

Role of Emotions and Aesthetics in ICT Usage for Underserved Communities: A NeuroIS Investigation

Research-in-Progress

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Abstract

Usability and efficiency has received lot of attention in terms of ICT usage and attitude however non instrumental factors like emotions and aesthetics and their impact on ICT usage attitude and performance has not been extensively tested. Further underserved communities are focused communities that have limitations in terms of formal and functional literacy and technology experience. Aesthetics have been shown to be an important predictor of usage but this has not been tested in underserved communities. Also positive emotions have been linked to greater ICT usage as well as aesthetic experience. The measurement of factors like emotions, aesthetic preferences and ICT usage has so far been restricted to questionnaires however we propose to use objective measures like brain imaging technique (EEG) to supplement existing methodologies. The current paper is a research in progress that addresses potential role of aesthetics and emotions for understanding aesthetic preferences and ICT usages in underserved communities.

Keywords: Emotions, aesthetics, underserved communities, ICT, India, and EEG

Introduction

This study looks at non instrumental factors i.e., emotion and aesthetics based design guidelines that can impact information communication technologies (ICT) usage attitude and performance in underserved communities. While usability and efficiency is extremely importance for technology acceptance, it has been recognized that a fundamental aspect, interaction has not been recognized (Tractinsky et al. 2000). Traditional frameworks based on technology acceptance model (TAM), theory of reasoned action (TRA) and theory of planned behavior (TPB) has a common assumption that technology use is a well-reasoned, cognitive decision. However cognitive models can hardly capture the full range of emotional reactions of users and account for their relationship to IT use (Beaudry and Pinsonneault 2010). Thus we need more realistic models that are better aligned with how people actually decide in real life (Suri and Gross 2012). In this study we focus on special communities called the underserved communities. Underserved communities have been identified as communities that are ready to use cost effective ICT but have not been fully served (Jain et al. 2011).

A general agreement in the existing literature is that the role of emotions for continued use has received little attention in regards to technology (Bagozzi 2007). Emotions play fundamental role in consumer's decision making (Schwarz 2000) and coincidentally, increased interest in role of emotions for ICT use has been seen (Zhang and Li 2005), (Zhang 2013). Further, it has been shown that individuals procure information from their emotions. The impact of emotional response carries with it a signal that encapsulates information with regards to reaction to a stimuli or object (Schwarz 2013). Popularly known as '*halo effect*', this phenomenon describes the impact of emotional response towards an object and how it carries over to the evaluation of object characteristics and general attitude towards the object (Norman and Ortony 2003), (Rafaeli and Vilnai-Yavetz 2004). In this regards, (Russell 2003), has made great progress in defining a number of important affective concepts and this perspective has been used for this study as well.

The relevance and importance of emotions in previous research has been established however little is known about how and to what extent emotions lead to technology use in focused communities like *underserved communities*. Despite the fact that mobile ICTs can assist in rapid search, access and retrieval of information, and can support communication and collaboration between communities (Yeh et al. 2006), the retention rate of ICT tools is extremely low (Bhandari and Chang 2013). The argument is that current design principles do not focus on majority of the worlds' population -underserved communities and thus require more focused studies (Wan et al. 2013). Since these communities are adopting low cost and effective mobile solutions to improve their productivity and efficiency it is imperative to further understand ICT use in this context (Chang et al. 2011).

It has also been suggested that aesthetics can sometimes supersede perceived usability in terms of decision making (Norman 2004). Physical form or design of a product is an unquestioned determinant of its marketplace success (Bloch 1995) and it is highly important to get the first impression right (Lindgaard and Dudek 2003). This is understandable since that is what users become aware of first (Reinecke and Bernstein 2011). Underserved communities are being touted as the "next billion" customers of mobile technologies (Bahn and Tait 2008), (Pralhad 2012) and thus it would be highly useful to know which design elements specifically influences their ICT usage. In fact, design can actually be the most important predictor of choice when performance information is absent or ambiguous (Yamamoto and Lambert 1994). This perspective is immensely useful for underserved communities. Due to their limited knowledge and exposure to technology, their response to aesthetic design elements and reliance on emotional cues is expected to be different than their privileged community counterparts. We use reaction time and choice as indicators of aesthetic preference (Sternberg 2004).

Aesthetics have been linked with emotional response from various perspectives (Holbrook and Hirschman 1982). Aesthetic design triggers certain positive responses in customers like desire to own the product (Norman 2004) or willingness to pay for the product (Bloch et al. 2003). The reverse has however not been tested so far. Do we prefer certain kind of aesthetics in certain emotional states? When dealing with decision to use a technology artifact, aesthetic design will also influence the intention to use. Because emotions are an essential factor that influences consumer responses to product aesthetics, the understanding of linkage between emotions and aesthetic design is critical. Thus we examine the following research questions:

RQ1: What are the impacts of emotions on ICT usage in underserved communities?

RQ2: Why does aesthetics impact ICT usage attitude/performance in underserved communities?

RQ3: How does technology experience influence the impact of aesthetics on ICT usage attitude/performance in underserved communities?

This area has been identified in need for strong theoretical development (Orth and Malkewitz 2008). By breaking down aesthetics into its subcomponents i.e., classic and expressive aesthetics and linking them with the valence-arousal dimension of emotions we are able to discover clear design principles. Thus a major theoretical contribution of this work is the clear linkages between emotional dimensions and aesthetic elements. Practically, measuring aesthetic preferences and emotions of underserved communities objectively using different variations of aesthetic interfaces we provide direct implications on how to manipulate aesthetics design elements while developing ICT tools and how emotions are related to these manipulations in order to have a higher success rate at ICT usage.

Theoretical Background

Emotions

Emotion literature is vast and spans across multiple disciplines (Brosch et al. 2010). It has been extensively studied in relation to user judgments (Porat and Tractinsky 2012), (Thüring and Mahlke 2007). For core emotion, a major classification is from the dimensional perspective. The dimensional perspective is based on the fact that emotion has two components namely, *arousal* and *valence*. Russels' circumplex model of emotions is one of the most widely explored frameworks in this regard. *Valence* represents the pleasantness or unpleasantness dimension. *Arousal* on the other hand represents the degree of activation associated with the emotion. The two dimensions have been known to capture most of the variance in self-reported mood ratings (Suri and Gross 2012). They are the core components of emotional states and have been argued to be responsible for predicting choice.

For valence it has been shown that higher the amount of pleasure more desirable will be the outcome (Elster 1998), (Isen et al. 1978), (Lang 1995). Arousal also has been recognized as one of the components responsible for decision choice though slightly less than valence (Suri and Gross 2012). How much each one contributes to the final decision, there are two perspectives. One is that they contribute equally, fifty-fifty to the decision making process. However the other view is that one may take over the other, thus we need to be clear about which dimension is expected to play a more prominent role.

Other than core affect, emotional qualities have been studied in the information systems literature in the form of affective quality, perceived affective quality (PAQ), affective judgment, and affective reaction etc. (Russell 2003), (Zhang and Li 2004). These take into account the subjective evaluation of user towards the affect eliciting qualities of an artifact. Although we recognize that this evaluation is influential and take measurements for emotions after the stimulus has been exposed, this is not the focus of the study.

We chose to work with the dimensional model of (Russell 1979) as it is more appropriate and preferred for emotion recognition studies. Also taking both valence and arousal as suspects for determining ICT usage attitude and performance in underserved communities we can see which one has more/less impact. Underserved communities might be compensating the lack of technical resources by overreliance on these emotional dimensions i.e. arousal and valence to gather information about certain stimuli for e.g., being exposed to an ICT tool like mobile app.

ICT Usage Attitude and Performance

User judgments like attitude and usage has been looked extensively in literature. In this regard role of emotions on user judgments has also been explored (Norman 2004), (Porat and Tractinsky 2012), (Thüring and Mahlke 2007). This is understandable as emotions appeal to the immediate processing of interfaces. It is the part of forming first impression of systems and thus can heavily impact future interactions with the interface like forming an attitude or performing with the interface. We look at ICT usage from two perspectives. One is the formation of ICT usage attitude and other being the objective measure of actual ICT usage performance. Usage attitude has been defined as a "psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Van Birgelen et al. 2003). It can also be understood as an appraisal process associated with an object (Malhotra 2005).

Both positive and negative reactions can form components of attitude. Consumers will rely more on affective responses in case the cognitive processing resources are low (Malhotra 2005). This is evident in underserved communities, due to little exposure to technology they find it challenging to evaluate the stimuli cognitively. Both arousal and valence have been shown to contribute to decision making (Suri et al. 2013). Positive relationship was found between consumer's arousal and their attitude to buy. Valence and arousal have both been linked to approach and avoidance behavior, where positive valence enhances approach tendency and high arousal emotions lead to approach based tendencies as well (Mehrabian and Russell 1974). Positive relationship was also observed between consumer's valence or pleasure and attitude (Baker et al. 1992). Thus linking valence and arousal dimensions of emotions to ICT usage we hypothesize:

H1: ICT usage attitude/performance will be greater in a positive valence than those in negative valence emotions for underserved communities.

H2: ICT usage attitude/performance will be greater in a high arousal than those in low arousal emotions for underserved communities.

Aesthetics

Aesthetics is a non-instrumental factor that has recently received lot of attention (Lavie and Tractinsky 2004), (Lindgaard 2007), (Van der Heijden 2004). The multidisciplinary approach (architecture, engineering, design etc.) to aesthetics has given rise to various perspectives. The most common and mentioned practically in every study is the relationship between aesthetics and beauty (Kant 2000). This approach has its roots in theory of architecture (1st BC) when beauty was counted among architecture's three basic requirements (Kruft 1994). Other perspectives have linked it as a "response to a product" (Hassenzahl 2004), "visual appeal" (Lindgaard and Dudek 2003) and "beauty in appearance" (Lavie and Tractinsky 2004). A constant debate in design literature has thus been whether too much focus is being paid on aesthetics or too much emphasis is on performance (Jordan 2000), (Norman 2002), (Norman and Riley 1988). While both schools of thoughts have their fair share of supporters, it remains a general agreement that aesthetically pleasing objects have a positive influence on product preference (Yamamoto and Lambert 1994). Strengthening the fact that when decisions are complex it has been found that consumers prefer products with pleasing aesthetics, there is rising interest in looking at aesthetics from "pleasure providing" perspective (Schenkman and Jönsson 2000), (Van der Heijden 2003). Studies have shown that emotional states like pleasure and pain play an important role in formation of a consumer's aesthetic judgment (Guyer 2008), (Schroeder 2008), (Iseminger 2003). We focus on the classic and expressive aesthetic model proposed by (Lavie and Tractinsky 2004) due to its suitability for exploratory study like this and for clearer aesthetic manipulation.

Classic and Expressive Aesthetics

The two dimensions classic and expressive comprise of and cater to two distinct design aspects of a product. The classical aesthetics form the "visual clarity" dimension with dimensions like clean, clear, symmetric design etc. Expressive aesthetic on the other hand look at the creative side by looking at fascinating design elements, originality, sophistication etc. So while classic aesthetics lend a harmonious vibe to the design where all the different elements go together, expressive aesthetics deal with the creativity and overall feel of the design. It mainly lies with the developer to play on these aspects and thus it is important to explore how different dimensions of design elements are related to various emotional dimensions. A seemingly related question is what kind of aesthetics or their combination thereof do we prefer when we are in different valence and arousal based emotions is something not yet answered? Do we prefer clean and symmetrical design when we are feeling positive and less aroused or do we like unique designs when we are experiencing negative emotion and highly aroused. Mappings like these can be effective for customization for our target communities and to better design ICT tools. Regarding whether aesthetic evaluation is a cognitive or an affective process, (Tractinsky 2004) mentioned that although both can contribute significantly there are hints that aesthetic impressions are affective and formed immediately at a low level and thus precedes cognitive processes (Fernandez-Duque et al. 2003), (Norman 2004), (Pham et al. 2001), (Zajonc and Markus 1982).

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(Schenkman and Jönsson 2000), (Van der Heijden 2003). Studies have shown that emotional states like pleasure and pain play an important role in formation of a consumer's aesthetic judgment (Guyer 2008), (Schroeder 2008), (Iseminger 2003). Studies have also recently mapped Russell's arousal-valence dimension to classic-expressive aesthetics whereby classic aesthetics are related to valence based emotions and expressive aesthetics are linked to arousal based emotions (Tractinsky and Lowengart 2007). The rationale is that classic aesthetics ensures that interface design looks generally clean and all elements go together leading to a positive response from user. Expressive aesthetics dealing with the creative aspect of interface leads to more excitement which leads to the activation of positive emotions. Classic aesthetics also lend familiarity and calmness to the design hence it contributes to the valence dimension of emotions. Expressive aesthetics goes beyond harmonious design and appeals to the novelty in design thus appealing to the arousal state. Based on above arguments we hypothesize:

H3: Classic aesthetics will be preferred for positive valence as compared to negative valence emotions.

H4: Expressive aesthetics will be preferred for higher arousal emotions as compared to low arousal emotions.

Users also have been found to rapidly judge the aesthetics of a webpage reliably within 50 milliseconds (Lindgaard 2007). This implies that aesthetic preferences of users will majorly impact their subsequent interaction with the interface. This includes initial first impression formation leading to attitude and ultimately extending to ICT usage. Additionally aesthetics have been long associated with usage (Van der Heijden 2003). Based on the above arguments linking aesthetic evaluation and emotion dimensions we hypothesize:

H5: ICT usage attitude/performance is impacted significantly by aesthetic preferences.

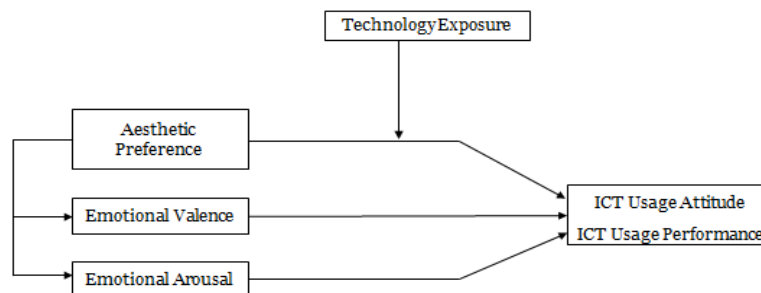


Figure 1: Theoretical Framework

Technology Exposure in Underserved Communities

Mobile applications are now accessible in underserved communities due to increasing mobile penetration. However, often after being exposed to the system and initial excitement, the continuance of such system is minimum. We believe technology experience has an important role to play when it comes to ICT use for underserved communities. It has been shown that efficiency based parameters render inefficient as the number of years with technology increases (Chau 1996). Since in this study, we look at aesthetics and its impact on ICT usage we believe technology exposure can still moderate this relationship. A higher number of years with technology can reduce the impact aesthetics have in terms of ICT usage attitude/performance. Thus even though aesthetics have an impact on emotional dimensions like arousal or valence, these effects can fade after repeated exposure to technology (Sonderegger et al. 2012). Following this argument, we hypothesize:

H6: Technology experience moderates the role of aesthetic preferences on ICT usage attitude/performance

Methodology

We intend to test the research model by conducting a field study in underserved communities in India. The measurement of non-instrumental factors in IS so far has been restricted to traditional measures like surveys or self-report measures. Other physiological measures like EEG/MEG, fMRI etc. have only

recently started to get attention (Dimoka 2012). They are not subjected to the fear of cognitive decision overshadowing the impact of affective processes since participants are not asked to remember the aesthetic experience and self-report it and thus rules out the possibility of retrospective analysis. We use low cost Electroencephalograph (EEG) for this study to gather immediate feedback to presented stimulus as fluctuations in brain signal frequencies.

EEG for emotions

Traditionally EEG has been used mainly for medical applications. Information systems research has rarely used EEG for emotion recognition particularly. Part of the problem is the cost associated with heavy equipment and the setup required in order to obtain objective data. The other issue being lack of knowledge in analyzing EEG data, however with development of new less obtrusive and easier to work with wireless headsets (Emotiv EPOC), EEG is now being extended to areas beyond just medical application, the adoption for entertainment, online learning is particularly exciting. However it would be interesting if we can extend it to emotion based information systems research. It can be particular useful for manipulation checks and collecting objective data. There are no standardized available benchmarks that can map EEG signals to emotions however there are databases like International Affective Digitized Sounds (IADS) (Bradley and Lang 2007) and International Affective Picture Systems (IAPS) (Lang et al. 1999) which have gained popularity in neuroscience for emotion induction in regards to EEG (Liu et al. 2011).

Emotions for EEG

Emotions can be understood as physiological arousal, a behavioral expression (affect) or a conscious expression of emotion (feeling). Our facial expression and vocal expression comes under behavioral expression. However research has shown that they have been known to be manipulated for various reasons e.g. social appropriateness. Moreover they are subjective in nature and interpretation can almost never be objective. Our focus for this study is to get as many objective measures for emotions as possible and thus we focus on physiological arousal as our independent variable for emotions. We do supplement this with traditional subjective measures. We use EEG data since it is most useful to study emotions as a neural process. Research in psychophysiological research has shown a direct link between amount of action in left/frontal lobe and right/frontal lobe and emotion (Coan and Allen 2003; Niemic and Warren 2002). In order to interpret emotion related data from EEG we follow below mentioned principles:

- Valence: positive/happy emotions result in higher frontal coherence in alpha and higher right parietal beta power, compared to negative emotions
- Arousal: excitement has higher beta power and coherence in parietal lobe, plus lower alpha activity

Most emotional valence recognition systems are based in the difference in hemispherical activity in frontal cortex (Coan and Allen 2004). Thus fixed electrode signals are used because of their appropriate positioning above the prefrontal cortex.

Emotions, Aesthetics and ICT Usage

Participants

Our subjects belong to underserved communities in four different villages of Maharashtra, India. Three are in Pune (Pabal, Kheranagar ad Jatagoun) while one in Nasik (Chandiro). Most participants have limited formal and functional literacy These communities represent a major chunk of Indian farming population who rely on agriculture for their livelihood and are starting to think about mobile based ICT technologies as a means to improve their socio economic conditions. We balance age, gender, formal education (years) differences across the treatment groups.

Independent and Dependent Variables

Independent Variable: Emotion Manipulation via IADS and IAPS

IADS and IAPS use for emotion manipulation has been popular in neuroscience studies. They are successful at manipulation of emotions ranging on both valence and arousal dimension. It has 97.4% classification accuracy for arousal and 94.9 for valence (Liu et al. 2011). All the sounds in IADS are labeled with their arousal and valence values. IADS provides a set of standardized sound stimuli to evoke

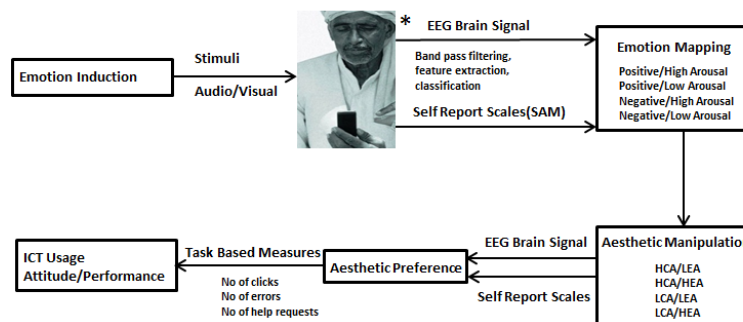
emotions that can be described by Arousal-Valence model. Clips have been chosen to induce five emotional states. 3 clips for neutral, 6 clips for each positive/low arousal, positive/high arousal, negative/low aroused and negative/high aroused emotions. These have been used earlier for successful manipulation of emotions in studying mouse movements (Grimes et al. 2013).

Aesthetics

For creating various versions of the interface of the mobile app, we choose two dimensions each from the classic and expressive scale forwarded by (Lavie and Tractinsky 2004). For classic aesthetics we chose clean and symmetric design. For expressive aesthetics, we chose creative and original design. We vary these four parameters to create four versions of the same app (Figure 3).

Drawing from (Lavie and Tractinsky 2004) model of classic aesthetics and extant work we manipulate symmetry which lends its effects to cleanliness dimension as well. We took further guidelines from work by (Park et al. 2005) to manipulate symmetry as one of the interface variations. Symmetry is the mirroring of the visual composition across a vertical or horizontal pivot line (Ngo and Byrne 2001). We use these principles to arrive at interfaces with varying degrees of symmetry. As a result two interfaces out of four seem to possess more cleanliness in design while interface with low symmetry seem cluttered.

For expressive aesthetics we use guidelines provided by (Lavie and Tractinsky 2004) for originality and creativity. We found inspiration in design literature for creativity being associated with custom-built shapes. Custom shapes help add creativity to the design. For two interfaces with high expressive aesthetics we use customized curve shapes to display some functionality while for two interfaces with lower expressive aesthetics we stick with default shapes like square. Using custom shapes also adds the originality of the design. Thus expressive aesthetics are manipulated effectively on two dimensions creativity and originality.



*Photo Source: <http://www.nextbigwhat.com/wp-content/uploads/2013/02/RML-Farmer-Mobile.jpg>

Figure 2: Process diagram of experimental setup for emotion and aesthetic manipulation

Dependent Variable: The first dependent variable is ICT usage attitude (Keng and Ting 2009). This is a subjective evaluation of intention to use ICT tool. Second is task based objective measure for ICT usage performance (task completion time, number and type of errors, number of clicks needed to accomplish a task and number of help requests made). Thirdly, for aesthetic preference, we use choice as a behavioral measure for individual preference (Bettman et al. 1998). We also ask participants to rank the four interfaces in the order of preference to get finer granularity of aesthetic preference.

Design and Procedure

EMOTIV headset will be used to carry out the experiments. It has 14 electrodes (AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, and AF4) with sampling rate of 128 Hz and Bandwidth 0.2-45 Hz (Liu et al. 2011). Due to its low cost and easy portability it is ideal for a field study of this nature. After a participant is invited to the lab setup, he/she will be briefly introduced to the experiment protocol and the questionnaire purpose. They will then be seated in front of a computer in a comfortable position, which has the audio/visual stimuli as well as the aesthetic manipulations installed on it. The EMOTIV headset will be prepared and placed on the participant. At the beginning electrodes on the EMOTIV EPOCH

headset are adjusted on the participants' head and checked for full signaling. Later baseline recording is made for 2 minutes. The experiment is expected to take on average 30 minutes.

There will be 5 sessions, session 1: neutral, session 2: positive/high arousal, session 3: positive/low arousal, session 4: negative/low arousal, session 5: negative/high arousal and participants are randomly assigned to one (Figure 2). Clips pertaining to the respective session are then displayed. For a neutral session since 3 clips are available, we would play them twice to maintain the frequency of stimuli and keeping interval for each session consistent. During this time readings from the headset are recorded. For valence based emotions, right hemisphere has been found to be more active during experience of negative emotions and left hemisphere for positive emotions. Thus differences between FD from AF3 (left hemisphere) and F4 (right hemisphere) identifies the valence level. For arousal it has been shown that beta waves are indicative of an alert state of mind and alpha is dominant for a relaxed person or brain inactivation (Liu et al. 2011). These two perspectives are taken to classify emotion induction manipulations. Questionnaires will later be completed using the SAM (self-assessment manikin, Lang 1980) indicating dimension of arousal and valence. The participants are also asked to briefly mention how they feel about the setup (happy/sad) for data triangulation. Responses for which SAM scales and EEG recordings do not match will be dropped.

After successful emotion induction, participants are exposed to aesthetically manipulated interfaces of the system, in our case we use a pest reporting application developed for agricultural purposes (Figure 3). Each manipulation has one of the four possible combinations of the classic and expressive aesthetics (for space constraints we show four variations of one of the screen i.e. homepage) (Table 1). Each interface shows up for 10 seconds during which EEG recordings from corresponding electrodes are made. It has been observed that an appropriate duration for taking EEG recordings is 200 milliseconds after the stimulus. This is enough to record immediate affective response to stimulus but not long enough for cognitive processing to take place. We will instruct the participants to indicate their aesthetic preference by clicking the button provided when they like an interface design displayed on the screen. Since the EMOTIV headset is low density equipment, this is done to minimize noisy signals from the EEG recording headset. We make a note of this preference. After this we show all four interfaces together for another 15 seconds and ask them to rank their preferences from 1-4. These serve as objective measures for aesthetic preference as well.

Participants will then be asked to respond to survey questions regarding usage attitude. We adopt usage attitude scale from (Keng and Ting 2009). They are then asked to perform certain tasks during which objective measures for performance are obtained via video recording. These tasks are different from the homepage manipulations that we show them earlier. The purpose is twofold. First is to avoid learning effect by repeated exposure of the homepage manipulations; second being that performing different tasks allows them to navigate between pages and thus gives us better objective indicators of performance like number of clicks, errors etc..

Classic Aesthetics	Expressive Aesthetics	Interface Options for Aesthetic Stimuli
High	Low	4 (pest report, homepage)
Low	High	4 (pest report, homepage)
High	High	4 (pest report, homepage)
Low	Low	4 (pest report, homepage)

Table 1: Aesthetic manipulations and interface options

Conclusion

With increasing focus being paid on communities like the underserved there is a need for specialized studies that try to focus on special needs and constraints in these contexts. Our vision is to provide practical and theoretical implications for managers, developers and other stakeholders who are trying to develop ICT solutions for these communities. Better understanding of the underlying mechanism of how users in the underserved communities interact with ICT technologies is critical if we want a higher success rate of them using it. This study is aimed at exploring whether there is more to be focused on rather than

giving functional systems to these users. Their sensibility in terms of aesthetics and reliance on emotional cues for decision making can help shed light on why existing ICT tools are not having the desired behavioral changes. For this purpose we use the valence-arousal dimensional space of emotions and apply it to the context of underserved communities to see how emotions are influencing the ICT usage attitude. Secondly we propose that design, focusing on aesthetics here, influences the above relationship and can be the most important driver of a positive ICT usage attitude and actual use. Third in order to explore this phenomenon in a comprehensive manner we use subjective as well as EEG data that provides us objective measures of emotions and aesthetic preferences.

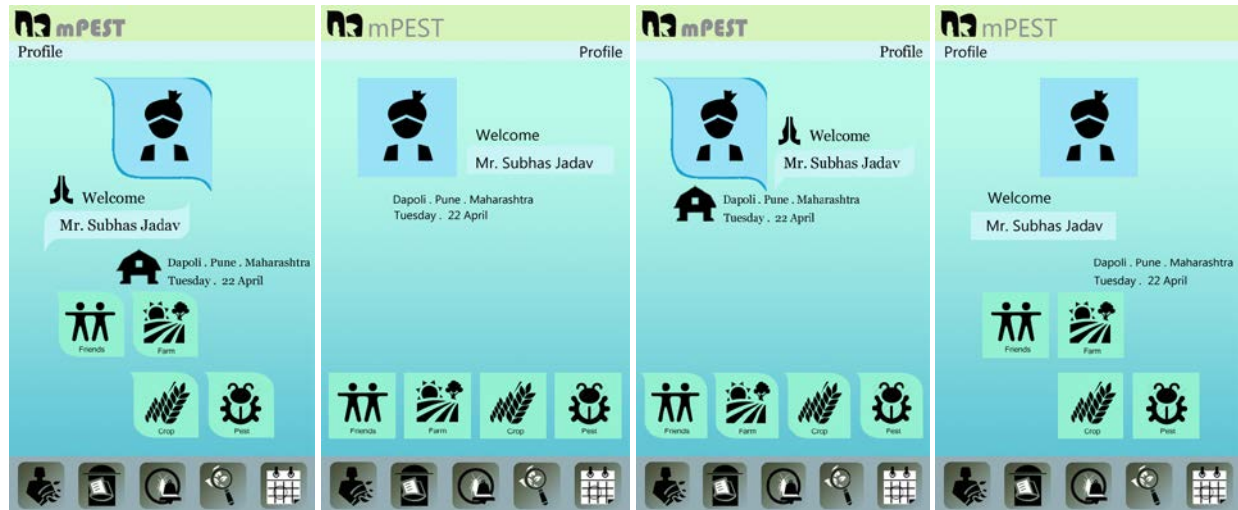


Figure 3: Aesthetic variations in the interface design (Lavie and Tractinsky, 2004)

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