Hedonic evaluation can be automatically performed: An electroencephalography study of website impression across two cultures

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ABSTRACT

The study of cognitive processes underlying Internet users’ fast impression formation is important to understand how people behave in an information-overloaded environment. Here we study how Internet users form fast website impression by investigating which evaluative dimension, i.e., usefulness and enjoyment, is automatically activated when people are required to rapidly evaluate website logos. To capture the transient processes in website impression formation, we have applied dense-array (128 and 256 channels) electroencephalography (EEG) to conduct experiments in two cultures (USA and Taiwan). The results of the EEG analysis showed that usefulness and enjoyment evaluations were consistently performed quickly (450–800 ms) in both cultural groups. More importantly, the results showed that enjoyment evaluation could be automatically performed. No clear evidence was found that usefulness evaluation was performed when usefulness evaluation goal was irrelevant. The finding suggests that people can form rapid website impression, and enjoyment is a critical component in the impression formation process.

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1. Introduction

In Information Systems (IS) research, an important trend is to apply neurophysiological tools to understand the nature of adoption and use of IS (Dimoka et al., 2012). In particular, studying the automatic evaluative process of IS has been considered one of the key topics in the NeuroIS research agenda (Dimoka et al., 2012). This trend of studying automatic evaluation process reflects a major paradigm shift in conceptualization of evaluation in social psychology. Specifically, earlier theories hold that evaluation is performed with conscious and deliberate integration of available information (Ajzen & Sexton, 1999; Fishbein & Ajzen, 1975). However, since 1980s, evidence has shown that evaluation can be performed automatically with limited information input. For example, an extremely brief exposure (e.g., 100 ms) to a social stimulus such as a face is sufficient to trigger associated thoughts that bias subsequent behavior (Willis & Todorov, 2006). In some case, evaluation can even start or be affected before or without seeing the stimulus (Colas & Hsieh, 2014; Hsieh, Colas, & Kanwisher, 2012; Huang, Soon, Mullette-Gillman, & Hsieh, 2014; Huang, Tan, Soon, & Hsieh 2014). Social psychologists, therefore, have re-conceptualized evaluation with a dual-process model, which is composed of the controlled process and the intuitive process. The controlled process is slow, analytical, rule-based, and effortful, and the intuitive process is fast, holistic, associative, and can be effortlessly executed (Chaiken & Trope, 1999).

The study of the automatic process is difficult because this process might never come to people’s awareness or is too transient to be accurately reported (Cacioppo, Crites, Berntson, & Coles, 1993). Early studies have relied on behavioral experiments to reveal the automatic process (Fazio, Jackson, Dunton, & Williams, 1995; Greenwald, McGhee, & Schwartz, 1998), but critical advancement came with the advent of neurophysiological tools. For example, a series of studies in the 1990s have shown that electroencephalography (EEG, or brain waves) could index automatic evaluation processes (Cacioppo, Crites, & Gardner, 1996; Cacioppo, Crites, Gardner, & Berntson, 1994; Cacioppo et al., 1993; Crites, Cacioppo, Gardner, & Berntson, 1995; Ito & Cacioppo, 2000; Ito & Umland, 2003). In the 2000s, researchers further applied brain imaging tools to show that the controlled and intuitive evaluation processes activate different brain areas...
Due to accumulating evidence, it has been proposed that neuroscience tools can be used to identify automatic evaluation process engaged in IS evaluation, including perceived usefulness and perceived enjoyment (Dimoka et al., 2012).

Most IS researchers have adopted the rationalistic paradigm and held that Internet users, being rational actors, form their evaluations toward a website with a deliberate process that retrieves and weights information available to them (Davis, 1989; Venkatesh & Bala, 2008). These series of studies have successfully predicted website usage behaviors in conditions under which users (1) have abundant information or knowledge about the target website, (2) are allowed ample cognitive resources to make evaluation, and (3) are evaluating a limited number of web sites (Davis, 1989; Venkatesh & Bala, 2008; Venkatesh, Morris, Davis, & Davis, 2003).

Alternatively, it is possible that people can rapidly form evaluations, i.e., the “impression” to websites. Similar to the impression rapidly formed when people come across strangers, Internet users may rely on rapid evaluation mechanisms that employ only limited website information. Users nowadays encounter numerous website logos when browsing the Internet or app store. Yet, they want to orient themselves only to those websites that might be useful or enjoyable (Davis, Bagozzi, & Warshaw, 1992; Van der Heijden, 2004). Rapid evaluation is necessary in these situations, because deliberation (i.e., acquiring and weighting available information) on each website to form a usage intention is impractical given the large number of evaluative targets, especially when cognitive resource is limited and motivation is low.

Recently, researchers have recognized the importance of rapid evaluation in the electronic commerce (EC) domain and showed that brief exposure to Internet stimuli is adequate to evoke basic psychological responses. For example, a study has shown that people can form primitive emotional reactions to company logos (Handy, Smilek, Geiger, Liu, & Schooler, 2008), and that logo design factors can affect consumers' recognition performance toward the logos (Henderson & Cote, 1998). Studies have also shown that a brief presentation of a famous brand logo or a product picture can bias people's subsequent information processing strategy (Fitzsimons, Chartrand, & Fitzsimons, 2008; Yeung & Wyer, 2004). The study by Lindgaard, Fernandes, Dudek, and Brown (2006) has further shown that webpages presented with 50 ms are sufficient to affect people's rating of a webpage's visual appeal.

However, in addition to investigating simple evaluations or psychological functions such as attention and perception, a complete understanding of impression formation in EC should address how high-level evaluations are performed rapidly. This question is complicated by the fact that Internet stimuli can be evaluated along multiple dimensions such as usefulness and enjoyment (Van der Heijden, 2004). Therefore, a key question is which evaluative dimension can be performed automatically (Ito & Cacioppo, 2000; Ito & Urland, 2003). That is, it is possible that during rapid evaluation not all dimensions are activated in parallel and only the well-practiced evaluative dimension will be activated without explicit task requirements.

In the present study our aim is to understand (1) the speed at which website evaluation can be performed, (2) whether and which of the high-level evaluative dimensions can be automatically performed during rapid evaluation, and (3) whether there is cultural difference in the rapid evaluation process. Toward this end, we examined two evaluative dimensions: usefulness and enjoyment, both of which have been extensively studied in EC and might be engaged in rapid evaluation processes.

To pursue this aim, we apply dense-array electroencephalogram (dEEG) technology to derive the event-related potentials (ERPs) associated with evaluative functions. In social psychology studies, ERPs have been used to track transient neural activities associated with rapid evaluation. Although self-reports have been used to understand fast responses to social stimuli (e.g., Fazio et al., 1995; Greenwald et al., 1998), these reports are indirect measures of the evaluation process, because it is not obvious whether people can accurately report when information becomes available or the relative importance of the dimensions (Ito & Urland, 2003). In this study we focus on the Late Positive Potential (LPP, P300, or P3b) component of the oddball paradigm, which has been established as a reliable psychophysiological marker of the evaluation process (Cacioppo et al., 1993; Ito & Cacioppo, 2000).

In the present study, participants were exposed to website logos that vary on usefulness and enjoyment dimensions, but were asked to evaluate these logos on only one dimension at a time. The oddball paradigm was conducted in two cultural groups (USA and Taiwan) to determine whether the evaluative processes are culturally specific or whether they reflect fundamental processes that cut across cultures.

2. Literature

Our research adopts the dual-process framework to study rapid evaluation (Brewer, 1988; Fiske, Lin, & Neuberg, 1999; Fiske & Neuberg, 1990). Although this framework has been applied in different decision making scenarios and various terms have been used to describe the two processes, the dual-process framework generally posits that people process information either in a rapid/effortless or a slow/deliberate manner (Chaiken & Trope, 1999; Hsee & Rottenstreich, 2004; Kahneman, 2003; Lieberman, 2007; Petty & Cacioppo, 1986; Schuette & Fazio, 1995).

Studies of rapid evaluation have examined impression formation and impression regulation processes (Brewer, 1988; Fiske & Neuberg, 1990). Studies of impression-formation cover the topics of impression content and impression activation, whereas studies of impression-regulation describe how impressions can be modified by the latter developed and deliberate evaluation (Brewer, 1988; Fiske & Neuberg, 1990). In this study we focus on the impression formation problem and investigate the dimensions that can be automatically activated.

2.1. Multi-dimensional evaluation in EC

Social stimuli can be evaluated along multiple dimensions. Importantly, this multi-dimensionality exists in rapid evaluation processes (Pham, Cohen, Pracejus, & Hughes, 2001; Willis & Todorov, 2006). In the EC domain, usefulness and enjoyment are two important, high-level evaluative dimensions (Batra & Ahtola, 1990; Childers, Carr, Peck, & Carson, 2001; Davis et al., 1992; Mathwick, Malhotra, & Rigdon, 2001; Oliver, 1993; Van der Heijden, 2004; Voss, Spangenberg, & Grohmann, 2003). Usefulness is the anticipation that a product, such as a website, can enhance task performance by assisting the user to solve future problems efficiently and effectively. On the other hand, enjoyment is the anticipation of inherent pleasure and excitement arising from interacting with the product (Davis et al., 1992; Van der Heijden, 2004; Voss et al., 2003).

Usefulness is considered a higher-level evaluative dimension because it requires the consideration of a website's function for problem solving (Van der Heijden, 2004). However, it is important to note that enjoyment is also a high-level dimension rather than a primitive emotional response to an Internet stimulus. Psychological models classify emotions into the lower- and higher-order types (Berkowitz, 1993; Buck, 1985). While lower-order emotions involve primitive and bottom-up processes, higher order emotions engage top-down control processes for active...
interpretation of a stimulus (Lazarus, 1991). Such models have been supported by evidence from neuroscience studies. For example, when people make higher order emotional appraisal, the frontal lobe (believed to be involved in top-down control) is activated while the amygdala (believed to be involved in bottom-up emotional experiences) is deactivated. In contrast, activation of the amygdala, but not the frontal lobe, becomes evident when people merely report the feelings induced by the stimuli (Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner et al., 2009). In a website evaluation scenario, the derivation of enjoyment requires top-down control process to interpret a website in terms of anticipated fun and resulting excitement, and therefore should be considered a higher-level of evaluation (Davis et al., 1992; Van der Heijden, 2004).

It has been implied that enjoyment evaluation is more salient than usefulness evaluation (Pham et al., 2001). Specifically, compared to cold, reason-based assessments of a consumer product, conscious monitoring of feelings (i.e., enjoyment evaluation) provides faster judgmental responses and is more consistent across contexts (Pham et al., 2001). It is reasoned that when people are making appraisal of enjoyment, they consciously and actively consult themselves about their feelings about the stimuli, which can be accessed with less effort than the reasoned assessment (Pham, 2007; Pham et al., 2001).

Although these studies imply that enjoyment weighs more than usefulness in evaluation of consumer products, it is not clear whether enjoyment evaluation can be automatically performed and empirical evidence should be established for a rapid evaluation condition in EC. Furthermore, in these studies people were given rather long time (10 s) to perform the evaluation, and therefore it is still unknown how enjoyment and usefulness evaluation is performed for rapid evaluation (for example, 1 s).

2.2. The oddball paradigm and the Late Positive Potential

To understand the formation of website impression, we employ dense-array EEG and the oddball paradigm to study evaluation processes. Originally, the oddball paradigm is designed to elicit a brain signature associated with the detection of stimulus change on a priori defined dimension (Donchin & Coles, 1988; Ritter & Vaughan, 1969; Sutton, Braren, Zubin, & John, 1965). For example, stimuli are first separated into two categories based on a dimension of stimulus attribute (such as shape, an X and an O). Then the two categories of stimuli are arranged in a way that one category has lower probability of occurrence, called the target, and the other category has higher probability of occurrence, called the non-target. The successful detection of target provides direct evidence that people can differentiate the two categories along the defined dimension (Donchin & Coles, 1988).

Studies have shown that a target stimulus induces larger LPP amplitude than a non-target (Donchin & Coles, 1988). The LPP is most evident approximately 300–800 ms after stimulus appearance and has a distribution focused over central and parietal scalp sites (Cacioppo et al., 1993; Donchin & Coles, 1988). LPP amplitude is believed to reflect cognitive resources devoted to an update of the representation of the environment, as a consequence of stimulus categorization (Donchin & Coles, 1988). Furthermore, it has been shown that latency (timing) of LPP peak amplitude reflects the time that decision making occurs (McCarthy & Donchin, 1981). Stimulus complexity seems to have little effect on LPP; stimuli can be simple figures (Sutton et al., 1965) or complex social symbols, such as faces (Ito & Cacioppo, 2000). LPP amplitude is independent of response selection and stimulus modality (Crites et al., 1995; Ritter & Vaughan, 1969). In short, these properties suggest that LPP is an ideal ERP component to study the underlying cognitive processes associated with decision making.

2.3. LPP and rapid evaluation

Cacioppo and colleagues have extended the oddball paradigm to investigate rapid social evaluation processes (Cacioppo et al., 1993, 1994; Ito, Thompson, & Cacioppo, 2004). They defined evaluation as a categorization process in which people categorize a social stimulus along the good–bad dimension. They reasoned that people should differentiate targets from non-targets if the target deviated from the non-targets on the evaluative dimension of good and bad. For example, LPP amplitude should be larger for the target category if (1) one category of stimuli was negatively evaluated and the other category was positively evaluated, (2) people could differentiate between both evaluative categories (i.e., they could evaluate the negative and positive features), and (3) the two categories were arranged such that one served as target and the other served as non-target (Cacioppo et al., 1993). Support for this proposal has been acquired in a series of studies involving social stimuli, such as trait words and faces (Crites, Mojica, Corral, & Taylor, 2010; Ito et al., 2004).

Using this paradigm, it has also been shown that people can automatically engage in an evaluative dimension irrelevant to the current task (Ito & Cacioppo, 2000; Ito et al., 2004). Specifically, Ito and Cacioppo asked people to categorize pictures along either an evaluative dimension (good vs. bad) or a non-evaluative dimension (the presence of a human vs. absence). The results showed that people still demonstrated a clear LPP deflation when a change occurred on the good–bad dimension even when they were categorizing along the non-evaluative dimension. This finding suggests that good-bad evaluations can be automatically performed even when people are not required to do so (Ito & Cacioppo, 2000), and that task-irrelevant LPP is an ideal psychophysiological marker of automatic evaluative processes.

2.4. The current study

We extend the evaluative oddball paradigm (Cacioppo et al., 1993; Ito & Cacioppo, 2000; Ito & Urland, 2003) by including two high-level evaluative dimensions (usefulness and enjoyment) to investigate whether these two dimensions can be performed rapidly and automatically in website evaluation. Following the paradigm employed by Cacioppo and colleagues (Cacioppo et al., 1993; Ito & Cacioppo, 2000), we defined four types of stimuli (Fig. 1, Table 1): Explicit target, Implicit target, Both target, and non-target. First, a target was defined as a stimulus (website logo) that was different on a defined dimension (e.g., enjoyment or usefulness) and occurred less frequently than non-target. Targets were divided into three types. An Explicit target was defined as a target that was inconsistent with the non-target on the task-relevant evaluative dimension. An Implicit target was defined as a target in which the inconsistency occurred on a task-irrelevant evaluative dimension. The Both target was a target that was inconsistent on both task-relevant and task-irrelevant evaluative dimensions. We followed previous social psychology studies and used 1 or 1.2 s stimulus duration in two studies to present website logos (Ito & Cacioppo, 2000).

We specifically explore three questions: (1) Can people perform both usefulness and enjoyment evaluations when website logos are briefly presented? (2) Which dimension can be performed automatically? (3) Are rapid evaluation processes similar in different cultures?

We hypothesized that usefulness and enjoyment evaluation of websites can be performed rapidly (i.e., within 1 s), based on previous findings that social stimuli can be evaluated in a short time (Ito & Urland, 2003; Willis & Todorov, 2006). Successful evaluative performance would be supported when the LPP amplitudes of the Both and Explicit targets are larger than that of the non-target. This is because people can differentiate between target from non-target
on the specific evaluative dimensions (i.e., they can detect the odd-balls on the usefulness or the enjoyment dimension). Conversely, it is assumed that people cannot perform the evaluations (e.g., randomly respond) if target-LPP amplitude is not larger than the non-target LPP amplitude.

H1. Website evaluation for both enjoyment and usefulness can be completed within one second after the stimulus is presented.

We also hypothesized that enjoyment evaluation of websites can be performed automatically (i.e., when enjoyment evaluation is task-irrelevant), based on previous studies showing that enjoyment evaluation can be performed with less effort (Pham et al., 2001). This will be assumed to be true if LPP amplitude of the Implicit target in the usefulness task is larger than that of the non-target.

H2. Website evaluation for enjoyment can be completed within one second even when people are performing usefulness evaluation task.

An interesting and open question is how the rapid evaluation is affected by culture. While evidence has shown that culture might affect high-level behaviors, such as shopping style (Lyonski, Durvasula, & Zotos, 1996) and technology acceptance (Straub, Keil, & Brenner, 1997), no study has examined how culture can affect rapid evaluation in the Internet domain. One possibility is that culture might play little role in affecting rapid evaluation. This is because young adults in areas with easy access to Internet (USA and Taiwan) have been heavily engaged in its associated activities, and therefore have developed heuristics through explicit or implicit learning to perform the rapid evaluation toward Internet stimuli.
H3. There are no differences in terms of evaluation responses between Taiwan and US participants in making usefulness and enjoyment evaluations.

3. Overview of the experiments

Similar procedures were used in the studies performed in the USA (Study 1, N = 23) and Taiwan (Study 2, N = 22). Participants were required to evaluate the enjoyment and usefulness of websites logos. We included logos that contained brand name, title, or description of websites that participants could easily infer their possible website functions to form an impression. Examples included Comedy.com and Job.com. We avoided logos that contained only pictures or artwork not suggestive of their website functions. The logo pool for the studies performed in the USA and Taiwan were mostly composed of regional websites. Participants might have visited some of the websites before the study and had developed an attitude toward them. To control for this possibility, familiarity of a website was measured so that familiar websites were subsequently excluded from analysis. In both studies, a familiarity Likert scale (1: familiar to 5: unfamiliar) was used to measure a participant’s familiarity of each website represented by the logo. For each individual participant, logos received scores between one and three were categorized as familiar and were excluded from EEG analysis.

A dense-array EEG (dEEG) system was used for studies in both cultures. Specifically, a 256-channel EEG system was used in the USA study and a 128-channel system was used in the Taiwan study. Both dEEG systems are produced by the same company (EGI, Eugene, OR). In both studies, LPP measures were derived from electrodes that cover the centro-parietal scalp region, where the LPP is maximal (see Figs. S1 and S2 in Supplement for further details). Because current from the cortex is volume conducted to the scalp, it is the spatial topography that must be adequately captured for measurement and quantification rather than the activity at single electrodes per se. In fact, measuring LPP activity across multiple electrodes over the relevant scalp region is more stable than measurement of LPP at any single electrode.

In Study 1 participants’ evaluation of the website logos was acquired from their responses during the EEG session and in Study 2 the evaluation was collected before EEG session. In Study 1, we followed the criteria established by Cacioppo et al. (1993), Ito & Cacioppo (2000) to define targets. That is, the criterion for defining a target was whether it is preceded by at least two non-targets. In Study 2 the Cacioppo and colleagues’ paradigm was strictly followed, and the target was randomly inserted in the 3rd, 4th, and 5th position in a sequence. Further details are described in later sections.

4. Study 1

4.1. Participants

Twenty-three participants (10 males) were recruited from University of Oregon (USA) for an EEG experiment with the 256-channel Hydrocel Geodesic Sensor Net (HCGSN, EGI, Eugene, OR) and were paid USD $15 per hour for their participation. All participants are right-handed, native English speakers with normal or corrected-to-normal vision, and without history of seizures, attention disorders, head injuries, or medications that could affect EEG. The details of EEG recording and processing can be found in the Supplement (EEG Processing of Study One).

4.2. Materials

Pre-selection of the logos was conducted in a separate study (see Supplement: Pre-selection of the logo pool). A total of 160 logos were obtained from this process. To make the logos more consistent in appearance, they were resized to 120 × 45 pixels and all their background colors were changed to white. Some logos were further edited using Photoshop so that they would look natural after resizing.

4.3. Procedure

On the arrival at the lab, participants read and signed the consent form, which stated the purpose, compensation, and procedure of the experiment. The 256-channel HCGSN was applied and participants were seated in front of a computer screen. Their distance from the screen was 40.5 cm, which was controlled by placing their chin in a chin rest. Participants were then provided with instructions to perform the enjoyment or usefulness task. For the usefulness task, participants were instructed to judge whether the website represented by the logo “makes things more efficient, productive, effective or easier.” For the enjoyment task, participants were required to judge whether the website represented by the logo can be “exciting, pleasant, interesting or enjoyable.”

Participants were provided with 10 logos for practice before the experiment began. Each trial started with presentation of a logo, which lasted for 1200 ms. Logos were presented in the center of a 43.18-cm screen whose resolution was set to 800 × 600 pixel. During the variable inter-trial interval (ITI), which randomly lasted between 1.2 and 2.4 s, participants performed the enjoyment evaluation task or usefulness evaluation task. Participants were instructed to press one of two keys using the index and middle finger of one hand (response hand counterbalanced across participants). One key indicated a high and the other a low rating for “enjoyment” (enjoyment task) or “usefulness” (usefulness task). Trials were grouped into blocks of 100 trials. The trials were grouped into sets of five, with a pause in between each set (Cacioppo et al., 1993). The duration of the pause was controlled by the participant. Participants performed four blocks in each of the evaluation task (i.e., eight blocks in total, resulting in 800 trials). Task order was counterbalanced across participants. Participants were asked to make evaluations as accurately as possible, and not necessarily to be consistent with previous ratings if the logo had been repeated.

Once the study was completed, the HCGSN was removed. Participants then reported their familiarity to each website logo and demographic data. Finally, they were debriefed and provided with their compensation.

4.4. Analysis

Targets and non-targets were defined post hoc in Study 1. We first acquired individual participant’s rating toward each logo by their responses in the EEG study. Then, we selected the logos that were evaluated inconsistently compared to the two preceding stimuli and categorized these targets into Explicit, Implicit and Both target types (Table 1). Other trials were classified as non-targets. Because a logo were evaluated multiple times, to be conservative, we only chose those logos that were evaluated consistently across trials into targets. We also dropped the logos that participants subjectively reported to be familiar with (10.44% of 800 trials).

Since target probability affects LPP amplitude, it is important to check whether the number of occurrences of each target type differed. Our procedure produced similar number of targets in both tasks, except the Both target. Specifically, in the 800 trials, this procedure produced 1.52% Both target trials, 4.10% Explicit target trials, 3.74% Implicit target trials, and 35.55% non-target trials for the enjoyment task, and produced 1.48% of the Both target trials, 3.75% Explicit target trials, 4.20% Implicit target trials, and
35.30% non-target trials for the usefulness task. The probability of targets was not different between the two tasks ($F(1,22) < 1$). However, there were significantly fewer number of trials for the Both target than the Explicit and Implicit targets ($F(3,66) = 819.76, p < 0.01$). We excluded the Both target from further analysis to avoid the possible confound due to different probability of occurrence.

4.5. Results

Two participants were excluded from analysis because of excessive ocular artifacts and one was dropped due to low number of target trials (on average 11.5 trials for each target type). Consistent with prior studies, LPP could be observed at central and parietal electrode sites between 450 and 800 ms after stimulus onset, peaking at 620 ms (Fig. 2). The LPP was quantified as the mean amplitude between a 450 and 800 ms interval of all the electrodes included in the LPP area. The electrodes selected for quantification were defined a priori based on reports from the literature of LPP (i.e., from central to parietal sites, see Supplement: Fig. S1). We presented the average of all the channels of the selected channels across participants in Fig. 2.

To test whether LPP amplitudes differed between targets and non-targets, the amplitude of LPP was submitted to a two-way repeated measures ANOVA. Task (Enjoyment vs. Usefulness) and target (Explicit, Implicit, None-target) served as within-subject variables. All reported p-value were Greenhouse-Geisser corrected. The results showed a significant main effect of target, $F(2,38) = 6.30, p < 0.01$, $\eta^2 = 0.24$, but not the main effect of task, $F(1,19) = 1.45, p = 0.24, \eta^2 = 0.01$, nor the interaction term $F(2,38) = 1.90, p = 0.17, \eta^2 = 0.01$.

To further understand the target type main effect, the amplitude of each target-type was submitted to a paired t-test in which targets were tested against non-target (Fig. 3, upper panel). The LPP of the Explicit target types were significantly larger than the non-target in both the enjoyment task, $t(19) = 2.83, p = 0.01, d = 0.63$, and usefulness task, $t(19) = 2.21, p = 0.04, d = 0.55$. These results demonstrated that participants could clearly detect the explicit evaluative inconsistency on both usefulness and enjoyment tasks, and that participants could perform the two evaluation tasks within the LPP interval (i.e., 450–800 ms). Therefore, $H1$ (website evaluation can be performed rapidly) was supported.

More importantly, in the usefulness task, the Implicit target (i.e., enjoyment target embedded in usefulness task) also induced a larger LPP amplitude. The LPP of the Implicit target types were significantly larger than the non-target in the usefulness task, $t(19) = 2.99, p < 0.01, d = 0.67$. This finding indicates that the enjoyment evaluation was still processed even when it was task-irrelevant, suggesting enjoyment evaluation was performed automatically. Conversely, the Implicit target in the enjoyment task (i.e., usefulness target embedded in enjoyment task) did not induce larger LPP amplitude, $t(19) = 0.23, p = 0.82, d = 0.05$, suggesting that participants did not perform usefulness evaluation when it was task-irrelevant. The results that enjoyment evaluation was performed automatically supported $H2$ (website evaluation can be performed automatically).

5. Study 2

Scientifically, it is important to replicate the finding of Study 1 in a different culture group ($H3$). Also, in Study 1 the Both target could not be analyzed. To ensure equal probability of each target type, we acquired participants’ evaluation in a behavior study session prior to EEG session (see Supplement: Individual Evaluations in Study 2). Based on individual participants’ evaluation, a customized set of logo pool was constructed for each participant’s EEG session. An equal number of targets was produced and presented in such a way that a target was preceded by at least two evaluative inconsistent stimuli. The details of EEG recording and processing can be found in the Supplement (EEG Processing of Study Two).

5.1. Participants

Twenty-two student participants (13 males) were recruited from a southern Taiwan university to finish a two-session study. They were paid 100 NT for each hour of participation. All participants are right-handed, native Mandarin speakers with normal or corrected-to-normal vision, and without history of seizures, attention disorders, head injuries, or medications that could affect EEG results.

5.2. Material

One hundred and sixty logos were pre-selected. The pre-selection of the website logo pool is similar to Study 1 (see Supplement:
Pre-selection of the logo pool. During the EEG session, the stimulus was processed and presented in the same manner as in the Study 1, except that the logos were then presented following the design of Cacioppo and colleagues (Cacioppo et al., 1993). Specifically, within each set of five trials, a target logo was embedded randomly between the 3rd, 4th, and 5th positions. This structure ensured that each target was preceded by at least two inconsistent logos and the number of each type of target was equal (Ito & Cacioppo, 2000). This structure resulted in 2.5% of each target-type, and 42.5% of the non-targets in both tasks (out of 960 trials).

5.3. Analysis and results

Two participants were excluded from further analysis due to excessive ocular artifacts or bad channels. The LPP waveforms were similar to that of the Study 1 and could be observed during 450–800 ms over central to the parietal sites. As in Study 1, LPP amplitude was quantified by the mean amplitude between 450 and 800 ms interval of all electrodes over the centro-parietal region (Supplement: Fig. S2, Fig. 4).

Analytical procedure was identical to that of Study 1. The amplitude of LPP was submitted to a two-way repeated measures ANOVA, in which task (Enjoyment vs. Usefulness) and target type (Both, Explicit, Implicit, None-target) were within-subject variables. The results showed a significant main effect of target type $F(3, 57) = 4.57, p < 0.01, \eta^2 = 0.06$. The results showed no main effect of task, $F(1, 19) < 1, \eta^2 < 0.01$, or the interaction term, $F(3, 57) < 1, \eta^2 < 0.01$.

Mean LPP amplitude was also submitted to a paired t-test in which targets were tested against non-target (Fig. 3, lower panel). Consistent with the results of Study 1, LPP amplitude associated with the Explicit target was significantly larger than amplitudes for non-target in both the enjoyment task, $t(19) = 3.48, p < 0.01, d = 0.91$, and usefulness task, $t(19) = 2.70, p = 0.01, d = 0.60$. In addition, the LPP amplitude of the Both target stimulus was significantly larger than LPP amplitude of the non-target stimulus in both enjoyment, $t(19) = 2.20, p = 0.04, d = 0.55$, and usefulness tasks, $t(19) = 2.10, p = 0.05, d = 0.51$. Similar to Study 1, the Implicit target also induced larger LPP amplitude in the usefulness task, $t(19) = 2.25, p = 0.04, d = 0.57$, but not in the enjoyment task, $t(19) = 1.22, p = 0.24, d = 0.21$.

Replicating Study 1, these results suggest that participants could perform usefulness and enjoyment evaluations within the time range of the LPP (450–800 ms), supporting H1. In addition, the enjoyment evaluation was automatically processed even when it was not task-relevant (H2). Similarly, the result of Study 2 did not provide evidence that the usefulness evaluation was processed under a task-irrelevant condition.

Finally, because we found the same LPP response profile in both studies, the results did not reject H3: that evaluation mechanisms
are similar across cultural groups. The response profile was examined with a mixed ANOVA, in which task (Enjoyment vs. Usefulness) and target type (Explicit, Implicit, None-target) served as the within-subject variables and study (Study One vs. Study Two) served as the between-subject variable. The results showed that the target type was significant, $F(2,76) = 13.15, p < 0.01$, $\eta^2 = 0.24$ for usefulness evaluation and $p = 0.27$, $\eta^2 > 0.01$, were insignificant. The threeway interaction effects was also insignificant, $F(2,76) < 1$, $\eta^2 < 0.01$.

6. General discussion

6.1. Findings and implications

The two studies provide techniques (research paradigm and neurophysiological marker) and results that address questions regarding automatic evaluation in the NeuroIS research agenda (Dimoka et al., 2012). We used the LPP component to assess people's evaluation process toward briefly presented website logos. The results showed that enjoyment and usefulness evaluations were performed under the rapid evaluation scenario, in which website logos were presented briefly and provided limited website information. Past studies of website impression suggest that perceived visual appeal can be established with a 50 ms exposure to the webpage (Lindgaard et al., 2006), and the brain can generate primitive emotional response within 200 ms after the appearance of business logos (Handy et al., 2008). We have extended this line of study by showing that people can perform even higher-level evaluations (usefulness and enjoyment) between 450 and 800 ms after the appearance of website logos. Our finding provides evidence suggesting that adaptive evaluative processes are engaged, perhaps routinely, for stimuli that are encountered in daily life, such as Internet stimuli.

Our two studies also provide the evidence that enjoyment is likely to be the first impression that can be automatically registered (i.e., when it is task irrelevant) when people encounter a website logo. Conversely, we did not find clear evidence that usefulness evaluation could be performed automatically. It should be noted that the null finding was associated with small effect size and low power (in Study One, $p = 0.82, d = 0.05$, power = 0.05; and in Study Two, $p = 0.24, d = 0.27$, power = 0.21). This suggests that our study could not completely rule out that there was a small-sized effect of automatic usefulness evaluation. However, we could rule out that there was a medium to large (0.5 and 0.8, Cohen, 1977) effect size involved in automatic usefulness evaluation. In addition, the fact that we did not find automatic evaluation of usefulness with LPP does not mean that such automatic process did not occur at all. Automatic process of usefulness might be captured with ERP components different from that we had adopted in this study. In short, although whether there is automatic usefulness evaluation requires further investigation, our results have provided conclusive evidence that enjoyment evaluation can be performed automatically. Nevertheless, the finding suggests that usefulness evaluation might not easily occur in the absence of an explicit usefulness task, possibly because usefulness evaluation requires effortful control. This finding is consistent with the proposal that enjoyment is more salient than usefulness evaluation (Pham et al., 2001), but we extend this proposal by showing that these evaluation properties also apply to stimuli that are briefly presented and that enjoyment evaluation can be automatically performed.

Our finding that evaluation of a website logo can be performed rapidly contributes to both the dual-process framework and the technology acceptance theory. Previously, IS acceptance studies have followed the rationality paradigm and assumed that users perform IS evaluation in a controlled and effortful manner (Ajzen & Fishbein, 1999; Davis, 1989). Our study has shown that a rapid and uncontrolled (automatic) IS evaluation process exists. This expands the dual-process framework to include the Internet stimulus, as well as extends the technology acceptance theory to include this rapid process (i.e., initial impression of an IS) as preceding factors that may affect usage behavior. We propose that, compared with the controlled evaluation, this rapid evaluation of IS might better explain the choice behavior (e.g., clicking on one of numerous websites or apps) and attentional processes (e.g., paying more attention to a certain website or an app) when users have low motivation and limited cognitive resources to perform the evaluation. Similarly, this proposal also applies when users have little knowledge about a website and are browsing a great number of websites. This proposal can produce testable hypotheses. For example, we predict that website logos or apps that imply high enjoyment can pop out (attract attention and choice) among competing logos or apps. This testable hypothesis regarding technology usage can be further examined.

We did not find evidence that rapid website evaluation was influenced by cultural differences. Even though our cultural comparison is explorative, the results contribute to the long-lasting debate regarding the homogeneous vs. heterogeneous nature of consumer shopping style across cultures (Lysenski et al., 1996). To the extent that enjoyment and usefulness affect consumer choices and style, when they are employed and the consciousness (i.e., willfulness) that goes into the processes that determines choices may be culturally independent. Nevertheless, whether there is cultural difference in rapid evaluation is not yet conclusive and requires more examination.

6.2. Future studies of impression

The study of impression regulation is concerned with the processes that contribute to the development of favorable or unfavorable impressions about a website and how these impressions are maintained or altered. To establish a deeper understanding of impression regulation requires that we understand how neural measures, such as the ones studied here, relate to behavioral measures and subsequent choices. One example topic for future research is “to what extent can rapid evaluation be overridden by the latter formed, deliberate evaluations?” According to social cognition studies, rapid, automatic evaluations might be modified by motivation and presentation of additional information (Chaiken & Trope, 1999). Conversely, if people do not form deliberate evaluations, evaluations by impression are likely to be the only input that determines behavior (Fazio, 1995; Kahneman, 2003). For example, researches have shown that a product picture may bias subsequent information processing and problem solving behavior (Fitzsimons et al., 2008; Yeung & Wyer, 2004). In our studies we did not investigate how impression might bias complex decisions such as intention to use and how deliberation may correct such a bias. We propose that the study of connections between impressions and deliberations and how they moderate behavior will expand our understanding of Internet users’ decisions making processes. Particularly, it is important to investigate the role of motivation and cognitive resources in regulation of the impression and in the formation of deliberate evaluations.

Note that in this study we did not examine how the features of our logos could affect rapid website evaluation. Given the prevalence of websites and apps and the speed of their release, we believe that the examination of the effect of logo feature on evaluation is important for IS and advertisement designers. Future studies can extend our findings into other set of logos, and preferably seek to systematically manipulate perceptual (e.g.,
color and luminance) and semantic (e.g., slogan design) properties of a logo pool to understand their effects on rapid usefulness and enjoyment evaluation.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.chb.2015.02.016.

References


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