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Users' Cognitive and Emotional Costs of Rebuilding Habits: The Case of Mobile Banking

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ABSTRACT

Users' constant interaction with digital interfaces and applications facilitates the development of habits in a given context. An interface redesign can disrupt a person's established use pattern. As companies frequently update and redesign their digital applications, it is crucial to uncover the impact of interface re-adaptation on their clients' attitudes and user experience. A within-subjects laboratory experiment was conducted with current users of an existing mobile banking application. Participants performed a series of tasks during consecutive visits to the current and updated versions of the application. Psychophysiological, perceptual, and behavioral data were collected via measurement of cognitive load, emotional experience, subjective attitude, and objective performance. Results suggest interface changes that disrupt users' cognitive scripts impair re-adaptation; this entails greater cognitive load, perceived effort, and task completion times, as well as worsened perceptions of navigability during the completion of familiar tasks on the new interface. Theoretical and practical implications are discussed.

Keywords

User interface design; Cognitive load; NeuroIS; Emotion; Habit; User Experience

INTRODUCTION

The increasingly competitive marketplace makes it imperative for today's businesses to engage in digital transformation and gain advantages over their competitors. According to Gartner (2022), worldwide IT spending in 2022 is poised to reach $4.4 trillion, with a shift of focus from mortar to virtual business. Accordingly, to improve the service experience of their users in this digital world, firms and organizations are making considerable investments in upgrading their official websites and mobile applications, especially in terms of user interface presentation and interaction logic design (Veilleux et al., 2020). These changes are expected to elicit positive feedback from users, in both the cognitive and emotional responses to the redesigned interface (Éthier et al., 2008; Schmutz et al., 2009). However, such a redesign may also degrade the user experience of browsing a digital application interface and performing tasks since even marginal changes in a habitually-used webpage can impose a necessary re-adaptation process on its users (Dargent et al., 2019; Garaialde et al., 2020). As a result, it is possible that the consequent increase in cognitive effort involved in the re-adaptation can temporarily worsen the user's experience and attitude toward the updated interface. Therefore, a user's ability to quickly re-adapt to the changes in an interface may suggest whether a redesign can indeed achieve its desired outcome. However, to the best of our knowledge, there is no prior research comparing the immediate responses from users who can easily adapt to performing tasks on the first use of the new interface and those who cannot. Thus, this study aims to explore the cognitive and emotional costs, as well as the attitude changes of using the updated version of a utilitarian application for the first time. Specifically, we are interested in the following research question:

RQ. What are the differences in the experience and perceptions of users as a function of their ability to quickly readapt and perform tasks on a redesigned digital application interface?

To answer this question, this study measured the user's attitudes and experience before and after the release of an updated mobile application of a major North American bank. We conducted a within-subjects experiment in a usability laboratory with 15 participants sampled among the users of the current application.

BACKGROUND AND THEORY

Cognitive Script Theory

Derived from the concept of schema, cognitive script theory originated in cognitive psychology through the work of Schank and Abelson (1975). A cognitive script indicates a sequence of events that can be expected in a certain context, including the role an individual is assumed to perform and the consequences of this individual's behaviors (Schank and Abelson, 1975). When practicing performing a task, the involved actions are arranged and stored in a human's long-term memory in the hierarchical or causal order of their elements (Erasmus et al., 2002), formulating cognitive scripts. Through reinforcement via continuous learning, these scripts can be automatically applied when the same context occurs (Bozinoff and Roth, 1983). In other words, scripts function as a mental model developed from the repetition of task execution, enabling humans to perform the same tasks without consciousness. Cognitive scripts theory was later introduced to other disciplines. So far, cognitive scripts theory has been acknowledged and broadly applied in marketing and information system research to explain consumer behavior in both online and offline settings (Erasmus et al., 2002; Sénécal et al., 2012), such as the decision-making for purchasing. Once accessing stimuli associated with a cognitive script, the individual will activate the script and draw on the previous behavior pattern to make decisions that reduce the mental effort needed (Bar and Neta, 2008). For example, a loyal customer of an e-shopping vendor will automatically follow the same path for each visit to the website. The user does not need to consciously learn how to navigate through different web pages and use varied website elements each time, thus minimizing the cognitive effort of learning the functions and navigation of the web interface. When an individual is faced with variations in the logic of action execution, there can be different script paths functioning as alternatives (Forrest-Pressley et al., 1985). For instance, if the product that customers want to purchase is displayed on the main page of a shopping website as a special deal, the customers do not need to search for it using the search engine on the site; Instead, they only need to use the shortcut.

The Interface Habits

A cognitive script can sometimes become a habit, especially when there is no alternative script path (Erasmus et al., 2002). Habits refer to "*learned sequences of acts that have become automatic responses to specific cues and are functional in obtaining certain goals or end states*" (Verplanken and Aarts, 1999, p. 104). Through a certain amount of repetition or practice in a relatively stable context, individuals will form learned, automatic responses to situational cues. Once established, habits will be executed automatically when individuals detect situational cues, leading to effortless and efficient habitual behaviors that do not need cognitive processing and deliberate control (Polites and Karahanna, 2013). In the context of IS use, individuals' habits have been identified as an alternative mechanism for rational models to explain post-adoptive behaviors (Bhattacherjee and Lin, 2015). HCI researchers have long engaged in discussions related to habits such as the mechanism of habituating the interaction with digital interfaces (Gerlach and Cenfetelli, 2020; Oulasvirta et al., 2012). In practice, the concept of fostering user habits has also been considered in the general guidelines of interface design. For instance, the rule of consistency, predictability, and standardization of presentation proposed by Shneiderman and Plaisant (2010) implies the IT interface characteristics capable of facilitating the formation and maintenance of user habits. The long-term use of utilitarian digital interfaces often involves similar or the same set of actions in a consistent and familiar environment, creating the three favorable conditions for habit development: stable contexts, frequency of behaviors, and satisfaction. First, a consistent and familiar environment corresponds to stable contexts, signifying the situational cues that could trigger one's propensity to repeat automatic action execution (Wood et al., 2002). Therefore, if individuals use a specific application to perform a fixed set of tasks over a period of time, especially when there are no frequent changes in the interfaces, it is highly possible that they have habituated their behaviors on those interfaces. Second, long-term use means a higher frequency of action execution, and similar actions allude to repetition. Highly repetitive tasks will increase individuals' familiarity with the digital interface and application, facilitating the "learning" of automatic responses (Limayem et al., 2007). Third, the use of interfaces for utilitarian purposes implies the behavioral execution should lead to desirable rewards (e.g., complete transactions) in most cases (since the interface is designed to have such a function), and satisfactory experiences can increase users' willingness to engage in the repetition of the same actions, increasing the frequency of behaviors (Verplanken and Aarts, 1999).

The Consequences of Interface Update

An interface redesign with the improvement of information architecture and interaction logic, ideally, will lead to a decrease in user cognitive load during the interaction with a digital application. Such changes in a user's physiological state should in turn enhance their efficiency (e.g., time taken for task completion) and effectiveness (e.g., quality of task completion outcome), thus shaping a more positive perception of the usability of the application. On the other hand, the redesign of an interface introduces changes in the paths for task completion. Users cannot finish the same tasks if they mindlessly follow their previous habits to navigate through the pages because the destination of the established paths does not point at the desired function anymore. Accordingly, they would have to re-adapt to the new information architecture, navigation design, and take a different route (Garaialde et al., 2020), implying a process of breaking current habits and reconstructing cognitive scripts. Constructing cognitive scripts and redeveloping habits requires active learning, thus users are expected to be cognitively involved in this process (Erasmus et al., 2002). Consequently, the redesign of an established interface could increase the cognitive effort exerted to fulfill the same goal (e.g., acquire information). Cognitive load, the required amount of users' working memory resources to perform a task (Antonenko et al., 2010), will increase during initial interactions with a brand-new interface (Sénécal et al., 2012). Furthermore, cognitive load is often associated with the difficulty of use (Ikehara and Crosby, 2005), which can be reflected in user emotional experience and attitudes during the interaction with an IT artifact (Davis, 1989; Tuch et al., 2009). A rich tradition of research has also recognized the users' emotional changes while coping with IT changes (Beaudry and Pinsonneault, 2010; Sénécal et al., 2015). Since breaking habits means scripts cannot reduce the difficulties of performing tasks through automatic cognitive processing, user valence and arousal, the two dimensions of emotion (Russell, 1980), are expected to be adversely impacted in this re-adaptation process, which also applies to the perceptions of the usability of the new interface. Only if a user can finish re-adaptation to a new version in a relatively short time, the reconstructed cognitive scripts can help minimize the cognitive effort required for task completion. In contrast to when the users are able to quickly re-adapt, a distinct changing pattern in user attitudes and experience is expected for the cases where they cannot re-adapt quickly and perform tasks as effectively as before.

METHOD

Participants

Fifteen participants (i.e., six females and nine males) who regularly used the current version of a financial institution's mobile application were recruited for this study and compensated with $125 at its completion. The age of participants ranged from 19 to 63, with a mean of 42. This study was approved by the HEC Montréal Research Ethics Board (REB) (certificate #2022-4850) and was carried out with written informed consent obtained from all participants involved.

Experimental Design

This experiment adopted a within-subjects design. Participants visited the prototype of the current banking application and then switched to an updated version (i.e., a prototype that featured a redesigned information architecture intended to improve the application's usability) that had not been released. For each visit, they were required to perform nine randomized tasks (e.g., check the last transaction), which generated 135 pairs of trials (n = 270 trials in total). For each trial, three sets of variables, namely user experience of task execution, performance, and attitude towards the application, were collected using psychophysiological methods, a back-end timer (not visible to the user), and questionnaires, respectively.

Measures

Performance. In each trial, the time taken by the participant to finish the given task (i.e., reach the destination page) was used as an indicator of the objective performance of task completion. During the experiment, Tobii Pro Lab software (Tobii Technology, Danderyd, Sweden) was used to record the screen that the participants interacted with. The start and end of each trial were marked with time stamps based on the recording. The time taken was calculated as the time lag between the two markers.

User Attitude Toward Application. The user's attitude toward the application was assessed in *navigability*, *understandability*, and *effort*. *Navigability* is the degree to which an interface facilitates specific user tasks, with a focus on design elements that allow users to find information (McKinney et al., 2002; Wojdynski and Kalyanaraman, 2016): users feel it is easier to navigate a website and locate information to fulfill their goals when the interface navigability is high. *Understandability* refers to the ease of comprehension of the information that an interface presents to users, often associated with the clearness and goodness of information (Cheung and Lee, 2005). *Effort* was assessed via the Customer Effort Score (CES), which measures how much effort customers perceive they must exert to fulfill a goal (Dixon et al., 2010). All variables were assessed with 7-point Likert scales adapted from validated scales in extant literature: navigability, understandability (McKinney et al., 2002), and customer effort score (CES) (Dixon et al., 2010).

User Experience. The user's experience was evaluated on the basis of their emotional (i.e., valence and arousal) and cognitive (i.e., cognitive load) states. Emotional valence was recorded and modeled as a continuous numeric value by Noldus FaceReader (Noldus Technology, Wageningen, Netherlands), a facial expression recognition tool. This software captures the micro-movements of facial muscles and scores valence from –1 to +1 for negative and positive emotions, respectively. Arousal was measured with the Biopac MP-150 system (Biopac Systems, Goleta, United States) with electrodermal activity (EDA) sensors. Phasic EDA scores measure eccrine activity that is impacted by sympathetic nervous system activity evoked by stimuli (Dawson et al., 2017) and has been used as an indicator of arousal ranging from calm to excitement (Maia and Furtado, 2016). Pupillometry (i.e., pupil diameter) was used as the measure of cognitive load as it has been shown to have a positive relationship with cognitive load (Laeng et al., 2012). The dilation of pupils implies an increase in cognitive load when distance and lighting conditions are controlled. A Tobii Pro Nano eye tracker (Tobii Technology, Danderyd, Sweden) was used to trace participants' pupil diameter. Post-synchronization of the three types of original physiological data was performed with the Cobalt Photobooth system (Courtemanche et al., 2022; Léger et al., 2019).

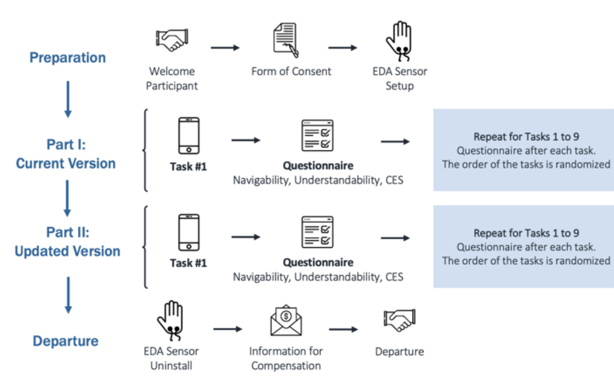

Figure 1. Experimental Design

Data Analysis

Participants completed a questionnaire measuring the user attitude variables at the end of each task. EDA sensors, FaceReader, and an eye tracker kept working throughout the experiment. Therefore, each of the 270 trials in this experiment produced observations of the abovementioned single performance variable, three user experience variables, and three attitude variables. After removing invalid trial pairs in which users did not follow the instruction to complete the specific task, a total of 131 pairs of trials were produced to compare observed measures of the same tasks between the old and new versions.

For each participant, the difference in the time taken to complete a given task with the new and old versions is calculated (Δ time = time(new) – time(old)). Prior research has found that development of interface use habits will lead to the improvement of task performance speed, while breaking the established habits increased the time taken to finish tasks until the re-habituation was finished (Garaialde et al., 2020). In accordance with this finding, we used Δ time to determine whether participants had finished re-adaptation in the initial visit. When Δ time ≤ 0 for a pair of trials (i.e., the time taken is reduced after changing to the new interface), participants are deemed as having successfully re-adapted to the new design. Otherwise, they are viewed as not having successfully re-adapted on the first visit to the new interface. We grouped all trial pairs based on whether the re-adaptation was successful. For each pair of trials, the changes in users' attitudes (e.g., Δ navigability) and experience (e.g., Δ valence) were also calculated using the same method as that of Δ time. For each variable, we captured the direction of changes by examining whether the delta Δ is positive or negative. For example, for a pair of trials involving participant *i* and task *j*, Δ valence > 0 means the participant has a higher valence level when using the new version for this task. To compare the magnitude of the changes in each variable, a two-tailed Mann–Whitney U test was conducted to examine whether there are significant differences in the changes in attitude (e.g., Δ navigability) and experience (e.g., Δ valence) between the trial pairs where participants successfully re-adapted to the new design (i.e., Δ time ≤ 0) and the pairs in which they failed to do so (i.e., Δ time > 0).

RESULTS

Figure 2 presents the difference in the time participants used to complete the same set of tasks after the banking application update. In 86 out of all 131 pairs of trials, the use of the new version of the application reduced the time taken to perform a given task (Δ time < 0); in another two pairs of trials, the time taken remained the same after the update (Δ time = 0). That means participants successfully re-adapted to the new design in most cases. Based on this result, trials were divided into successful (Group 1: n_1 = 88, Δ time ≤ 0) and unsuccessful re-adaptation groups (Group 2: n_2 = 43, Δ time > 0) for further comparisons.

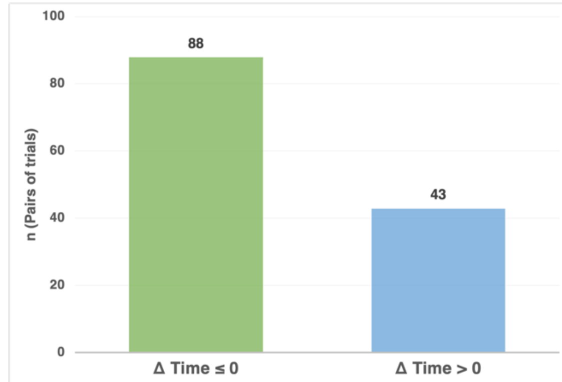

Figure 2. The Changes in the Time Taken for Task Completion after the Update

*Δ time = time (new) – time (old), calculated for the same task

Successful vs. Unsuccessful Re-adaptation in terms of the Changes in User Experience

The comparison of Δ valence, Δ arousal, and Δ cognitive load between the successful re-adaptation group (Group 1) and the unsuccessful group (Group 2) is shown in Figure 3.

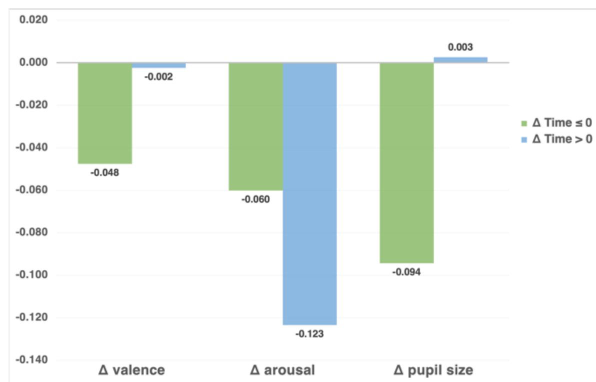

Figure 3. Successful vs. Unsuccessful Re-adaptation in terms of Δ Valence, Δ Arousal, and Δ Pupil Size

Δ Valence for Group 1 (Δ time ≤ 0) and Group 2 (Δ time > 0) are both less than zero, meaning no matter if performing a task with the new version took more or less time than doing it on the old version, participants always had lower emotional valence when faced with a new design. Δ Valence of Group 2 (M_{group2} = - 0.002) is greater than that of Group 1 (M_{group1} = - 0.048), but the difference is not significant (U = 984.0, p = 0.111).

Δ Arousal for Group 1 and Group 2 are both negative. The emotional arousal of participants decreased when they interacted with a new design, no matter whether they were able to quickly re-adapt to the update. There is no significant difference between Δ Arousal of Group 1 and Group 2 either (M_{group1} = - 0.060, M_{group2} = - 0.123, U = 1295.0, p = 0.570).

Δ Pupil size is negative for Group 1 and positive for Group 2. When performing tasks with the new version takes the same amount of time or less time (i.e., successful re-adaptation), participants exerted less cognitive effort; otherwise, they exerted more cognitive effort. Δ Pupil size of Group 1 (M_{group1} = - 0.094) is less than that of Group 2 (M_{group2} = 0.003), meaning the decrease in cognitive load is significantly greater (U = 827.0, p = 0.002) for the successful re-adaptation group than the unsuccessful one.

Successful vs. Unsuccessful Re-adaptation in terms of the Changes in Users' Attitudes

As Figure 4 shows, Δ Navigability is positive for Group 1 and negative for Group 2. Participants perceived the new interface as having a better navigation design when they could successfully re-adapt to the updated version. When the new version took the same or less time, the increase in perceived navigability is significantly greater (M_{group1} = 0.250, M_{group2} = - 0.512, U = 2474.0, p = 0.002).

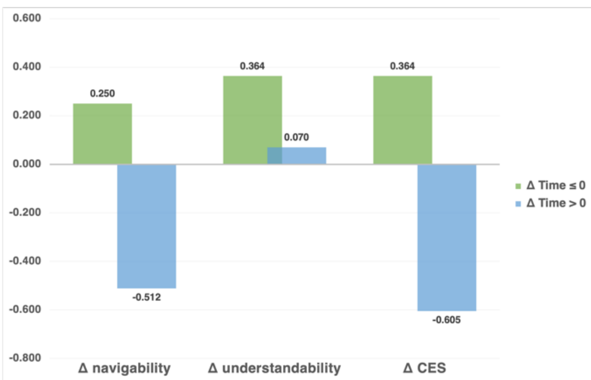

Figure 4. Successful vs. Unsuccessful Re-adaptation in terms of Δ Navigability, Δ Understandability, and Δ CES

Δ Understandability is positive for both groups. Regardless of the relative time taken for performing tasks, participants always perceived the redesigned application as better than the old one in terms of comprehensibility. The rise in understandability shows no significant difference between the successful and unsuccessful re-adaptation group (M_{group1} = 0.364, M_{group2} = 0.070, U = 2094.5, p = 0.279).

Δ CES is positive for Group 1 and negative for Group 2. When they could immediately re-adapt to the updated version, users perceived that it was easier to complete tasks on the new version; otherwise, they felt harder to complete the same task after the update. Δ CES of Group 1 (M_{group1} = 0.364) is greater than that of Group 2 (M_{group2} = - 0.605). The decrease in the self-reported cognitive effort is significantly larger (U = 2343.0, p = 0.017) when successfully re-adapting to the update, consistent with the psychophysiological measures presented in Figure 3.

DISCUSSION

Although their ability to successfully re-adapt to the changed interface does not impact emotions significantly, whether users can quickly re-adapt to a new design is indeed relevant to their cognitive responses. In the trials where users could rebuild habits quickly (i.e., efficiently), their cognitive load decreased when using the new version. Compared to those trials where the use of the new version increased the time taken, namely, where users are viewed as failing to re-adapt efficiently, the magnitude of such decrease in cognitive load is significantly larger for the successful re-adaptation group. The differences in the re-adaptation also imply the changes in users' attitude toward the interface: in contrast to trials with unsuccessful re-adaptation, the trials associated with successful re-adaptation show a significantly different changing trend of navigability and CES. In a nutshell, the two opposite directionalities of behavioral changes (i.e., successful and unsuccessful re-adaptation) always correspond to two distinct changing patterns in physiological and perceptual variables.

Theoretical Implications

This study enhances our understanding of the potential challenges incurred following an update of utilitarian application interfaces. As we theorized and observed, a script-based, habit-driven mechanism exists that explains individuals' physiological states and attitudes. As results showed, when the two groups of trials differ in the success of re-adaptation, they also show opposite trends in physiological and perceptual changes. It implies a potential causal effect in which breaking interface habits can lead to an increase in cognitive costs, and in turn adversely impact users' attitudes toward the new interface. On the other hand, the two opposite patterns of physiological responses and perceptions coexist in our dataset, suggesting the positive effect driven by intended design improvement and the negative effect driven by habit breaking may act together to shape the user's responses to an application interface redesign. Not all people are equal in the capability of handling the disturbance to their script-based, ingrained habits. Only if users can quickly rebuild their habits to an interface redesign will they benefit from said redesign (which often involves elements that are newly introduced to facilitate use) to save efforts. Otherwise, the negative impact of breaking habits is likely to worsen the user's experience and attitude toward the updated digital interface. In this case, the cognitive costs of re-adaptation offset the envisioned benefits of the interface improvement. By tracing the changes involved in the process of disturbing the established interface routine and unpacking the dual mechanisms that induce these changes, our results contribute to the literature on cognitive scripts, habits, and interface design.

Managerial Implications

This study also offers implications for practitioners to foster optimal user experience of interacting with a redesigned interface: Facilitating the re-adaptation process and minimizing the negative effects of breaking habits should be a primary concern. Design elements (e.g., icons and buttons) involved in the script paths formed on the old interface act as habitual cues. Any design changes in such cues may block the "gateway" to the automatic execution of behaviors (Garaialde et al., 2020). Thus, practitioners may consider maintaining consistency in some elements across the old and updated design. That is, some key gateway can be preserved to gradually acclimatize users to the updated interface. Managers and designers should focus more on cognitive costs rather than allocating substantial effort to evoke positive emotional responses from users when planning a release of application updates. Speeding up the re-adaptation process imposes stronger influences on cognitive load than on emotional valence, at least in utilitarian contexts. Furthermore, our findings also highlight a possible way to improve the technical and financial feasibility of usability tests in the industry. This empirical study further confirms that the key performance indicator (KPI) of task completion time can be viewed as a proxy for users' re-adaptation and be used to infer their physiological state in terms of cognitive load with a high degree of confidence. It can also be a proxy for navigability and perceived effort, and to a lesser degree, understandability. Therefore, this easier-to-use measure – task completion time - can serve as an alternative to psychophysiological measurement, which is often prohibitive for organizations (e.g., too expensive, lacking the necessary knowledge and equipment).

Limitations and Future Work

This study has two main limitations. Some tasks involve very short navigation paths. Thus, the average time taken to complete them is also shorter, leading to fewer observations of physiological variables sampled for these tasks. Since the values of valence, arousal, and pupil size were calculated as the standardized average score of the sampled records, fewer records mean the values for these shorter tasks were more susceptible to errors induced by measurement systems (e.g., outliers). Also, the sample size of this study was 15, i.e. a relatively small sample for a laboratory experiment. However, the average sample size of neurophysiological studies is smaller than that of information system studies using traditional research methods like surveys (Riedl et al., 2020). Considering this study adopted repeated measures based on within-subject designs, and the number of trials used for analysis is 131, we believe it is an acceptable sample size. Nevertheless, we encourage future research to explore the generalizability of our results with a larger population group.

CONCLUSION

Changing a familiar interface could disrupt its users' habitual routines of frequently performed tasks, thus offsetting the benefits expected by a redesign aimed at improving the digital interface and application. To aid designers in solving this paradox, this research examined the impact of an interface redesign on users' cognitive and emotional responses, performance, and attitudes, as assessed by psychophysiological, behavioral, and perceptual measures. The results suggest that the users' ability to quickly re-adapt to the new design is highly relevant to their cognitive responses and perceptions of usability. The successful rebuilding of interface use habits is always associated with a greater decrease in user cognitive load experienced during task completion as well as a greater increase in the perceived navigability and ease of use of the digital interface and application.

REFERENCES

1. Antonenko, P., Paas, F., Grabner, R. and Van Gog, T. (2010) Using Electroencephalography to Measure Cognitive Load, *Educational Psychology Review*, 22, 4, 425–438.
2. Bar, M. and Neta, M. (2008) The Proactive Brain: Using Rudimentary Information to Make Predictive Judgments, *Journal of Consumer Behaviour: An International Research Review*, 7, 4-5, 319–330.
3. Beaudry, A. and Pinsonneault, A. (2010) The Other Side of Acceptance: Studying the Direct and Indirect Effects of Emotions on Information Technology Use. *MIS Quarterly*, 34, 4, 689–710.
4. Bhattacherjee, A. and Lin, C.-P. (2015) A Unified Model of IT Continuance: Three Complementary Perspectives and Crossover Effects. *European Journal of Information Systems*, 24, 4, 364–373.
5. Bozinoff, L. and Roth, V. J. (1983) Recognition Memory for Script Activities: An Energy Conservation Application, *Advances in Consumer Research*, 10, 1, 655-660.
6. Cheung, C. M. and Lee, M. K. (2005) The Asymmetric Effect of Website Attribute Performance on Satisfaction: An empirical study, *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, 175c–175c.
7. Courtemanche, F., Léger, P. M., Fredette, M. and Sénécal, S. (2022) COBALT-Photobooth: Integrated UX Data System. *Montréal: HEC Montréal*.
8. Dargent, T., Karran, A., Léger, P.-M., Coursaris, C. K. and Sénécal, S. (2019) The Influence of Task Types on User Experience after a Web Interface Update, *The Eighteenth Annual Pre-ICIS HCI/MIS Research Workshop*, Munich, Germany.
9. Davis, F. D. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information technology, *MIS Quarterly*, 13, 3, 319–340.
10. Dawson, M. E., Schell, A. M. and Filion, D. L. (2017) The Electrodermal System, In *Handbook of Psychophysiology*, pp. 217–243.
11. Dixon, M., Freeman, K. and Toman, N. (2010) Stop Trying to Delight your Customers, *Harvard Business Review*, 88, 7/8, 116–122.
12. Erasmus, A. C., Bishoff, E. and Rousseau, G. G. (2002) The Potential of Using Script Theory in Consumer Behaviour Research, *Journal of Family Ecology and Consumer Sciences*, 30, 1, 1–9.
13. Éthier, J., Hadaya, P., Talbot, J. and Cadieux, J. (2008) Interface Design and Emotions Experienced on B2C

Web Sites: Empirical Testing of a Research Model, *Computers in Human Behavior*, 24, 6, 2771–2791.

14. Forrest-Pressley, D.-L., MacKinnon, G. E. and Waller, T. G. (1985) *Metacognition, Cognition, and Human Performance*, Vol. 2, Academic Press.
15. Garaialde, D., Bowers, C. P., Pinder, C., Shah, P., Parashar, S., Clark, L. and Cowan, B. R. (2020) Quantifying the Impact of Making and Breaking Interface Habits, *International Journal of Human-Computer Studies*, 142, 102461.
16. Gartner. (2022, April 6) *Gartner Forecasts Worldwide IT Spending to Reach $4.4 Trillion in 2022*. Retrieved 20 August 2022, from https://www.gartner.com/en/newsroom/press-releases/2022-04-06-gartner-forecasts-worldwide-it-spending-to-reach-4-point-four-trillion-in-2022
17. Gerlach, J. P. and Cenfetelli, R. T. (2020) Constant Checking Is Not Addiction: A Grounded Theory of IT-Mediated State-Tracking, *MIS Quarterly*, 44, 4.
18. Ikehara, C. S. and Crosby, M. E. (2005) Assessing Cognitive Load with Physiological Sensors, *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, 295a–295a.
19. Laeng, B., Sirois, S. and Gredebäck, G. (2012) Pupillometry: A Window to the Preconscious? *Perspectives on Psychological Science*, 7, 1, 18–27.
20. Léger, P.-M., Courtemanche, F., Fredette, M. and Sénécal, S. (2019) A cloud-based lab management and analytics software for triangulated human-centered research, In *Information Systems and Neuroscience*, Davis, F.D., Riedl, R., vom Brocke, J., Léger, P.-M., Randolph, A.B. (eds.) pp. 93–99. Springer, Cham.
21. Limayem, M., Hirt, S. G. and Cheung, C. M. (2007) How Habit Limits the Predictive Power of Intention: The Case of Information Systems Continuance, *MIS Quarterly*, 705–737.
22. Maia, C. L. B. and Furtado, E. S. (2016) A Study about Psychophysiological Measures in User Experience Monitoring and Evaluation, *Proceedings of the fifteenth Brazilian Symposium on Human Factors in Computing Systems*, 1–9.
23. McKinney, V., Yoon, K. and Zahedi, F. Mariam. (2002) The Measurement of Web-Customer Satisfaction: An Expectation and Disconfirmation Approach, *Information Systems Research*, 13, 3, 296–315.
24. Oulasvirta, A., Rattenbury, T., Ma, L. and Raita, E. (2012) Habits Make Smartphone Use More Pervasive, *Personal and Ubiquitous Computing*, 16, 1, 105–114.
25. Polites, G. L. and Karahanna, E. (2013) The Embeddedness of Information Systems Habits in Organizational and Individual Level Routines: Development and Disruption, *MIS Quarterly*, 221–246.
26. Riedl, R., Fischer, T., Léger, P.-M. and Davis, F. D. (2020) A Decade of NeuroIS Research: Progress, Challenges, and Future Directions, *ACM SIGMIS Database: The DATABASE for Advances in Information Systems*, 51, 3, 13–54.
27. Russell, J. A. (1980) A Circumplex Model of Affect, *Journal of Personality and Social Psychology*, 39, 6, 1161.
28. Schank, R. C. and Abelson, R. P. (1975) Scripts, Plans, and Knowledge, *IJCAI*, 75, 151–157.
29. Schmutz, P., Heinz, S., Métrailler, Y. and Opwis, K. (2009) Cognitive Load in eCommerce Applications – Measurement and Effects on User Satisfaction, *Advances in Human-Computer Interaction*, 2009, 1-9.
30. Sénécal, S., Fredette, M., Léger, P.-M., Courtemanche, F. and Riedl, R. (2015) Consumers' Cognitive Lock-in on Websites: Evidence from a Neurophysiological Study, *Journal of Internet Commerce*, 14, 3, 277–293.
31. Sénécal, S., Léger, P.-M., Fredette, M. and Riedl, R. (2012) Consumers' Online Cognitive Scripts: A Neurophysiological Approach, *Proceedings of the 33rd International Conference on Information Systems.*
32. Shneiderman, B. and Plaisant, C. (2010) Designing the User Interface: Strategies for Effective Human-Computer Interaction, Pearson Education India.
33. Tuch, A. N., Bargas-Avila, J. A., Opwis, K. and Wilhelm, F. H. (2009) Visual Complexity of Websites: Effects on Users' Experience, Physiology, Performance, and Memory, *International Journal of Human-Computer Studies*, 67, 9, 703–715.
34. Veilleux, M., Sénécal, S., Demolin, B., Bouvier, F., Fabio, M.-L. D., Coursaris, C. and Léger, P.-M. (2020) Visualizing a User's Cognitive and Emotional Journeys: A Fintech Case. *International Conference on Human-Computer Interaction*, LNCS, 12200, 549–566.
35. Verplanken, B. and Aarts, H. (1999) Habit, Attitude, and Planned Behaviour: Is Habit an Empty Construct or an Interesting Case of Goal-Directed Automaticity? *European Review of Social Psychology*, 10, 1, 101–134.
36. Wojdynski, B. W. and Kalyanaraman, S. (2016) The Three Dimensions of Website Navigability: Explication and Effects, *Journal of the Association for Information Science and Technology*, 67, 2, 454–464.
37. Wood, W., Quinn, J. M. and Kashy, D. A. (2002) Habits in Everyday Life: Thought, Emotion, and Action, *Journal of Personality and Social Psychology*, 83, 6, 1281.