaches (Belkin 1982). It is not a surprise, therefore, that the general findings remain somewhat subjective based on observation of users and linguistic tools that estimate judgment.

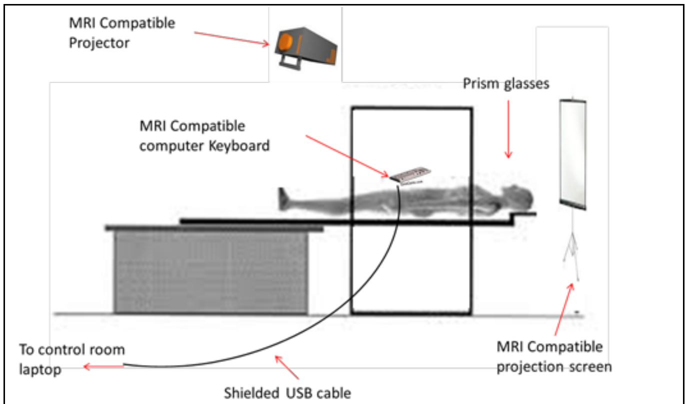

Figure 1. fMRI subject study setting

Functional magnetic resonance imaging (fMRI) is a well-studied non-invasive tool capable of localizing neuronal activation associated with complex cognitive activities in humans (Ogawa 1992). The development of a standardized methodology for identifying neuronal activation patterns associated with information search and retrieval is essential for obtaining consistent accurate results. We wish to identify cognitive neural evidence to explicate the information seeking process by using fMRI. Here we present a broad outline for data capture. The intent is to image the brain during the initiation of an information-seeking epoch. Specifically, the point of conscious recognition of an information need, the retrieval of central lexical representations that form the basis for the semantic conception of that need, and the subsequent translation into the peripheral motor responses required to express the need by typing the query into a search box. The subject will be in a controlled comfortable environment within the imager, viewing an MRI compatible monitor holding an MRI compatible keyboard. They will indicate to the investigators the initiation of a search task while being imaged. The MRI compatible keyboard will be connected, by an appropriately shielded USB cable, to a laptop located in the observation suite. The laptop will share its desktop with an MRI compatible monitor within the viewing range of the subject. The subject will initiate a typed search. The information-seeking epoch will be time logged in synchrony with the fMRI scanning process for later correlation and analysis of images (Wang 2011).

We realize there remains an immense gap between the actual mechanics involved in developing a comfortable procedure for allowing subjects to interact with a search engine while inside an MRI gantry and the voluminous data generated from the scanning process. We present this procedure only as a starting point to encourage discussion for its potential refinement. We envision the panel event to motivate further exchanges on the nature of the data captured and its analysis. If our proposal is accepted, we plan to invite two additional colleagues with established scholarly record in the intersecting areas of cognitive science and information science. We hope an outcome of the forum would be a clearer understanding of the challenges involved in establishing a robust method, as well as a foundation for future interdisciplinary collaborations in NeuroIS.

References

- Belkin, N. J. (n.d.). ASK for Information Retrieval: Part I. Background and Theory. 1982. The Journal of Documentation 38 (2): 61-72.
- Ogawa, S, D W Tank, R Menon, J M Ellermann, S G Kim, H Merkle, and K Ugurbil. 1992. "Intrinsic Signal Changes Accompanying Sensory Stimulation: Functional Brain Mapping with Magnetic Resonance Imaging." *Proceedings of the National Academy of Sciences of the United States of America* 89 (13) (July 1): 5951–5.
- Wang, Jiaping, Hongtu Zhu, Jianqing Fan, Kelly Giovanello, and Weili Lin. 2011. "Adaptively and Spatially Estimating the Hemodynamic Response Functions in fMRI." *Medical Image Computing and Computer-assisted Intervention : MICCAI ... International Conference on Medical Image Computing and Computer-Assisted Intervention* 14 (Pt 2) (January): 269–76.

Emotions in Dynamic Bargaining with Humans and Computer Agents

Marc T. P. Adam, Henner Gimpel, Timm Teubner

Karlsruhe Institute of Technology (KIT)
Corresponding author: marc.adam@kit.edu

Bargaining is prevalent in daily business life. Managers negotiate with employees about wages and bonuses, buyers and sellers haggle over prices and conditions. At that, management decisions today are taken by human beings, not by robots. Consequently, these decisions, and respective humans too, are affected by their emotions. Hence, considerations about one's negotiation partner's intentions, fairness and reciprocity may be as relevant as the bare economic facts and figures. Therefore, we argue that IS research should build on the advances in cognitive neuroscience and harness the potential of NeuroIS tools in the field of economic decision making and management, in particular, negotiation support.

In our study, we investigate the emotions of participants in a structured 3-period alternating offer bargaining process (cf. Rubinstein, 1982) and their impact on economic decision-making. The goal of the negotiation is to find an agreement about the division of a shrinking pie. The study is structured along two dimensions: 1) the type of negation partner (human or computerized), and 2) the discount rate at which the underlying pie decreases each round if no agreement is made (δ = 10% or 90%). Participants were assigned the role of making the initial offer (A) or responding to the initial offer their negotiation partner made (B). Information about roles and discount factor was common knowledge for both negotiation partners. Figure 1 schematically depicts the bargaining process.

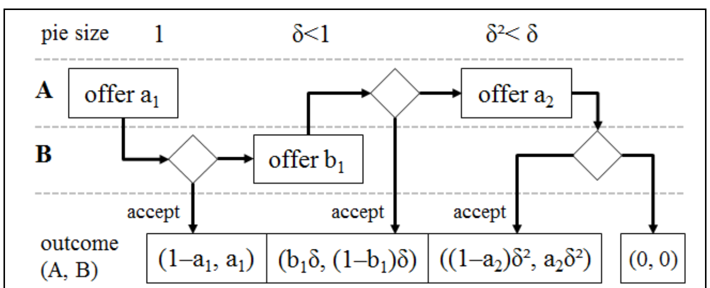

Figure 1. Bargaining Process

Using NeuroIS methodology as described in Dimoka et al. (2010), we measure skin conductance response (SCR), heart rate (HR), and heart rate variability (HRV) of the participants during the entire negotiation process. The physiological measures serve as proxies for emotions and are combined with the negotiation results in order to provide insight into the interplay of decision-making and emotions–particularly arousal–during the process and at discrete events, such as submitting or receiving an offer, and facing an accepting or rejecting answer.

The experiment was conducted at the Karlsruhe Institute of Technology (KIT) in Karlsruhe, Germany in December 2012. In total 216 subjects participated in the experiment. The experiment consisted of two treatments, a computer negotiant (CN) and a human negotiant (HN) treatment. Subjects knew which treatment they were in. Each subject participated in 24 subsequent negotiation processes. After each of these processes, the participants were anonymously and randomly re-matched with another human participant or computer agent, respectively.

Our preliminary results indicate that subjects tend to systematically offer a smaller share of the pie in the first and in the second bargaining round when they face computerized negotiants. This share, however, deviates considerably from the subgame perfect equilibrium and is shifted towards a more equitable allocation. The emotional responses, measured by SCR, are lower when facing computer rather than human counterparts. The physiological reactions appear to be stronger for the discount factor δ = 10%, which represents a more harmful threat in terms of welfare destruction.

The results have important implications for the broader IS community and in particular for the understanding of situations in which both humans and automated agents interact. Our daily life will increasingly be permeated with interactions in human only, machine only, and mixed participant environments. We show that there are distinct differences in the behavior of human participants depending on the type of situation they face. These differences have an impact on bargaining behavior, allocations, and emotional responses. One could imagine more complex interactions and more dynamic market settings. Focusing on a controlled and straightforward setting, our results present a first step towards understanding the interplay of emotions and actions in dynamic bargaining processes.

References

- Dimoka, A., Pavlou, P. A., & Davis, F. (2010). NeuroIS: The potential of cognitive neuroscience for Information Systems research. *Information Systems Research*, 1–18.
- Rubinstein, A. (1982). Perfect Equilibrium in a Bargaining Model. *Econometrica*, 50(1), 97–109.

Preventing Information Avoidance Behavior

Tillmann Neben, Erik Hemmer, and Armin Heinzl, University of Mannheim

Corresponding author: neben@uni-mannheim.de

Only information that is being used can contribute to a firm's success. The avoidance of useful information can be considered a pathologic information behavior. A main cause of avoidance is the perception of information dissonance (Nickerson, 1998). Information is dissonant if it challenges existing beliefs. The threat of having to change existing beliefs leads to a negative affective state in the individual. Since information may be *dissonant* but *relevant* the question of how to prevent this psychological process emerges (Sweeny and Melnyk, 2010).

Based on the Elaboration Likelihood Model (Tam and Ho, 2005) and Social Exchange Theory (Shelby, 1986) we hypothesize that social information cues have the ability to decrease the likelihood of information avoidance. Social information cues in this context refer to information about the author of a text, and include a photo, the name, and the job title of the author. The effects of social information on cognitive processes have previously been studied (Benbasat et al., 2010). Based on the literature on persuasion (Cialdini and Trost, 1998) we hypothesize that the author's *conveyed power* (work hierarchy), and the author's *conveyed expertise* (domain knowledge) have significant effects on the likelihood of avoidance. *Power* refers to the ability to influence others because of institutionalized leadership. *Expertise* refers to the ability to influence others because of informational capital. Figure 1 presents the simplified version of our working model.

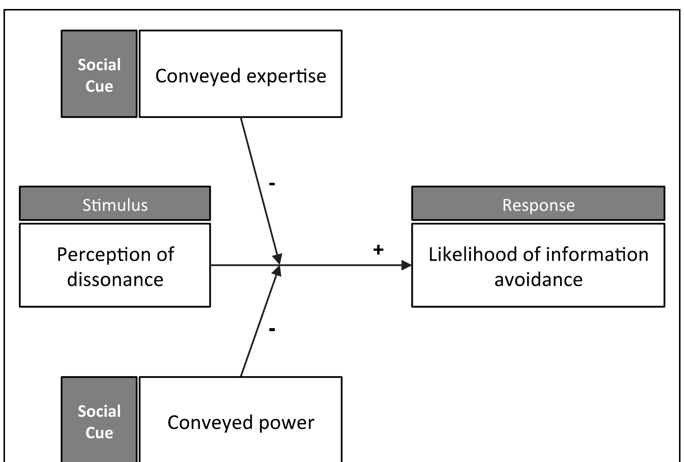

Figure 1. Simplified Research Model

For testing our model we conduct an experiment. Participants read a sequence of articles on a subject they have no prior knowledge of. One subset of the articles speaks in favor of opinion *A*, another subset speaks in favor of opinion *B*. Through the sequence of presenting combinations of *A* and *B*, and the associated priming effects, we induce the perception of dissonance. Each article is equipped with a social cue. We manipulate the cue's *conveyed power* by presenting the author to hold a "junior" or "senior" work position. We manipulate the cue's *conveyed expertise* by presenting the author as being a domain "expert" on the article's subject. These manipulations are summarized in table 1.

Table 1. Factorial Design

	Factor "Expertise"	Factor "Power"
Level 1	Conveyed as expert	Conveyed as junior manager
Level 2	No information on expertise	Conveyed as senior manager

We anticipate social cues to have strong attention-allocation effects. However, we are not interested in whether or not participants fixate the cues, but in the cues' effects on the consumption of the surrounding texts. Because information avoidance may occur unconsciously traditional methods of inquiry have limits. We thus use the psychophysiological methodology of eye-tracking to measure information avoidance. For that we statistically analyze differences in view patterns of the texts between the experimental conditions (table 1). We work towards theory building. However, it is also of great relevance to IS designers to potentially prevent information avoidance by including social cues.

References

- Benbasat, I., Dimoka, A., Pavlou, P. A., and Qiu, L. 2010. "Incorporating Social Presence in the Design of the Anthropomorphic Interface of Recommendation Agents: Insights from an fMRI Study". *Proceedings of the 31st International Conference on Information Systems*, pp. 1-22.
- Cialdini, R. B., and Trost, M. R. 1998. Social influence: Social norms, conformity, and compliance. In D. Gilbert, S. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (pp. 151–192), McGraw-Hill.
- Nickerson, R. 1998. "Confirmation bias: A ubiquitous phenomenon in many guises," *Review of General Psychology* (2:2), pp. 175.
- Tam, K., and Ho, S. 2005. "Web personalization as a persuasion strategy: An elaboration likelihood model perspective," *Information Systems Research* (16:3), pp. 271–291.
- Shelby, A. 1986. "The theoretical bases of persuasion: A critical introduction," *Journal of Business Communication* (23:1), pp. 5–29.
- Sweeny, K., and Melnyk, D. 2010. "Information avoidance: Who, what, when, and why," *Review of General Psychology* (14:4), pp. 340–353.

Specific Eye-gaze Metrics as a Construct in a Holistic Causal Model of Online Shopping Behavior

Harald Kindermann

harald.kindermann@fh-steyr.at

Electronic commerce has grown rapidly in recent years. However, the success of an online store depends on several factors like trust, aesthetics, attitude, perceived costs and so forth (e.g. Schlosser et al. or Hall and Hanna, 2004). Besides these latent constructs, it is indisputable that the usability of an online store is a crucial prerequisite for gaining good sales.

According to DIN EN ISO 9241-11, usability is defined as "the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specific context of use." For the assessment of usability, different methods (mostly in combination) will be used: (1) heuristic evaluation: this is a holistic examination of a web shop based on specific rules (Wild & Macredie, 2000), (2) cognitive walkthrough: an evaluation method which is task-specific (Blackmon et al., 2002), and (3) user testing: an evaluation method that involves users to accomplish specific tasks and to answer an appropriate questionnaire afterwards – sometimes in combination with eye-gaze measurement techniques (e.g. Konradt et al., 2003, Nielsen & Pernice, 2010).

However, irrespective of the complexity of usability, this construct is just one factor in a holistic causal model for explaining online shopping behavior. So, if somebody is going to confirm a theoretically established causal model (see Figure 1), he has to deal with an enormous amount of items, which leads to participants' fatigue, frustration, and boredom (Robins et al., 2001). As a result, respondents have just low cognitive participation and the probability of invalid answers increases dramatically (Stanton et al. 2002). All this reduces the validity of such studies.

As aforementioned, eye-gaze-measurement in combination with questioning is an often used technique to assess usability from the user´s perspective. Especially if somebody wants to derive clues to improve the page layout from the information, as to how people look at a page. However, this approach neglects the influence of all other factors on the buying-intention. If somebody wants to include all these factors to a holistic model, he has to administer an appropriate usability questionnaire with all the necessary indicator questions, which are necessary for a valid measurement model. So, if eye-gaze technique is used anyway, it would be helpful to fall back on specific eye gaze metrics to measure usability holistically. In doing so, this should reduce the number of items significantly. This is exactly the focus of a scheduled study: I try to validate specific eye-gaze metrics for the measurement of usability in a holistic causal model to explain the coherences of online shopping behavior.

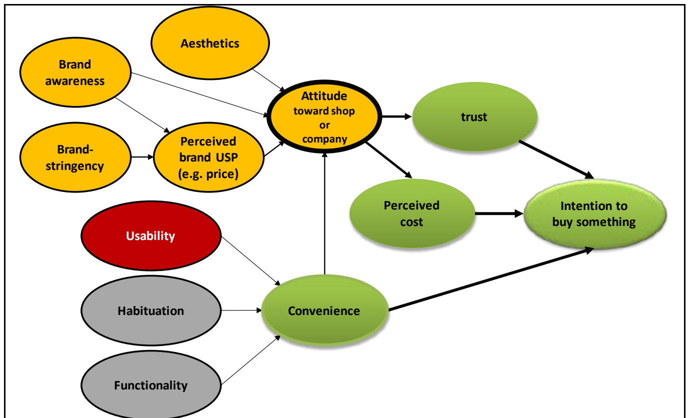

Figure 1. A holistic causal model to explain online shopping behavior

I will do a pilot study by May. So it would be possible to present the developed methodology and preliminary results at the NeuroIS 2013. Furthermore I would appreciate a vital discussion about this new approach.

References

- Blackmon, M. H. Polson, P.G. Muneo, K & Lewis, C. (2002) Cognitive Walkthrough for the Web CHI 2002 vol.4 No.1 pp463–470
- Hall, R.H., Hanna, P., 2004.The impact of web page text-background colour combinations on readability, retention, aesthetics and behavioural intention. Behaviour & Information Technology 23, 183–195.
- Konradt, U., Wandke, H., Balazs, B., Christophersen, T., 2003. Usability in online shops: scale construction, validation and the influence on the buyers' intention and decision. Behavior & Information Technology 22, 165–174.
- Nielsen, J., Pernice, K. (2010): Eyetracking Web Usability, New Riders, Peachpit.
- Robins, R.W., Hendin, H.M., Trzesniewski, K.H., 2001. Measuring global self-esteem: construct validation of a single-item measure and the Rosenberg self-esteem scale. Personality and Social Psychology Bulletin 27, 151–161.
- Schlosser, A.E., Barnett White, T., Lloyd, S.M., 2006. Converting web site visitors into buyers: how web site investment increases consumer trusting beliefs and online purchase intentions. Journal of Marketing 70, 133–148.
- Stanton, J.M., Sinar, E.F., Balzer, W.K., Smith, P.C., 2002. Issues and strategies for reducing the length of self-report scales. Personnel Psychology 55, 167–194.

Stopping Information Search: A NeuroIS Investigation

Glenn J. Browne, Eric A. Walden
Texas Tech University

Corresponding author: glenn.browne@ttu.edu

Information search is now a ubiquitous aspect of users' interactions with information systems and a fundamental first step in their decision-making processes. To make decisions or solve problems, people must *stop* their information search. Prior research has investigated cognitive stopping heuristics, or rules, in various types of search (e.g., Browne and Pitts 2004; Browne, Pitts, and Wetherbe 2007; Ho, Bodoff, and Tam 2011). The purpose of the present research is to investigate information search and stopping using functional Magnetic Resonance Imaging (fMRI) data.

Information is now overly abundant in many contexts. There is more information available for processing than can be reasonably incorporated into decision making, problem solving, or in preparation for action. Our brains are simply ill-equipped to handle the quantities of information available to consume. Shallow processing (Carr 2010) often leads to the overconsumption of information, which interferes with consolidation of memories and results in information overload, attentional exhaustion, and even mental health problems. Thus, the need to stop information consumption is an important practical problem and raises a host of important research questions. In this research we aim to gain a better understanding of how and why people stop searching for information.

Based on a review of the information search literature (e.g., Pirolli and Card's (1999) Information Foraging Theory and Simon's (1996) theory of heuristic search) and stopping literature (e.g., Browne et al, 2007; Ho et al. 2011), we generated four research questions:

R1: How does brain activity differ for search activity and stopping activity?
R2: How does brain activity differ for various types of self-reported stopping rules?
R3: Does stopping information search activate the same areas of the brain as stopping motor responses?
R4: Does brain activity differ for searching and stopping when moderated by various psychological characteristics?

Subjects were 21 students from a business school subject pool at a large university in the southwestern U.S. The experimental task required a subject to search for information about three products individually within a product class, such as televisions, and this was repeated for seven product classes. When subjects indicated they had gathered sufficient information (that is, they indicated they wanted to *stop*), they were given a question about why they chose to stop. This type of design is different from typical inhibition studies in neuroscience, such as stop-signal and go/no-go tasks, because the subjects rather than the researcher controlled the decision to stop.

Results revealed that a number of brain networks showed significantly higher blood-oxygen-level-dependent (BOLD) activation during stopping than during searching. The first was an executive control network comprised of the dorsolateral pre-frontal cortex and the anterior cingulate cortex. Together the greater activation of these two areas suggests that subjects were actively employing top down executive control to attend to the stop decision and evaluate the value of a stop response.

Second, the insula and the caudate/putamen were more active on both sides of the brain during stopping than during searching. This is a typical network of activation in stop-signal tasks, and is indicative of inhibition, which represents the behavior of stopping. These areas inhibit the urge for a person to continue with what he is doing, which suggests that he will stop.

Together, these areas of activation provide strong evidence that different areas of the brain are involved in searching and stopping. Implications for decision making more generally will be discussed.

References

- Browne, G.J. and Pitts, M.G. 2004. "Stopping Rule Use During Information Search in Design Problems," *Organizational Behavior and Human Decision Processes*, (95), pp. 208-224.
- Browne, G.J., Pitts, M.G. and Wetherbe, J.C. 2007. "Cognitive Stopping Rules For Terminating Information Search in Online Tasks," *MIS Quarterly*, (31), pp. 89-104.
- Carr, N. 2010. *The Shallows*. New York: W.W. Norton & Company.
- Ho, S.Y., Bodoff, D., and Tam, K.Y. 2011. "Timing of Adaptive Web Personalization and Its Effects on Online Consumer Behavior," *Information Systems Research*, (22:3), pp. 660-679.
- Pirolli, P. and Card, S. 1999. "Information Foraging," *Psychological Review*, (106:4), pp. 643-675.
- Simon, H.A. 1996. *The Sciences of the Artificial*. Cambridge, MA: MIT Press.

The Influence of Group Flow on Group Performance: A Research Program

Pierre-Majorique Léger[1], Sylvain Sénécal[1], Caroline Aubé[1], Ann-Frances Cameron[1], Ana Ortiz de Guinea[1], Eric Brunelle[1], Francois Courtemanche[1], Fred Davis[2] & Paul Cronan[2]
[1]HEC Montréal, [2]University of Arkansas

Corresponding author: pml@hec.ca

Although prior research has extensively investigated individual flow, research on group flow is nascent. Individual level flow is a mental state in which a person is fully focused on, involved in, and enjoying the task at hand, and researchers have started to investigate flow episodes involving more than one person (Heyne et al. 2011; Walker 2010). It is argued that flow in a group context "may be a qualitatively different phenomenon than flow experience in isolation"(Walker 2010)(p.4). Literature on social psychology provides ample evidence that action, cognition, and emotions of individuals are different than groups (Fiske et al. 2010). Survey studies report that group flow episodes were rated more enjoyable than those under solitary conditions(Walker 2010). Some studies suggest a correlation between the aggregate flow of the team members and the performance in a planning task (Heyne et al. 2011). Investigating the influence of flow in group contexts on group performance is important because it may contribute to more productive, collaborative, and often geographically distributed, IT enabled work environments.

There are many problematic issues with the emerging literature on group flow such as anthropomorphizing and spurious aggregation of retrospective individual states (Rousseau 1985). The proposed research program aims to solve these issues by proposing a multi-method approach to answer the following research questions: 1) How is group flow related to the individual flow of each group member? 2) How is group performance influenced by group flow? Throughout this research, we conceptualize group flow as a "collective state of mind" (Sawyer 2007) which occurs at given points in time when individuals are performing an interdependent task. We will examine if psychometric measures of group flow corresponds to concurrent, synchronized, or non-linear relationships between the individual flows of group members.This definition does not simply aggregate individual flow, nor does it engage in anthropomorphizing.

Specifically, this research program proposes to: i) Conceptualize and develop a reliable and valid method to assess group flow members using both psychometric (Studies 1 and 2) and neurophysiological measures (Studies 3 and 4); ii) Assess the impact of group flow on group performance (Study 5). In Study 1, we will explore the phenomenon of group flow using a qualitative approach to understand how and when concurrent individual flow episodes among team members occur in a business context in order to explore the group flow concept. In Study 2, we will perform multiple data collections in order to develop, purify, and validate a group flow measurement scale. In Study 3, we will replicate and extend existing findings regarding neurophysiological measurements of individual flow episodes using a range of neurophysiological responses and technique such as EEG based hyperscanning (Astolfi et al. 2011; Lindenberger et al. 2009) from which it is possible to infer the affective, cognitive and behavioural components of the flow experience. The objective of Study 4 is to develop a reliable predictive model capable of identifying individual flow states and – through the concurrent, synchronized, or non-linear relationships between the individual flow of group members – to develop a model for identifying group flow. Finally, the objective of Study 5 is to investigate the impact of group flow episodes (using our predictive model developed in Study 4 and the group flow measurement scale developed in Study 2) on group performance.

The proposed research program is important for several reasons. A better understanding of group flow and its influence on group performance will lead to important theoretical and managerial contributions. The proposed multi-method approach will contribute to the nascent research stream of flow in social contexts.

References

- Astolfi, L., Toppi, J., Borghini, G., Vecchiato, G., Isabella, R., De Vico Fallani, F., Cincotti, F., Salinari, S., Mattia, D., He, B., Caltagirone, C., and Babiloni, F. "Study of the functional hyperconnectivity between couples of pilots during flight simulation: An EEG hyperscanning study," Engineering in Medicine and Biology Society,EMBC, 2011 Annual International Conference of the IEEE, 2011, pp. 2338-2341.
- Fiske, S. T., Gilbert, D. T., and Lindzey, G. *Handbook of Social Psychology* Wiley, 2010.
- Heyne, K., Pavlas, D., and Salas, E. "An Investigation on the Effects of Flow State on Team Process and Outcomes," *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (55:1), September 1, 2011 2011, pp 475-479.
- Lindenberger, U., Li, S.-C., Gruber, W., and Muller, V. "Brains swinging in concert: cortical phase synchronization while playing guitar," *BMC Neuroscience* (10:1) 2009, p 22.
- Rousseau, D. M. "Issues of level in organizational research : Multi-level and cross-level perspectives," in: *Research in organizational behavior*, B.M. Staw and L.L. Cummings (eds.), JAI Press, Greenwich, CT, 1985, pp. 1-37.
- Sawyer, K. *Group genius: The creative power of collaboration* Basic Books., Cambridge, MA, 2007.
- Walker, C. J. "Experiencing flow: Is doing it together better than doing it alone?," *The Journal of Positive Psychology* (5:1), 2010/01/01 2010, pp 3-11.

Looking for Information Relevance in the Brain

Jacek Gwizdka, School of Information, University of Texas at Austin

jacek@neuroinfoscience.org

The main goal of users engaged in information search is to retrieve *relevant* information. Relevance is a fundamental concept for information science and information retrieval. Relevance can be considered from two main perspectives, system and human (Borlund, 2003). Of our interest is the second kind of relevance that has been conceptualized as the user's judgment of the strength of the relationship between a document and the user's information need (e.g., Saracevic, 1975). Relevance judgments are important events during interaction with a search system. They can indicate user's interest, user's progress in a task, and reflect the search system's effectiveness. In experiments relevance is often measured in terms of cognitively-mediated explicit actions, such as saving a document, or through self-assessments of content relevance. Direct and non-intrusive detection of relevance judgements would provide an objective and deeper means to capture this important aspect of the user's mental state while in the 'flow' of search and so enable study of search behaviour in natural settings.

Cortical correlates of relevance decisions have received some attention. For example, Wakusawa et al. (2009) conducted an fMRI study comparing behaviours and objects that are relevant or irrelevant to a situation. Brain response regions were found to differ for behavioural and for object irrelevance, while relevant behaviours and objects activated the same regions. It is not clear how judgments of objects and behaviours are related to judgment of information relevance, but this work shows there is specific brain activation for both relevant and irrelevant judgments and so it is plausible that the brain activity in information relevance judgments is detectable. This hypothesis received partial support from an EEG study conducted by Behneman et al. (2009), who showed that changes in the EEG (theta and alpha bands) can be used to distinguish sentences that are relevant or irrelevant to a given information need.

We explore the possibility of detecting brain activity related to information relevance judgments. We hypothesize that there are fundamental neural processes associated with relevance judgements and that these processes can be detected by fMRI. We have conducted an fMRI+eye-tracking experiment with N=10 participants. Due to technical difficulties eye-tracking data is available for N=4. The experimental design is shown in Figure 1. Each subject performed two types of tasks: 1) word search, and 2) information search. The 1st task involved locating a target word in a short text displayed on screen and was expected to require low-level orthographic processing. The 2nd task involved finding relevant factual information in news stories and was expected to require higher-level lexical/semantic processing. Each session included 21 pseudo-randomized trials of each task type, as well as a few training trials. Each trial in the 2nd task consisted of presentation of three news stories of varied relevance: irrelevant, topically relevant and relevant. The specific hypotheses were: H1. The two tasks involve activity in different brain regions. H2. Judging relevance of texts differing in degree of relevance involves activity in different brain regions.

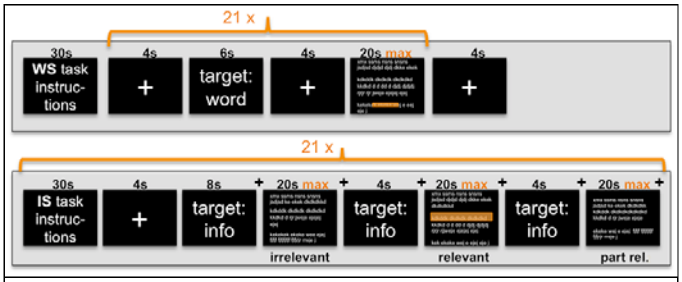

Figure 1. Experimental Design

We are carrying out fMRI data processing and analysis using FEAT (fMRI Expert Analysis Tool; part of FSL - FMRIB's Software Library: http://www.fmrib.ox.ac.uk/fsl) at the individual and at the aggregated (group) level on all participant data. Preliminary group analysis for N=4 shows distinct brain activations for texts stimuli of different degree of relevance.

At a theoretical level, our work contributes to better understanding of the multi-dimensional concept of information relevance. At an applied level, we believe that establishing distinctions in brain activity related to information search should lead to a better understanding of the search process and, as a consequence, to the design of better search engines.

Acknowledgments. We gratefully acknowledge collaboration and support from Dr. Catherine Hanson and Prof. Steve Hanson (RUBIC at Rutgers University) and from Prof. Paul Kantor and PhD student Michael Cole (SC&I at Rutgers University).

References

- Behneman, A., et al. (2009). Enhancing Text-Based Analysis Using Neurophysiological Measures. In D. D. Schmorrow, et al. (Eds.), *Foundations of Augmented Cognition. Neuroergonomics and Operational Neuroscience*. Vol. 5638, 449-458. Berlin, Heidelberg: Springer.
- Borlund, P. (2003). The concept of relevance in IR. *JASIST*, 54(10), 913–925.
- Saracevic, T. (1975) . Relevance: A review of and a framework for the thinking on the notion in information science. *Society for Information Science*, 26, 321–343.
- Wakusawa ,K., Sugiura, M., et al. (2009). Neural correlates of processing situational relationships between a part and the whole: an fMRI study. *Neuroimage*, 48(2), 486-96.

Application Strategies for Neuroscience in Information Systems Design Science Research

Jan vom Brocke, University of Liechtenstein, René Riedl, University of Applied Sciences Upper Austria & University of Linz, Pierre-Majorique Léger, HEC Montréal
Corresponding author: jan.vom.brocke@uni.li

In this talk, we present a recent paper on application strategies for neuroscience in information systems (IS) design science research (vom Brocke et al. 2013). Design science has evolved as a major research paradigm in the IS discipline, which aims to design innovative and useful IT artifacts, such as conceptual models and software systems. Despite the increasing attention paid to the cognitive and emotional mechanisms that underlie the perception of such artifacts, studies that examine the neurobiological determinants of these mechanisms have only recently begun to emerge. A major argument for the use of neurobiological approaches in IS design science research is that IT artifact design may significantly benefit from neuroscience theories, concepts, methods, and data. The consideration of neuroscience may improve IT artifacts' alignment with users' perceptual and information processing mechanisms, particularly the brain.

Against this background, this talk presents a taxonomy of application strategies for neuroscience in IS design science research. It describes three major areas of application (see Figure 1) and explains that conducting research in an area comes with a specific set of requirements (e.g., applicability, costs, accessibility, and knowledge relevant to planning and conducting a research project). Therefore, if an IS design science scholar decides to draw upon neuroscience, the taxonomy transparently explains possible working areas and corresponding requirements. The taxonomy is described based on example studies.

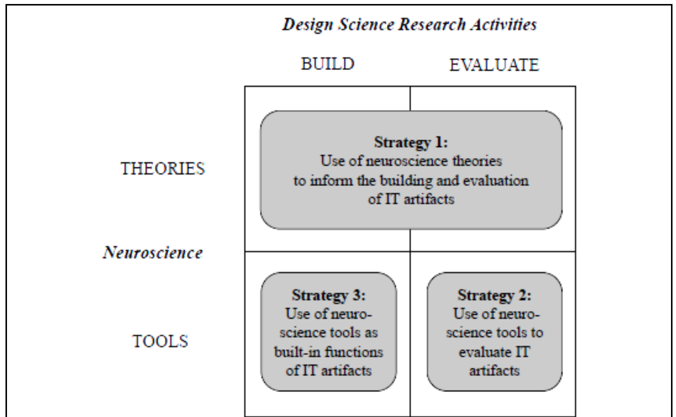

Figure 1. NeuroIS Design Science Research Framework (Source: vom Brocke et al. 2013, p. 3)

Taking this taxonomy as a basis, in the talk we also discuss the current NeuroIS literature and research from related fields (e.g., affective computing). We also explain that the degree of knowledge required implementing the strategies increases from Strategy 1 to Strategy 3. For example, developing an IT artifact with a built-in neuroscience functionality (Strategy 3) requires more knowledge than does using a neuroscience theory to inform the design of an IT artifact (Strategy 1).

References

- vom Brocke, J., Riedl, R., Léger, P. 2013. "Application Strategies for Neuroscience in Information Systems Design Science Research," *Journal of Computer Information Systems* (53:3), pp. 1-13.

A NeuroDesign Model for IS Research

Alan Hevner, Rosann Collins, Grandon Gill, University of South Florida, Tampa
Christopher Davis, University of South Florida, St. Petersburg

Corresponding author: ahevner@usf.edu

Little NeuroIS research has studied the cognitive tasks of performing the design Build activities (vom Brocke et al. 2012). While we recognize the existence of a vast neuroscience literature examining the locations in the brain that are activated by the processes of creativity, insight, design, communication, collaboration, and control (e.g. Dietrich 2004; Srinivasan 2007), our aim in this presentation is not to exhaustively plumb such depths but rather to initiate an investigation on how to apply this extensive neuroscience knowledge base to design research activities of building innovative IS artifacts. We propose a conceptual model of the design activity that highlights four key cognitive constructs essential to successful design research. The model strives to align the epistemological challenges evident in mainstream neuroscience with the specific opportunities that neurophysiological imaging techniques present the design researcher.

We posit that *Build* remains the most ill-defined and 'arbitrary' activity in design research. Here is where human cognitive (e.g. complexity, creativity, control) and social (e.g. collaboration) traits work together to design novel artifacts to improve the human condition. As shown in Figure 1, we model the design activity as an iterative process with three key flows:

1. From an external problem space to an internal problem space via problem requirements;
2. From the internal problem space to an internal solution space via candidate designs; and
3. From the internal solution space to an external solution space via use artifacts.

The human design team performs within this process through cognitive interactions at critical points in the flow as illustrated in Figure 1:

1. Structure Problem – What cognitive strategies are used to deal with the *complexities* of the problem space? How does the brain search the problem statement for potential solution patterns while finding effective representations of problem structure?
2. Produce Novelty – How does the brain *create* new ideas for the production of innovative design candidates?
3. Manage Refinement – How does the brain *control* the assessment of candidate designs and search for the 'best' designs to instantiate as use artifacts?
4. Achieve Consensus – How do humans *collaborate* with others on the design team and with design stakeholders throughout the design process?

The model emphasizes the iterative interplay of action and interpretation (doing and making sense) rather than merely the influence of evaluation on choice (Weick et al. 2005, p. 409). The model provides a basis to 'broker' and realign neuro-scientific theory and IS design research. The emphasis on the design Build process provides a tenable empirical focus but without the dependence on reified artifacts-in-use – as has been the case to date in NeuroIS. The emphasis in the model on the interplay of 'doing' tasks and 'making' sense focuses directly on the task at hand and in mind. These iterations are manifest in four interactions, each of which has a set of important cognitive challenges which we explore. Use of the model to guide NeuroDesign research presents a number of fruitful opportunities to extend the use of neuroimaging techniques in design research beyond the evaluation of IT artifacts. The model also highlights the potential of design as an empirical context to identify, frame, and address some of the limitations of prior studies of complexity, creativity, control and collaboration that, to date, have stymied mainstream neuroscience.

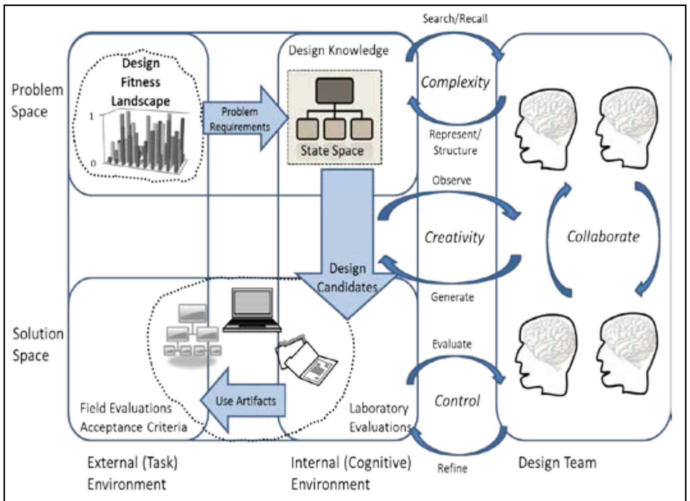

Figure 1. NeuroDesign Model

References

- Dietrich, A. 2004. "The Cognitive Neuroscience of Creativity. *Psychonomic Bulletin and Review* (11:6), pp. 1011-1026.
- Srinivasan, N. 2007. "Cognitive Neuroscience of Creativity: EEG based Approaches," *Methods* (42), pp. 109-116.
- Vom Brocke, J., Riedl, R., Léger, P. 2013. "Application Strategies for Neuroscience in Information Systems Design Science Research," *Journal of Computer Information Systems* (53:3), pp. 1-13.
- Weick, K., Sutcliffe, K. and Obstfeld, D. 2005. "Organizing and the Process of Sensemaking," *Organization Science* (16:4), pp. 409-421.

Towards a "Product Design BCI" based on Event-related Potentials: Preliminary Results and Lessons Learned

Selina C. Wriessnegger, Philipp Freislederer, Gernot R. Müller-Putz
Graz University of Technology

Corresponding author: gernot.mueller@tugraz.at

The human visual system is a powerful tool for the recognition and discrimination of objects. Several studies have been conducted in order to determine the speed of visual processing during rapid serial visual presentation (RSVP). If placed in front of a monitor and focused on it, the human eye and visual cortex can thoroughly distinguish between rapidly flashing target and distractor images (Bigdely-Shamlo et al., 2008). This phenomenon has been already used to design computer vision systems for rapid image search (Gerson et al., 2006) and reactions to these images can be recorded with modern electroencephalography (EEG) methods. Furthermore results of recent studies showed that emotional target pictures show a greater detectability because of more distinct event-related potentials (ERPs) when presented during RSVP (Flaisch et al., 2008; Carretié et al., 2001; Olofsson et al., 2008). The question arises, whether such ERPs can also be used as a tool for product design by distinguishing between neutral objects and objects of someone's personal favour.

A preliminary study with 5 subjects has been conducted in order to examine possible distinct ERPs, wherein presumably "likeable" objects (causing favor of the subject) and "not-likable" objects (inflicting negative emotions) will be displayed in a RSVP paradigm. The classification accuracy between positive, neutral, and negative images was calculated in between 55.62% and 70.91% using stepwise linear discriminant analysis (SWLDA).

Based on these results a further EEG study was conducted presenting a series of different objects (images of cars and chairs) to a number of ten healthy participants. Right after the experiment the same participants were asked to perform a self-assessment test, where they had to rate the objects previously seen according to their attractiveness, comfortability, and innovativeness. To validate the paradigm and the processing routine, a so-called "oddball paradigm" was used, in which the subjects were asked to focus on one of the images (target). The results were quite promising, as the classification of the individual target condition reached accuracies between 82.48% and 98.55% for the individual subjects. The mean waveforms showed a clear difference between the target condition and all others. The method of classifying each class against the rest of the classes (One-vs-Rest) serves as a proper way of comparing a large number of classes (n = 80) with each other. There was no significant correlation between the results of the self-assessment test and the resulting classification accuracies for each condition. The difference between negative and positive pictures, as observed in the preliminary study, is not as clear when comparing attractive and unattractive images from the main study with each other. Only in 5 out of 10 subjects, this difference though is still observable. As in such a paradigm, focus of attention and concentration are the main effects providing good results, the paradigm for a "Product design-BCI" should also be implemented in consideration of the impact of visual attention achieving success.

Concluding, the results of this work are promising but there are several limitations, like timing parameters and analysing methods which should be improved for future studies. A successful implementation of a "Product Design BCI" would not only provide a new tool in arts and product design, but also in the design process in general.

References

- Bigdely-Shamlo, N., Vankov, A., Ramirez, R.R., Makeig, S. 2008. "Brain activity-based image classification from rapid serial visual presentation". *IEEE Trans Neural Syst Rehabil Eng*, 16(5):432–41.
- Carretié, L., Martín-Loeches, M., Hinojosa, J.A., Mercado, F. 2001. "Emotion and attention interaction studied through event-related potentials". *J Cogn Neurosci*, 13(8):1109–1128.
- Flaisch, T., Junghöfer, M., Bradley, M.M., Schupp, H.T., Lang, P.J. 2008. "Rapid picture processing: Affective primes and targets". Psychophysiology, 45(1):1–10.
- Gerson, A.D., Parra, L.C., Sajda, P. 2006. "Cortically coupled computer vision for rapid image search". *IEEE Transactions on Neural and Rehabilitation Systems Engineering*, 14(2):174–179.
- Olofsson, J.K., Nordin, S., Sequeira, H., Polich, J. 2008. "Affective picture processing: an integrative review of ERP findings". *Biol Psychol*, 77(3):247–65.

Neural Evidence of Uncertainty and Risk Processing Networks in Information System Research: A Multilevel-Mediation Approach

Marco Hubert, Zeppelin University, Marc Linzmajer, University of St. Gallen,
Mirja Hubert, Zeppelin University
Corresponding author: marco.hubert@zu.de

Many decisions in our everyday life such as decisions in an economic or social context are made under uncertainty. In uncertain situations people often have to make decisions under risk, where the probability of specific outcomes is known. Sometimes they even face ambiguous situations, where the outcome is not clearly predictable. Furthermore decisions under uncertainty in economic contexts, i.e. buying or investment decisions are framed by different determinants, i.e. perceived risk or anticipated risk, personality or situational factors. These determinants suggest that the role of uncertainty is particularly important for decisions in online settings.

One major focus of information systems (IS) research, are decision-making processes and consumer behavior in online settings, where the importance of investigating risk and uncertainty is enhanced (i.e. Pavlou et al. 2007). To understand consumer behavior in online settings, recent studies show for example the necessity to analyze specific decisions under uncertainty (Dimoka et al., 2012) or to investigate the interplay of risk and trust (Gefen and Pavlou, 2010).

In this context a newly emerged scientific field – NeuroIS integrates neuroscientific methods and theories in IS research to better understand how the brain interacts with an IS relevant context (Riedl et al. 2010). Experimental studies within this field currently focus on trust-related processes by integrating decision-making under uncertainty as external factor. In a next step, the analysis of uncertain and – more specifically – the analysis of risky decisions as well as the integration of results and theories from social neuroscience regarding uncertainty and risk processing networks could be of importance for (Neuro)IS. Furthermore the investigation of the brain as a complex network structure is now spotlighted by IS research by the means of integrating advanced neuroscientific methods in NeuroIS research (Hubert et al., 2012).

Therefore we suggest a conceptual model of analyzing decisions under uncertainty and risk in online settings by using an advanced neuroscientific method of multi-level mediation. This methodological approach takes into account the different brain networks that are associated with the processing of uncertainty and risk (see figure 1).

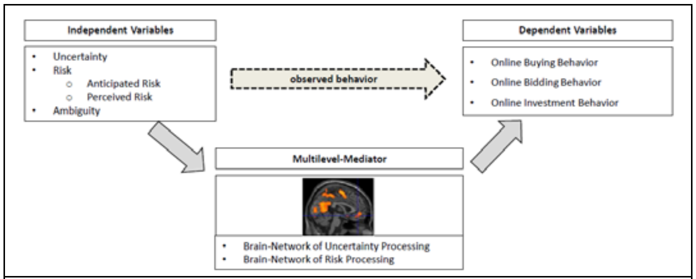

Figure 1. Conceptual Model

First, starting point of the multi-level mediation is the relevant and evident causal dependence of various levels of uncertainty as well as risk (independent variable) on various outcomes in online settings (dependent variable), i.e. bidding and purchase behavior or investment behavior.

Second, studies of social neuroscience provide evidence of the existence of networks of brain regions for risk and uncertainty processing which determine decision making (multilevel-mediator), i.e. in economic exchange or cooperation games (Mohr et. al, 2010). Those results could build a powerful theoretical basis that may be transferred to IS-related contexts.

Third, the possibility of neuroscientific multilevel-mediation analysis (i.e. described by Wager et al. 2008) allows us to integrate results and theories regarding risk or uncertainty processing networks into existing models and theories of observed behavior (see e.g., Berkman and Falk 2013) to broaden the understanding of decision-making under uncertainty in online settings.

References

- Berkman, E. T. and Falk, E. B. 2013. "Beyond Brain Mapping: Using Neural Measures to Predict Real-World Outcomes," *Current Directions in Psychological Science* (22:45), 45-50.
- Dimoka, A., Hong, Y. and Pavlou, P.A. 2012. "On Product Uncertainty in Online Markets: Theory and Evidence," *MIS Quarterly* (36), 395-426.
- Hubert, M., Linzmajer, M., Riedl, R., Kenning, P., and Hubert, M. 2012. „Introducing Connectivity Analysis to NeuroIS Research," *Proceedings of the International Conference on Information Systems (*15), 1-21.
- Mohr P.N.C, Biele, G., and Heekeren, H.R. 2010, "Neural processing of risk," *Journal of Neuroscience* (30), 6613–6619.
- Pavlou, P. A., Liang, H., and Xue, Y. 2007. "Understanding and Mitigating Uncertainty in Online Buyer-Seller Relationships: A Principal Agent Perspective," *MIS Quarterly* (31:1), pp. 105-136.
- Riedl, R., Banker, R. D., Benbasat, I., Davis, F. D., Dennis, A. R., Dimoka, A., Gefen, D., Gupta, A., Ischebeck, A., Kenning, P., Müller-Putz, G., Pavlou, P., Straub, D. W., vom Brocke, J., and Weber, B. 2010. "On the Foundations of NeuroIS: Reflections on the Gmunden Retreat 2009," *Communications of the Association for Information Systems (CAIS)* (27:15), pp. 243-264.
- Wager, T.D., Davidson, M.L., Hughes, B.L., Lindquist, M.A, and Ochsner, K.N. 2008. "Prefrontal-subcortical pathways mediating successful emotion regulation," *Neuron*, (59), 1037–1050.

The Influence of Emotional Context on the Comprehension of Descriptive Information of Websites: An ERP Analysis

Amir Riaz, Australian National University (ANU), Shirley Gregor, ANU, Qing Xu, Zhejiang University, Aleck Lin, National Dong-Hwa University, Alex Richardson, ANU

Corresponding author: Amir.Riaz@anu.edu.au

The aim of this study is to investigate whether or not emotional context as compared to non-emotional context improves the comprehensibility of descriptive information given on informational websites (e.g., government websites).

Descriptive information refers to "isolated facts without an explanation of the relationships between these facts" whereas explanative information refers to "organized facts connected by their underlying functional relationship." (Lim and Benbasat 2002, p.99). Any given informational website normally consists of descriptive as well as explanative information. Comprehension of both of these types of information on websites has been studied but findings concerning purely descriptive information do not offer any suggestions to improve its comprehension (Chmielewski and Dansereau 1998; Hong et al. 2004; Lim and Benbasat 2002). However, theory of cognitive neuroscience offers an opportunity to improve comprehension by presenting descriptive information in an emotional context (Smith et al. 2004). This challenge is taken up in this paper.

In line with prior literature (e.g., Lim and Benbasat 2002), comprehension of descriptive information in this study refers to the recall of facts that are explicitly mentioned in the given information. Theory of cognitive neuroscience of emotions posits that when information is presented in an emotional context, an emotional tag is added to the information being encoded, which facilitates the recall of such information at later stages (Smith et al. 2004). Therefore, it is proposed that the recall of descriptive information given in an emotional context will be higher than in neutral or non-emotional context. Kock et al. (2008) provide empirical evidence for this theoretical assumption. They showed some of the participants a picture of a snake during the presentation of web modules consisting of financial terms. They found that the participants who saw the picture, scored higher on information recall.

In a lab experiment, participants will be shown names of medicines embedded with emotional or non-emotional pictures (Wiswede et al. 2006) in a within-subjects design. Emotions will be measured using self-reported scales and electroencephalography (EEG). From raw EEG, time-locked changes in electrical potential associated with a specific event called event-related potentials (ERPs) will be extracted and analysed.

NeuroIS technique – ERPs, will be used to measure emotions for various reasons. First, emotions "often do not reach the level of awareness, and therefore it is not possible to report on them in survey or interview studies," (Davis et al. 2012, p.2). Second, though there are other NeuroIS techniques such as functional neuroimaging, skin conductance etc., which can be used to measure emotions, they may not be suitable for this study because of their poor temporal resolution. Emotions are short-lived and may alter early stages of information processing (Hajacak et al. 2012). Therefore, ERPs because of their capability of indexing neural activity with a time scale of milliseconds, offers a more reliable measurement. Emotional stimuli can enhance the amplitude of various ERP components from P1 to P3 (Hajcak et al. 2012), therefore, this study will examine all ERP components ranges from P1 to P3. Subordinate dimensions of emotion – valence and arousal, will be examined in this study only, because "no ERP component has been found that reflects a specific emotion" (Hajcak et al. 2012, p. 442). Comprehension of descriptive information will be measured using fact-based questions. Post-experiment interviews will also be conducted to further validate the findings.

References

- Chielewski, T. L., and Dansereau, D. F.1998. "Enhancing The Recall Of Text: Knowledge Mapping Training Promotes Implicit Transfer," *Journal of Educational Psychology* (90:3), pp. 407-413.
- Davis, F. D., Henver, A. R., and Riedl, R. 2012. "Methods, Tools, and Measurement in NeuroIS Research," *Journal of the Association for Information Systems,* Call for Papers. Special Issue.
- Hajcak, G., Weinberg, A., MacNamara, A., and Foti, D. 2012. "ERPs and the Study of Emotion," In *The Oxford Handbook of Event-Related Potential Components,* S. J. Luck & E. S. Kappenman (eds), Oxford University Press, pp. 441-472.
- Hong, W., Thong, J. Y. L., and Tam, K. Y. 2004. "Does Animation Attract Online User's Attention? The effects of Flash on Information Search Performance and Perception," *Information System Research* (15:1), pp. 60-86.
- Kock, N., Chatelain-Jardón, R., & Carmona, J. 2008. "An Experimental Study of Simulated Web-Based Threats and Their Impact on Knowledge Communication Effectiveness," *IEEE Transactions on Professional Communication* (51:2), pp. 183-197.
- Lim, K., and Benbasat, I. 2002. "The Influence Of Multimedia On Improving The Comprehension Of Organizational Information," *Journal of Management Information Systems* (19:1), pp. 99-127.
- Smith, A. P. R., Dolan, R. J., and Rugg, M. D. 2004. "Event-Related Potential Correlates Of the Retrieval of Emotional and Non-Emotional Context," *Journal of Cognitive Neuroscience* (16:5), pp. 760-775.
- Wiswede, D., Russeler, J., Hasselbach, S., and Munte, T. F. 2006. "Memory Recall In Arousing Situations – An Emotional Von Restroff Effect?" *BMC Neuroscience* (7:57), pp. 1-12.

The Neural Correlates of Rapid Website Evaluation

Yu-feng Huang[1], Feng-yang Kuo[2], Po-jang Hsieh[1]

[1]Duke-NUS Graduate Medical School, Singapore; [2] National Sun Yat-sen University, Taiwan

Corresponding author: yufeng.huang@duke-nus.edu.sg

Literature has examined the cognitive processes that underlie user evaluation of websites. In general, these studies have found that usefulness and enjoyment can effectively predict usage behavior in conditions under which users have abundant knowledge about the target websites and are allowed ample resources to make such evaluations (Davis, et al., 1992, Van der Heijden, 2004). Alternatively, individuals may rely on a mechanism of extremely rapid evaluation that employs only limited information about a website. Indeed, recently researchers have recognized the importance of rapid evaluation in the Electronic Commerce domain and showed that brief exposure to Internet stimuli is adequate to evoke basic psychological responses (Lindgaard, et al., 2006).

However, the neural correlates of the rapid evaluation process are still unclear. It is also unclear whether these neural correlates, if any, can predict subjects' future enjoyment and usefulness evaluations toward these websites. To answer these questions, we seek to capture the neural signatures of rapid evaluation with the event-related potential (ERP, or the brain wave pattern) methodology. Twenty-four subjects participated in an ERP study and a behavioral study. In the ERP study, subjects needed to make extremely rapid evaluation (like vs. dislike) toward novel website logos that were presented with only 200 milliseconds (ms). Next, in the behavioral study, subjects reported their perceived enjoyment and perceived usefulness toward the website logos with a 5-point Likert scale at their own pace.

The results showed that four ERP components were correlated with subjects' like-dislike responses (Table 1). These findings suggest that liked and disliked logos were differentiated very early in the information process stream (120 ms). Furthermore, the results (Figure 1) suggest a negativity bias, i.e., logos that were disliked elicited stronger P1 amplitude than those that were liked. The liked stimuli only elicited stronger ERP signals in the later stages (P2, N2 and LPP). The finding of P1 is consistent with past studies of rapid evaluation using emotional pictures as stimuli (Smith, et al., 2003), in which negative emotional pictures show stronger P1 (peaking around 120 ms) than positive emotional ones. It is argued that P1 is activated from visual cortices and hence indicates early attention process (Smith, et al., 2003). According to this interpretation, our results suggest that a fast and bottom-up emotional response toward the logos might directly influence evaluations and that negative emotion may capture attention faster than the positive emotions.

Table 1 Results

Component	Peak Time	Direction	Areas
P1	120 ms	Dislike > Like	Occipital sites
P2	190 ms	Like >Dislike	Central sites
N2	300 ms	Like >Dislike	Frontal sites
LPP	510 ms	Like >Dislike	Centroparietal sites

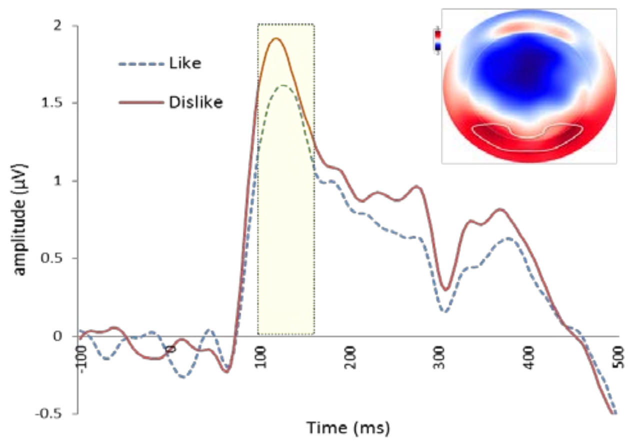

Figure 1 The waveforms (blue line: Like, red line: Dislike) for the P1 component; Upper right: the topography and the occipital sites used to quantify P1.

It has been shown that neural activities might predict future buying behavior (Knutson, et al., 2007). We hypothesize that these four components can predict subjects' future enjoyment and usefulness evaluations. Future analysis is needed to understand whether brain activations precede and predict subjects' website evaluations.

References

❖ Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and Intrinsic Motivation to Use Computers in the Workplace. Journal of Applied Social Psychology, 22(14), 1111-1132.
❖ Knutson, B., Rick, S., Wimmer, G. E., Prelec, D., & Loewenstein, G. (2007). Neural Predictors of Purchases. Neuron, 53(1), 147-156.
❖ Lindgaard, G., Fernandes, G., Dudek, C., and Brown, J. Attention web designers: You have 50 milliseconds to make a good first impression! Behaviour & information Technology, 25, 2 (2006), 115-126.
❖ Smith, N. K., Cacioppo, J. T., Larsen, J. T., & Chartrand, T. L. (2003). May I have your attention, please: Electrocortical responses to positive and negative stimuli. Neuropsychologia, 41(2), 171-183.
❖ Van der Heijden, H. (2004). User Acceptance of Hedonic Information Systems. MIS Quarterly, 28(4), 695-704.

How Privacy-Related Behavior is Induced by the Behavioral Activation and Inhibition Systems

Bryan I. Hammer, University of Arkansas
Nicholas S. Lockwood, Missouri University of Science and Technology

Corresponding author: bhammer@walton.uark.edu

Human behavior is often acted out through non-voluntary actions, which are sometimes emotion-based—originating from the amygdala—and are characterized as either approach behaviors (i.e., behavioral activation system, or BAS) or avoidance behaviors (i.e., behavioral inhibition system, or BIS) (Elliot and Church 1997; Elliot and Harackiewicz 1996; Elliot and Covington 2001). The behavior originates in one of three areas within the amygdala as a signal relating to the motivational significance of objects recognized by sensory processes: 1) corticomedial amygdala, which processes appetitive behavior (i.e., approach); 2) basolateral amygdala, which processes inhibitory behavior (i.e., avoidance); and 3) central nucleus, which organizes the output from the amygdala.

Approach behaviors are characterized by a motivation to experience positive affect whereas avoidance behaviors are characterized by a motivation to not experience negative affect (Elliot 1999). Much of these behaviors are developed through the priming of the human mind through human experience and resultant affect (Carver and Scheier 1998; Carver and White 1994; Gray 1987; Harmon-Jones and Allen 1997). This leads to an efficient behavioral system in which the decision to engage in approach or avoidance behavior originates in a non-conscious section of the brain.

Information sharing requires an individual to share (i.e., approach) or not to share (i.e., avoidance) information. To study the subconscious mechanisms involved in information sharing, we use electroencephalogram (EEG), galvanic skin response (GSR), Tobii eye tracking tools, and facial recognition software. It is hypothesized that an individual who is willing to share information engages in approach behavior and will experience positive affect; individuals who are not willing to share information engage in avoidance behavior and will experience negative affect. Participants include students enrolled in undergraduate courses at a Midwestern university.

Prior to the study, participants fill out a pre-survey questionnaire that captures demographics as well as various control variables, such as handedness (Chapman and Chapman 1987), brain disorders (e.g., psychiatric disorders, neurological disorders, brain traumas), and eye color and complications. Handedness and various disorders may influence neurological function, even beyond what is considered normal. Participants then engage in two scenarios in which they are asked to share information: 1) sharing personal information in Facebook and 2) sharing private information in Amazon.com. During each scenario, participants are asked to share both highly sensitive information (e.g., credit card number, bank account balance, types of personal debt) and low sensitive information (e.g., gender, first and last name, home address). Participants are randomly assigned to one of four conditions, each containing a different scenario order: Facebook or Amazon first and high or low sensitive information first.

Results of the study shed light on how the BAS and BIS are involved in subconscious decision making for privacy-related contexts. Specifically, because many decision are dependent on the reflexive system of the mind (Lieberman 2007), especially in routine situations, the amygdala is responsible for deciding whether to engage in or avoid the sharing of personal information. The usage of automatic mechanisms for behavior are important in alleviating resources within the mind and allow for quicker responses (Camerer et al. 2005).

References

- Camerer, C., Loewenstein, G., Prelec, D., Samuelson, L., Schumpeter, J. A., and Green, E. J. 2005. "Neuroeconomics: How Neuroscience can Inform Economics," Journal of Economic Literature (43:1), pp. 9–64.
- Carver, C. S., and Scheier, M. 1998. On the Self-Regulation of Behavior, Cambridge, UK: Cambridge University Press.
- Carver, C. S., and White, T. L. 1994. "Behavioral Inhibition, Behavioral Activation, and Affective Responses to Impending Reward and Punishment: The BIS/BAS Scales," Journal of Personality and Social Psychology (67:2), pp. 319–333.
- Chapman, L. J., and Chapman, J. P. 1987. "The Measurement of Handedness," Brain and Cognition (6), pp. 175–183.
- Elliot, A., and Church, M. 1997. "A hierarchical model of approach and avoidance achievement motivation," Journal of Personality and Social Psychology (72:1), pp. 218–232.
- Elliot, A., and Harackiewicz, J. 1996. "Approach and avoidance achievement goals and intrinsic motivation: A mediational analysis," Journal of Personality and Social Psychology (70:3), pp. 461–475.
- Elliot, A. J. 1999. "Approach and Avoidance Motivation and Achievement Goals," Educational Psychologist (34:3), pp. 169–189.
- Elliot, A. J., and Covington, M. V. 2001. "Approach and Avoidance Motivation," Educational Psychology Review (13:2), pp. 73–92.
- Gray, J. A. 1987. "Perspectives on Anxiety and Impulsivity: A Commentary," Journal of Research in Personality (21:4), pp. 493–509.
- Harmon-Jones, E., and Allen, J. J. B. 1997. "Behavioral Activation Sensitivity and Resting Frontal EEG Asymmetry: Covariation of Putative Indicators Related to Risk for Mood Disorders," Journal of Abnormal Psychology (106:1), pp. 159–163.
- Lieberman, M. D. 2007. "Social Cognitive Neuroscience: A Review of Core Processes," Annual Review of Psychology (58:1), pp. 259–289.

Exploring Sales Techniques through the Minds of Novice and Expert Salespersons

Adriane B. Randolph, A. Leila Borders, and Terry W. Loe, Kennesaw State University

Corresponding author: arandolph@kennesaw.edu

Neurophysiological recording techniques are helping provide an increased understanding of customers, where such methods are thought to uncover a person's true thoughts and feelings (Fugate 2007). These methods are now being extended to the salesperson to provide insights on selling methods through links with genetic markers and patterns of neuronal firing (Bagozzi, Verbeke et al. 2012). Here, we present an exploratory study using electroencephalographic (EEG) recordings to help salespeople have an increased understanding of their selling methods by looking through their eyes instead of through the eyes of the customer.

In today's market, power continues to shift to customers, and companies must increasingly focus on improving their marketing communication activities to be better than the competition. One aspect for focus is on personal selling, a direct attempt to influence and motivate customers to purchase goods and services by identifying their needs and providing personalized solutions to those needs. When companies focus on customer service, they gain six percent market share per year (Morrison 2001). It stands to reason that companies with experts in personal selling will gain the most. Thus, this study explores what can be discovered from EEG recordings of novice and expert salespersons.

Ten participants (5 expert and 5 novice) were fitted with a standard electrode cap for recording eight channels of EEG using a BioSemi Active Two bioamplifier system connected to a PC. The electrode cap was configured according to the widely used 10-20 system of electrode placement (Homan, Herman et al. 1987). Placement of the cap allowed for the recording of brain activations over the frontal lobe sampled at 256 Hz using active electrodes with a Common Average Reference (CAR). The eight recorded channels were: Fp1, Fp2, F3, F4, Fz, C3, C4, and Cz.

Once fitted with the electrode cap, participants sat still with their eyes open approximately three feet in front of a 21-inch LCD computer monitor which displayed a video clip lasting three minutes in duration of the initial approach used in a sales pitch. A woman was portrayed introducing herself to her male client and orienting him to a software product that she would be presenting. The video was recorded during the National Collegiate Sales Competition held annually at Kennesaw State University (www.ncsc-ksu.org).

Participant activations were measured according to the difference between the distribution of EEG amplitudes when the person was watching the video clip versus when he/she was at rest. Figure 1 illustrates preliminary data obtained from an expert and a novice salesperson who exhibited highest activity in the alpha and beta ranges respectively. The overall results indicate interesting differences between participants per hemispheric differentials (Davidson 1992) and frequencies.

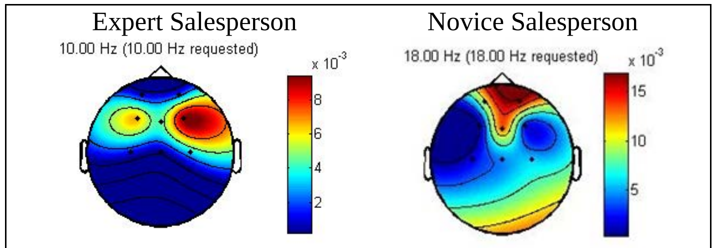

Figure 1. Topological plots of EEG activations across strongest frequencies for an industry expert in sales as compared with a novice.

Overall, this study seeks to lay a foundation for future exploration. It provides encouragement for more research to understand the differences between individuals, perceptions, and the impacts on selling techniques. This knowledge may be integrated into design considerations for computer-based training on sales that incorporates video to help model various techniques. Further, with the use of neurophysiological techniques, a salesperson's unconscious impressions about a customer and the scenario surrounding a sales pitch may be made conscious. Through this consciousness, the salesperson may better adapt his/her own selling techniques to the customer.

References

- Bagozzi, R. P., W. J. M. I. Verbeke, et al. (2012). "Genetic and neurological foundations of customer orientation: field and experimental evidence." Journal of the Academy of Marketing Science 40(5): 639-658.
- Davidson, R. J. (1992). "Anterior Cerebral Asymmetry and the Nature of Emotion." Brain and Cognition 20: 125-151.
- Fugate, D. L. (2007). "Neuromarketing: a layman's look at neuroscience and its potential application to marketing practice." Journal of Consumer Marketing 24(7): 385-394.
- Homan, R. W., J. Herman, et al. (1987). "Cerebral location of international 10–20 system electrode placement." Electroencephalography and Clinical Neurophysiology 66(4): 376-382.
- Morrison, R. (2001). "The Business Process of Customer Retention and Loyalty." Customer Interaction Solutions.

Reconceptualizing Information Systems from the Activity Modality Perspective

Lars Taxén

lars.taxen@telia.com

The information system (IS) community has long debated the nature of ISs without reaching closure (e.g. Baskerville, 2012). This uncertainty may have contributed to spectacular IT project failures (e.g. Dalcher, 2003). Thus, there is a need to reconceptualize ISs from new and innovative positions. At previous NeuroIS retreats (2011, 2012), I have discussed the construct of *activity modalities* as a conceptual link between the brain and human action (Taxén, 2009). In this contribution I will pursue this line of inquiry into the IS area.

The activity modalities – objectivation, contextualization, spatialization, temporalization, stabilization, and transition – stand for fundamental dimensions by which we cognize the world in order to perform purposeful, coordinated and integrated actions. For example, it is necessary to conceive of the object of actions; that which is acted on. This is achieved by integrating afferent sensations from sensory modalities into an efferent, object permanence perception (objectivation).

Actions may be divided into the phases of *perception*, *manipulation* and *consummation* (Mead, 1938). In the perceptual phase the actor tries to comprehend the situation and what action possibilities it offers. In the manipulation phase the actor intervenes and changes something, and in the consummation phase, the actor assesses the results and effects of the action. These phases are intertwined, constantly evaluated, and modified during the action. This basic pattern is repeated in every situation the actor becomes involved in.

The perception phase will invoke at least objectification, contextualization, and spatialization, since these modalities are pertinent to the comprehension of the situation. The temporalization modality is involved in the evaluation of action possibilities. The stabilization modality is manifested by repeatedly carrying out the action cycle; gradually resulting in the establishment of relevant actions patterns. Transition, finally, is at play when a new situation is attended.

An IS is a means used to support the integration of actions in a certain situation. A tentative analysis of ISs from an activity modality perspective is as follows. A first observation is that the inherent "worldview" of the IS, i.e., the type categories from which item instances can be instantiated, needs to comprise all modalities and their interdependencies. Thus, the IS must be capable of managing information pertinent to the object in focus for actions; the context formed around the object; relevant things in that context; the sequence of actions directed towards the object; rules, standards, norms, etc., expressing relevant actions; and the transition to other contexts. In addition, the IS must be easily modifiable as the situation stabilizes.

It can be noted that the perception phase may be associated with the constructs of perceived usefulness and perceived ease of use suggested by the Technology Acceptance Model (TAM; Davis, 1989). For example, perceived usefulness will be influenced by the IS's expressiveness of the object and the context around it.

A central observation is that there is, in principle, no difference between individual or collective use of the IS. The activity modalities are grounded in our biological constitution, which means that they are at play in both situations. As a consequence, the problematic notion of "levels" (e.g. individual, group, organization, etc.) can be eschewed.

I will illustrate the activity modality conceptualization of ISs by some concrete examples. In general, extant ISs appear to lack several features that would enable a complete, integrated management of the activity modality percept. In particular, support for the contextualization modality seems to be absent. Also, an evolutionary way of working is usually not endorsed.

The gist of this contribution is that ISs are, in principle, no different from other means that mankind have employed in the struggle for survival. In order to be proficiently used, ISs should adhere to our innate predispositions for acting in the world, i.e. the activity modalities. Thus, the modalities may inform a biologically grounded design and implementation of ISs in organizations.

References

- Baskerville, R. (2012). Reviving the IT in the IS. *European Journal of Information Systems, 21*, 587-591.
- Dalcher, D. (2003). Beyond Normal Failures: Dynamic Management of Software Projects. *Technology Analysis & Strategic Management, 15*(4), 421-439.
- Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, 13*(3), 319-339.
- Mead, G.H. (1938). *Philosophy of the act.* Chicago: University of Chicago Press.
- Taxén, L. 2009. *Using Activity Domain Theory for Managing Complex Systems,* Information Science Reference, PA: Hershey, ISBN: 978-1-60566-192-6.

The Neural Correlates of Seller Reputation in an Online Market

Qing Xu, Zhejiang University, Shirley Gregor, Australian National University

Corresponding author: xuqing@zju.edu.cn

Online feedback systems provide a mechanism to signal seller reputations to transactors and facilitate technology-mediated cyber markets. On eBay, total feedback score and a star symbol are placed next to the seller ID at the top of the feedback profile. The seller ranking can be strongly signaled by the star, which changes from a yellow star to silver shooting star with an increase in the feedback score. A body of research provides evidence for the effect of seller reputation, indicated by ratings and reviews, on online auction behavior, including sales (Li and Hitt, 2008; Archak et al., 2011; Chevalier and Mayzlin, 2006), price premium (Ba and Pavlou, 2002), sale time (Ghose et al., 2009), and market share (Duan et al., 2009). The development of neuroscience provides the potential to explore bidder behavior at a deeper level and to offer better theoretical explanations for online auction behavior (Dimoka et al., 2012b).

In electronic commerce, Dimoka et al. (2010) first identified the neural correlates of trust and distrust evaluation with four sets of seller profiles. They used textual scales for trust and distrust to measure the cognitive processing for these two constructs. This study extends their work and uses an advanced method to detect online seller reputation computation during online bidding activity.

In the process of online auction, bidders first assign a "goal value" (Rangel et al., 2008), to a product and then make a bid. "Willingness-To-Pay" (WTP) is computed during the bidding. The Becker-DeGroot-Marshak (BDM) auction (Becker et al., 1964) has been widely adopted to measure WTP in marketing science and was recently introduced into consumer neuroscience for a similar purpose (Plassmann et al., 2007; Linder et al., 2010; Harris et al., 2011). This study adopted the BDM auction mechanism to measure value computation in two real online bidding tasks.

This study aims to investigate the effect of online reputation, reflected by seller ranking (e.g., hearts versus crowns), on WTP with behavioral and neural data. A within-subject factorial fMRI experiment was designed with three phases: a pre-scanning, a scanning, and a post-scanning phase. The tasks of subjects were to bid a price for a range of products in BDM auctions. In the pre-scanning phase, subjects bid for products to get the "base" product value (without seller rankings). In the scanning phase, subjects bid for products provided by the given seller (five-heart seller or five-crown seller) to obtain the "combined" value (with seller rankings included). Self-report measures for seller reputation were collected in the post-scanning phase.

This study advances the measurement of online seller reputation by directly detecting value computation during auction bidding. Borrowing from consumer neuroscience, the BDM auction provides an effective method to evoke cognitive processing (i.e. value computation of WTP). A multi-method approach was applied to measure and understand the effect of seller reputation on WTP. The study contributes by identifying the brain area responding in the value computation of seller reputation, and providing the neural evidence for the effect of seller reputation on price.

References

- Archak, N., Ghose, A., & Ipeirotis, P. G. (2011). Deriving the Pricing Power of Product Features by Mining Consumer Reviews. *Management Science, 57*(8), 1485–1509.
- Ba, S., & Pavlou, P. A. (2002). Evidence of the effect of trust building technology in electronic markets: price premiums and buyer behavior. *MIS Quarterly*, *26*(3), 243–268.
- Becker, G. M., Degroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Behavioral Science*, *9*(3), 226–232.
- Chevalier, J., & Mayzlin, D. (2003). The Effect of Word of Mouth on Sales: Online Book Reviews. *Journal of Marketing Research, XLIII*(August), 345–354.
- Dimoka, A. (2010). What does the brain tell us about trust and distrust? Evidence from a Functional Neuroimaging study. *MIS Quarterly*, *34*(2), 1–24.
- Dimoka, A., Banker, R. D., Benbasat, I., Davis, F. D., Dennis, A. R., Gefen, D., Gupta, A., et al. (2012b). On the Use of Neurophysiological Tools in IS Research : Developing a Research Agenda for NeuroIS. *MIS Quarterly*, *3*, 679–702.
- Dimoka, A., Yili Hong, Paul A. Pavlou: On Product Uncertainty in Online Markets: Theory and Evidence. *MIS Quarterly, 36*(2): 395-426 (2012a)
- Duan, W., Gu, B., & Whinston, A. (2009). Informational cascades and software adoption on the Internet: An empirical investigation. *MIS Quarterly*, *33*(1), 23–48.
- Ghose, A. (2009). Internet Exchanges for Used Goods: An Empirical Analysis of Trade Patterns and Adverse Selection. *MIS Quarterly, 33*(2), 263–291.
- Harris, A., Adolphs, R., Camerer, C., & Rangel, A. (2011). Dynamic Construction of Stimulus Values in the Ventromedial Prefrontal Cortex. (B. J. Harrison, Ed.)*PLoS ONE*, *6*(6), e21074.
- Li, X., & Hitt, L. M. (2008). Self-Selection and Information Role of Online Product Reviews. *Information Systems Research, 19*(4), 456–474.
- Linder, N. S., Uhl, G., Fliessbach, K., Trautner, P., Elger, C. E., & Weber, B. (2010). Organic labeling influences food valuation and choice. *NeuroImage*, *53*(1), 215–20.
- Pavlou, P. A., & Dimoka, A. (2006). The Nature and Role of Feedback Text Comments in Online Marketplaces : Implications for Trust Building , Price Premiums , and Seller Differentiation. *Information Systems Research, 17*(4), 392–414.
- Plassmann, H., O'Doherty, J., & Rangel, A. (2007). Orbitofrontal cortex encodes willingness to pay in everyday economic transactions. *The Journal of neuroscience, 27*(37), 9984–8.
- Rangel, A., Camerer, C., & Montague, P. R. (2008). A framework for studying the neurobiology of value-based decision making. *Nature reviews. Neuroscience*, *9*(7), 545–56.

Sponsors