Designing Web Pages for Increased Content Familiarity: A Strategy 1 Study

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There are numerous motivations for small-to-medium businesses to engage in ecommerce (Grandon and Pearson 2004, O'Reilly 2007). Yet in order for these businesses to generate value from their ecommerce activities, it is important that they can foster a sense of familiarity among users with the content of their websites (Gefen 2003). Thus, the objective of this study is to identify some design mechanism for websites that allows for increased content familiarity.

The concept of familiarity is one that has received significant attention in the field of neuroscience, particularly with regard to its differentiation from other forms of memory (Haist et al. 1992; McLaren et al. 2013). This perspective typically divides memory into 'recollection', in which objects are brought to mind in relation to some cue, and 'familiarity', in which objects are perceived as familiar only once they are presented (Ochsner 2000; Buckner and Wheeler 2001; Norman and O'Reilly 2003). This distinction is supported by findings that different neurophysiological regions are responsible for each (Allan et al. 1998; Mayes et al. 2007; Rugg and Yonelinas 2003). Most notably, a range of findings suggest that the perirhinal cortex and anterior parahippocampal regions within the medial temporal lobe (MTL) are key areas for familiarity-based recognition, while the hippocampus and posterior parahippocampal regions are key areas for recollection (c.f. Yonelinas 2002).

An important component of these memory systems is the 'emotion modulation' of memory formation, which suggests that more emotive stimuli are encoded more effectively due to relationships between affective regions of the brain and memory-related areas in both the MTL (McGaugh 2000) and in sensory cortices (Hofstetter et al. 2012). Yet there have been suggestions that different networks are involved in the processing of positive and negatively affective stimuli, e.g. with the amygdala playing a more central role for negatively affective stimuli (Aldhafeeri et al. 2012; Kensinger 2004). This suggests that positively and negatively affective stimuli may affect different memory functions in different ways (Kensinger and Schacter 2007).

As one may expect, this moderating effect of emotional valence on memory is also associated with attentional differences, whereby negatively valenced content encourages attention on some specific details of scenes while positive valenced content encourages attention on more holistic aspects (Gasper and Clore 2002). This was illustrated by recent observations of faster response times in search tasks with positively valenced image distractors and slower response times in tasks with negatively valenced distractors (Sussman et al. 2013). Thus, in a web design context, ancillary images with positive valence may potentially increase the familiarity of core content. Yet the perirhinal cortex and anterior parahippocampal areas of the MTL are known to be especially sensitive to repetition suppression, whereby neural responses decrease following continuous exposure to the same stimuli (Gonsalves et al. 2005; Ranganath and Rainer 2003). This suggests that the benefits of positively valenced images in web design may be diminished as those images become less novel to users.

Like emotional valence, arousal plays an important role in the modulation hypothesis, as demonstrated by the observation that amphetamines can enhance memorization (Soetens et al. 1995). This moderating effect exists for both positive and negatively valenced stimuli, yet the effect is significantly greater when valence is negative, (Kensinger 2004). Interestingly, like negatively-valenced content, high-arousal content also serves to narrow the attentional focus, as opposed to low-arousal content which broadens it (Gable and Harmon-Jones 2010). This relationship between attentional focus, negative valence, and arousal appears to surround a central role for the same brain regions in each, e.g. the amygdala, nucleus accumbens, and anterior cingulate cortex (Anderson et al. 2001; Pessoa 2008). Such a relationship means the effect of high-arousal images in web design may be to draw attention to the images themselves, rather than the core content of webpages.

Thus the design hypothesis is proposed in this study that *webpages should include novel low-arousal images of positive valence to increase users' familiarity with the content of that webpage*.

The choice of methods to test this design hypothesis was determined by two factors. Firstly, the extent of existing research on familiarity lends itself to a deductive approach. Secondly, the desired utility of these design principles are behavioral in nature. Hence, a strategy 1 approach was adopted, i.e. existing theory from neuroscience was used to inform design theorizing while behavioral measures were used to determine the resulting theory's utility (vom Brocke et al. 2013). To this

end, a website was developed in the form of a web portal for third party massive open online courses (MOOCs). This web portal contained seven pages in total, including one homepage and six web pages dedicated to six specific categories of MOOCs. Images were placed in the center of the screen, above the main content of webpages, and below a logo for the fictitious website and a simple navigation bar. The images used were taken from the International Affective Picture System (IAPS), a standardized set of color photographs across a range of semantic categories, which are distributed to researchers upon request, along with quantitative ratings for valence, arousal, and dominance (Lang et al. 2008). The images that were used all possessed valence scores >6.5 on the negative-positive dimension, as well as scores on the arousal dimension of either <4.5 for low-arousal images or >6.5 for high-arousal images.

A 2x2x2 between-subjects factorial design was implemented to test the design hypothesis. The first factor represented image novelty, whereby the website either displayed the same image continuously across different webpages, or a novel image for each individual webpage. The second factor represented image arousal, whereby images displayed on the website were either high-arousal or low-arousal. The third factor represented the basic behavioral dynamics of the interaction. The focus of attention differs among search tasks and other visual behavior (Itti and Koch 2001), hence subjects were either (1) presented with six search tasks to find and select some specific course as quickly as possible, without being told in which category that course was located, or (2) to browse each category and select the course they found most interesting. Subjects were briefed that the purpose of the experiment was to evaluate some aspects of web design but were not made aware that familiarity or memory was the main focus of this investigation. This approach was taken to avoid giving subjects any knowledge that could compromise their ability to behave in a representative manner. Upon completion of the experiment, each subject was presented with 10 courses, 5 of which they had been exposed to in the original website and 5 of which had not. They were then asked to select the 5 courses they believed they had encountered.

131 subjects participated in the experiment as part of coursework for one undergraduate program and one postgraduate program. This included 77 males and 54 females with an average age of 23.67. The scores from the course recognition tests for these subjects were compared with a two-tailed analysis of variance, the results of which are illustrated in Table 1.

These results show two statistically significant relationships. The first of these is the interaction between whether the images used were alternating or constant, and whether the images used were low-arousal or high-arousal (see Figure 1). This interaction shows that subjects performed best on the familiarity test when their web pages contained novel low-arousal images, under which conditions they correctly identified an average of 3.406 courses. The absence of any interaction with browsing/searching conditions also suggests that this was unaffected by behavioral differences in the tasks set for users. Thus the design hypothesis put forward by this study is supported.

Table 1. Results for course recognition tests

	F	Sig.
Alternating/Constant	2.161	.245
High/Low Arousal	.055	.564
Browse/Search	26.025	<.001**
Alternating/Constant * High/Low Arousal	4.206	.044*
Alternating/Constant * Browse/Search	.034	.883
High/Low Arousal * Browse/Search	.657	.245
Alternating/Constant * High/Low Arousal * Browse/Search	.840	.314

* = p<0.05, ** = p<0.001

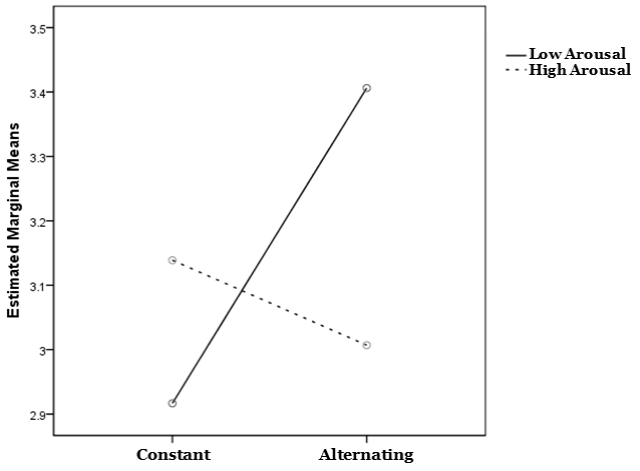

Figure 1. Interaction for content recognition between image-alternating and image arousal

The second statistically significant relationship was the main effect for the browsing/searching condition. The average subject correctly identified 3.09 courses, however this rose to 3.523 during browsing tasks and fell to 2.712 during search tasks. The existence of this difference is arguably not surprising, however the extent of the difference is interesting, as subjects in search tasks

performed subsequent familiarity tests at a level close to that of pure chance. This suggests that individuals searching an ecommerce website for some specific item will gain familiarity with it far slower than those engaging in browsing behavior.

The findings from this study have implications for both neuroIS research and industrial web design. With regard to neuroIS, there are opportunities to expand upon the current research with more strategy 1 studies looking at other features of web design that contribute to users' emotional response and content familiarity, e.g. colors, sounds, animations, layouts, etc. There are also opportunities for strategy 2 research that seeks to identify biological correlates of the interplay between positively affective web design, arousal, and familiarity. Such research could then lay the foundation for strategy 3 research based on biofeedback mechanisms, e.g. facial recognition could be used to determine whether users are responding positively to images, eye-tracking could be used to determine attention and arousal, etc. The interface could then adapt to optimize interaction for any particular user, replacing ineffective images, adjusting contrast, etc. Lastly, there are opportunities to investigate the separate but related issue of content recollection in web design, which this study has not explored in detail. The interplay between these two facets of memorization, emotional valence, arousal, and different forms of web behavior, remain to be examined more closely at a neurophysiological level.

The implications for industrial web design are both direct and indirect. The direct implications concern the use of novel low-arousal imagery as a means of increasing content familiarity. The findings also suggest that websites should encourage browsing behavior in users where possible, rather than encouraging visits where users are looking for some pre-determined items. Indirect implications can be abstracted to a more mindful consideration by designers of the arousal-level of images and the goals of the website. Where the temptation may exist to increase the arousal of images to add excitement and catch users' attention (e.g. Lindgard et al. 2006), designers must maintain careful management of emotional valence if they are to effectively cultivate users' familiarity with content.

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