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From Well-meaning to Well-being: A NeuroIS Study to Assess the Importance of IT Identity and Emotions in Technology Feedback Interactions Related to Health

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Research-in-Progress Paper

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Abstract

Growing use of patient-facing health information technologies (HIT) has contributed to increased prevalence of technology feedback in healthcare contexts. Although this feedback has potential to help users improve their well-being, prior studies indicate that its impacts on behaviour adaptation are inconsistent. Recent literature suggests that emotions and IT identity, or the extent to which one views technology as being integral to their sense of self, may have importance where technology feedback is concerned. The following research question is thus proposed: What are the relationships between emotions, IT identity, and behaviour adaptation in technology feedback interactions? A pilot study will be performed using a chatbot powered by artificial intelligence that provides feedback related to well-being. NeuroIS tools will be used to obtain physiological measures of emotions. The results will indicate how technologies can be designed to optimize behaviour adaptation by prompting positive emotions and IT identity in users.

Keywords: Technology feedback, emotion, valence, arousal, IT identity, source credibility, health information technology (HIT), patient-facing, chatbot, NeuroIS, electrodermal activity (EDA), facial recognition

Introduction

Health information technology (HIT) is increasingly pervasive in the lifestyles and self-care activities of individuals (Meskó et al. 2017). Defined as a range of technologies that allow medical information to be stored, shared, and analyzed (Kruse and Beane 2018), HIT has stimulated many changes in the healthcare environment. Among these changes, transformation of the process through which health feedback is acquired is notable (Nisha et al. 2019). Feedback, which is defined as information that indicates how well an individual is meeting various goals (Ashford and Cummings 1983), is of tremendous importance to well-being (DiClemente et al. 2001). HIT is valued for its capacity to generate and deliver feedback, which can help individuals to improve their health awareness and self-regulation (Hermsen et al. 2016). For example, wearable fitness trackers are commonly used to provide users with personalized feedback on their exercise performance (Becker et al. 2017). Technologies with such capabilities are considered patient-facing HITs as they enable individuals to independently collect and access personal health information without assistance from a healthcare provider (Ahern et al. 2011).

Patient-facing HIT can be programmed to provide technology feedback, which is generated using artificial intelligence to match a user's performance data. Although technology feedback is increasingly prominent in a variety of contexts (e.g. Schaeffer et al. (2016) discuss technology feedback in education), research concerning this type of feedback is deficient and urgently warranted (Hermsen et al. 2016). Levy et al.

(2020) note a lack of research around the use of digital applications and mobile devices as a means of providing real-time feedback. Furthermore, studies that assess these tools suggest that technology feedback does not consistently contribute to improved outcomes. As preserving health is the fundamental purpose of most healthcare activities (Porter 2010), technology feedback should be designed to help patients adapt their behaviours to improve their performance. However, behaviour adaptation is not always achieved. For example, Pagoto and Bennett (2013) highlight inconsistencies in the efficacy of mobile health apps intended to help patients track and improve their diets. Such inconsistencies have prompted calls for increased consideration of human behaviour in research related to digital health innovations and technology feedback (Meskó et al., 2017; Pagoto & Bennett, 2013).

Savoli and Bhatt (2017) propose that emotions are integral to users' responses to technology feedback. It is possible that the impact of emotions can explain some of the variance in prior patient-facing HIT studies, particularly as prior literature identifies a need to evaluate how digital applications for self-care affect patients' feelings and thoughts (Nijland et al. 2008). Savoli and Bhatt (2017) also propose that information technology (IT) identity, or the extent to which can individual views use of technology as being integral to their sense of self (Carter and Grover 2015), has an important influence where technology feedback is concerned. Since IT identity is connected to emotions and partly measured in terms of one's emotional attachment to technology (Carter et al. 2020), both emotions and IT identity ought to be considered in tandem as influences in technology feedback interactions. Therefore, a pilot study is proposed to better understand how emotions and IT identity contribute to behaviour adaptation. This study will explore the following question in the context of health-related technology feedback: *What are the relationships between emotions, IT identity, and behaviour adaptation in technology feedback interactions?*

This proposed study extends Savoli and Bhatt's (2017) propositions by empirically evaluating the influence of IT identity in technology feedback interactions and exploring how this construct may impact behaviour adaption, which is recognized as an important outcome in health-related interventions (Umberson et al. 2010). Additionally, this study will make use of NeuroIS tools to obtain physiological measures of emotions. NeuroIS is a developing area of research that applies cognitive neuroscience theories, methods, and tools to evaluate IS phenomena (vom Brocke et al. 2020). Most studies that employ NeuroIS methods use eye tracking or functional magnetic resonance imaging (fMRI) to measure physiological responses to a stimulus, but other tools can also offer valuable indications of an individual's physical and emotional reactions (Fischer et al. 2019). This study will employ emerging NeuroIS techniques, including facial recognition and electrodermal activity (EDA) monitoring, and thus offers a contribution to the IS field by testing these research tools to further develop NeuroIS techniques. These contributions align with the values of the Association for Information Systems Women's Network (AISWN) and its promotion of research that supports healthcare IT and the use of technology to stimulate healthy living.

Theoretical Background

Interactive technologies that enable self-management of health have experienced the largest growth among digital health developments (Singh et al. 2019). Thus, the influence of patient-facing HITs on health-related decisions and actions has increased and particularly impacted the way health information and feedback are accessed. Feedback is critical for patients to effectively manage their well-being, and patient-facing HIT can provide considerable value by enabling access to timely and personalized health feedback (Ahern et al. 2011). As these technologies grow in number and impact, researchers are increasingly evaluating and discussing these tools to better understand their capabilities and potential (see Table 1 for examples).

Table 1. Common examples of patient-facing HITs that can provide technology feedback

HIT	Definition	Examples in Literature
Chatbot	An intelligent agent programmed to converse and interact with humans through voice, text, and animation (Abd-Alrazaq et al., 2021).	(Hauser-Ulrich et al. 2020; Huang et al. 2018; Oh et al. 2020)
Mobile Health (mHealth) App	A commercially available application that allows individuals to self-monitor their health and/or fitness (Anderson et al. 2016)	(Brower et al. 2020; Licskai et al. 2013; Liu et al. 2011)

Wearable Fitness Tracker	A small device worn on the wrist or hip that provides the user with data related to their physical activity, such as number of steps taken, calories burned, or minutes spent exercising (Nuss and Li 2021).	(Gasparetti et al. 2020; Gualtieri et al. 2016; Nuss and Li 2021)

Recent literature suggests that feedback provided through patient-facing HIT elicits an emotional response in the user (Savoli and Bhatt 2017). Emotions are defined as "a mental state of readiness for action that promote behavioral activation and help prioritize and organize behaviors in ways that optimize individual adjustments to the demands of the environment" (Beaudry & Pinsonneault, 2010, p. 690). According to Russell's (1980) circumplex model of affect, emotions can be understood and evaluated on the basis of two critical dimensions: valence (the extent to which an emotion is positive or negative) and arousal (the extent to which an individual is activated or excited, as opposed to deactivated or calm). HIT is found to stimulate a wide range of emotions. For example, electronic medical records (EMR) provide patients with a sense of support, which evokes positive emotional reactions (Winkelman et al. 2005). HIT is also known to provoke negative emotions, as illustrated by a mobile app for mental health assessment that incites feelings of anxiety, frustration, and boredom (Liu et al. 2021). Interestingly, some studies indicate that the same technology can evoke a range of different emotions. In their investigation of a web-based portal for self-management of asthma, Savoli and Barki (2017) find that some patients experience positive emotions when using the portal, such as joy, while other patients react negatively to the portal with feelings of anger, guilt, and sadness. The authors suggest that the quality of a technology interaction may affect emotions, but the relationship between these interactions and patient emotions is not explained in their work.

Although some researchers speculate that technology feedback is related to emotions and IT use (e.g. Savoli & Bhatt, 2017), this is not known to have been empirically validated. Most studies that investigate emotional reactions to feedback tend to focus on feedback valence as a key attribute (e.g. Belschak & Den Hartog, 2009). While this work provides valuable insight, technology feedback is a multidimensional and complex construct involving many different attributes. For instance, the modality, timing, and credibility of feedback also have importance (Lechermeier and Fassnacht 2018). As technology feedback is increasingly discussed in HIT literature, it is critical that the impacts of this feedback on users are understood (Mannina and Addas 2021). This research will explore how technologies can be designed to provide technology feedback that is likely to prompt behaviour adaptation by assessing how IT identity contributes to emotions and a user's perception of feedback credibility.

Recent literature suggests that the extent to which a user identifies with technology can have a critical impact on their emotions during user interactions (Savoli and Bhatt 2017). Technologies are increasingly social objects. IT identity has thus been proposed as a construct to explain the changing boundaries between one's sense of self and technology (Carter et al. 2020). Three dimensions comprise IT identity: relatedness to IT, reliance on IT, and emotional attachment to IT (Carter and Grover 2015). This study will explore the impacts of IT identity on emotions by investigating these three dimensions and their impacts on valence and arousal. Since individuals emotionally react to situations that they consider relevant, Savoli and Bhatt (2017) assert that IT identity will prompt emotions of greater intensity. It is also expected that IT identity is related to perceived credibility of a feedback source, which describes the source's level of expertise and trustworthiness (Lechermeier and Fassnacht 2018). Some studies suggest that health advice generated through artificial intelligence is not trusted (e.g. Poote et al. 2014), which indicates that the credibility of technology feedback may be questioned by users. It is likely that when users identify strongly with a technology, they will perceive this technology as credible and will be more inclined to heed its advice.

Development of Hypotheses

A framework is proposed to capture the relationships between IT identity, emotion, and behaviour adaptation (Figure 1). These relationships draw on Savoli and Bhatt's (2017) framework, with several modifications to provide a more comprehensive understanding. While Savoli and Bhatt (2017) study IT use as the dependent variable in their work, the model proposed focuses on behaviour adaptation to determine the impact of the constructs studied on the health of users. The credibility of the feedback source is also hypothesized to mediate the relationship between IT identity and behaviour adaptation.

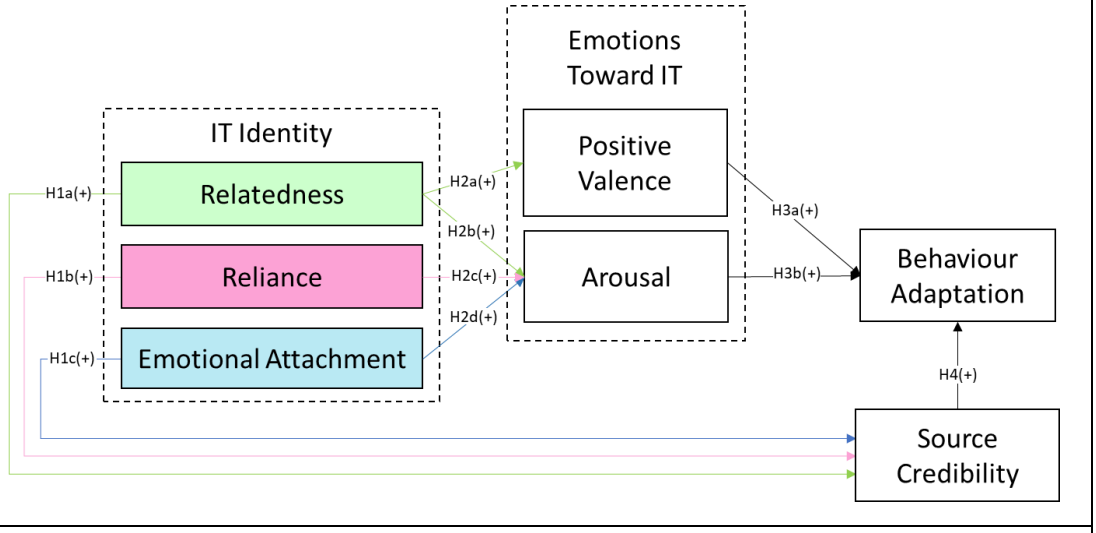

Figure 1. Proposed Framework

IT Identity to Source Credibility

Relatedness, reliance, and emotional attachment are known to have important relationships with credibility in numerous studies across broad contexts. This literature is thus drawn upon to explain how these dimensions of IT identity are likely to inspire perceived credibility in a technology feedback source.

Relatability is known to influence credibility in prior work. For example, Runnebaum et al. (2019) argue that for information to be valued, it must be related to one's own experiences and understanding. These authors suggest that relatability is embedded in transparency and will thus afford higher levels of credibility when prioritized in communications. Relatability is also known to be important in health decision making, as demonstrated in a study by Dada et al. (2019) concerning efforts to obtain community engagement in clinical vaccine trials. This study supports that when individuals are relatable, they are more likely to gain the trust of others. It is thus logical to expect that:

H1a: Relatedness contributes positively to source credibility.

Management literature supports a positive relationship between dependence and trust. For example, Park and Lee (2014) find that dependence on a partner in a project team contributes to higher levels of trust in this partner. Some researchers speculate that such relationships exist because one's dependence on another party may offer them benefits that contribute to feelings of confidence and trust (Gao et al. 2005). This suggests that in the context of technology feedback, users may consider a technology trustworthy and credible if they find that relying on this technology helps them to improve their well-being. Hence:

H1b: Reliance contributes positively to source credibility.

It is well-established in consumer behaviour literature that individuals develop emotional attachments to objects, people, places, and brands (Ladhari et al. 2020). These attachments can foster feelings of trust and affect perceptions of credibility. For example, affective responses to brands contribute to brand credibility (Kemp 2011). Research concerning social media also suggests that when individuals feel emotionally attached to influencers, such as YouTube vloggers, they are likely to perceive them as credible (Ladhari et al. 2020). If users feel that a technology provides them with emotional fulfillment, they can therefore be expected to view this technology as a credible source of information and feedback. Therefore:

H1a: Emotional attachment contributes positively to source credibility.

IT Identity to Emotions

Prior literature asserts that emotional reactions to a situation are warranted when one considers this situation to be relevant (Savoli and Bhatt 2017). As such, IT identity can be expected to impact a user's emotions since this construct indicates the relevance of IT to the user's sense of self.

Relatedness is known to help users feel supported and empowered in healthcare literature (Ng et al. 2012). If a user feels that a technology is highly relatable, they are likely to feel a sense of connection with this technology, which is likely to inspire positive emotions like happiness and comfort. This notion is supported by Carter and Grover (2015), who suggest that a high level of connectedness with an IT artifact will cause users to experience positive emotions in relation to this artifact. Therefore:

H2a: Relatedness contributes positively to positive valence of emotions toward IT.

It is also anticipated that relatedness will impact emotional intensity. Smith et al. (2007) find that when individuals feel connected to others and perceive a shared identity, they are likely to experience emotions of greater intensity. Carter and Grover (2015) also support that as a component of IT identity, relatedness contributes to the intensity of one's emotions. Hence:

H2b: Relatedness contributes positively to arousal of emotions toward IT.

Dependence on technology is growing in society, and this dependence is thought to contribute to emotional arousal. Forceful emotions, such as panic, are often experienced when one engages in intensive or dependent use of a technology (Serrano-Puche 2015). Reliance on technology has also contributed to sentimentality toward there artifacts. For example, mobile phones often contain texts, pictures, and other digital memories that can evoke powerful emotions in users (Carter and Grover 2015). This supports that the extent to which an individual relies on a technology is likely to influence the intensity of their emotions toward this technology. Thus:

H2c: Reliance contributes positively to arousal of emotions toward IT.

Emotional arousal is widely recognized as a byproduct of attachment. When users feel emotionally attached to a technology, they exhibit strong emotional energy and enthusiasm (Carter et al. 2020). Psychology research also supports that attachment fosters particularly intense emotions (Reis 2000), which indicates a relationship between emotional attachment and arousal. Therefore:

H2d: Emotional attachment contributes positively to arousal of emotions toward IT.

Emotions to Behaviour Adaptation

Prior work supports that both valence and arousal have significant relationships with behaviour adaptation.

Many IT studies explore how emotions stimulated by technologies affect IT use, and generally find that positive emotions contribute to increased use behaviours (e.g. Beaudry and Pinsonneault, 2010). It is likely that positive emotions contribute to adaptation of behaviours more broadly. Psychology literature suggests that positive emotions have an upward spiral effect, meaning that they prompt wellness behaviours and decisions that evoke subsequent positive emotions (Fredrickson 2013). Furthermore, positive emotions are found to expand thought-action repertoires, meaning that they prompt individuals to pursue a greater variety of thoughts and actions than usual (Fredrickson and Branigan 2005). This suggests that positive emotions are more likely to inspire behaviour adaptation in the healthcare context than negative emotions, which are found to narrow though-action repertoires. Hence:

H3a: Valence contributes positively to behaviour adaptation.

Arousal is an important component of emotion that is known to prompt adaptive behaviours in broad contexts (e.g. Zhen et al. 2020). Specifically in IT literature, users are found to feel energized when they are aroused by a technology stimulus (Ding and Chai 2015), which suggests that high levels of arousal may evoke changes in behaviour. It is therefore expected that:

H3b: Arousal contributes positively to behaviour adaptation.

Source Credibility to Behaviour Adaptation

For feedback to be effective, it is importance that the source of this feedback is considered credible (Poulos and Mahony 2008). Credibility contributes to one's intentions to accept and act upon feedback (Bell and Arthur 2008), and such action is likely to include changes in one's behaviours. For example, Ferguson et al. (2014) find that if a healthcare provider receives feedback on their work from a credible source, they are more likely to consider changing their behaviours and work practices in response to this feedback. Thus:

H4: Source credibility contributes positively to behaviour adaptation.

Proposed Methodology

A pilot study will be performed in December of 2021. An AI-powered chatbot will serve as the HIT to administer feedback. This technology is increasingly accepted as an effective method of providing feedback remotely (Sheth et al. 2019). The chatbot will be text-based and embodied, meaning that a virtual avatar will be presented. Twelve participants will be recruited using a student participant pool at Queen's University. Feedback related to exercise and nutrition will be provided to participants as these are general areas of health that can be easily monitored and understood.

To obtain an initial assessment of physical activity and dietary quality, a pre-test questionnaire will be administered using Qualtrics. The International Physical Activity Questionnaire (IPAQ) will be used to assess physical activity. This has been established as a reliable instrument for research in diverse contexts (Craig et al. 2003). The Short Healthy Eating Index (sHEI) survey will also be used to provide an estimate of dietary quality by assessing intake of vegetables, dairy, and other food groups. This 22-item tool has been systematically validated and is found to be less burdensome than other instruments used to measure dietary quality (Colby et al. 2020).

Participants will then be asked to visit a designated lab at Queen's University to interact with the online chatbot in a controlled environment. The chatbot will be programmed to generate feedback tailored to participants based on the responses obtained in the pre-test questionnaire. Participants will be randomly assigned to an intervention group and a control group. For the intervention group, the chatbot will adjust its language and social cues to manipulate the user's sense of relatedness, reliance, and emotional attachment to this technology as the interaction unfolds. For example, the degree to which a chatbot empathizes with a user and employs compassionate phrases (e.g. "everything will be okay") can be adjusted during the conversation to provoke feelings of relatedness. For the control group, the chatbot will provide similar feedback without manipulation of IT identity. The participants' emotions will be continuously monitored using NeuroIS tools. In collaboration with HEC Montréal, the COBALT Research Ecosystem will be used to capture physiological data. This NeuroIS tool will be employed to identify emotional valence and arousal during the chatbot interactions. This includes use of facial recognition technology to analyze valence in facial expressions and an EDA device to measure arousal through skin conductance. Afterward, participants will complete a questionnaire to indicate their overall level of IT identity in relation to the chatbot, as well as perceived credibility of the chatbot regarding its ability to provide valuable feedback. After one week, physical activity and nutritional quality will be re-assessed through a post-test questionnaire to determine whether participants demonstrate changes in their health behaviours.

Expected Contributions

Patient-facing HIT has little value if it does not prompt positive changes in users' behaviours and health. Evaluations of the impacts of patient-facing HIT on health outcomes in prior work reveal mixed results (Singh et al. 2019). For example, a review of mobile applications for smoking cessation indicates that some app features, including those that provide feedback, have inconsistent relationships with smoking abstinence (Regmi et al. 2017). Individuals and organizations continue to invest in patient-facing HIT without a clear understanding of how these technologies motivate and engage users to improve their health (Wannheden et al. 2021). The research model proposed offers an important contribution by hypothesizing the impact of IT identity and emotions in technology feedback interactions and relating these constructs to behaviour adaptation. This will expand existing knowledge of IT identity, which is a nascent construct that has received limited research attention (Sundrup et al. 2019). The results of this study can also help academics and practitioners recognize how technologies can be designed to evoke strong positive emotions

in users and promote behaviour change. The use of emerging NeuroIS tools in this study will additionally advance methodological practices as these tools will be tested to obtain physiological measures of emotion.

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