The Effect of Familiarity on Perceived Interestingness of Images

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ABSTRACT

We present an exploration of familiarity as a meaningful dimension for the individualized adaptation of media-rich interfaces. In this paper, we investigate in particular the effect of digital images personalized for familiarity on users' perceived interestingness. Two dimensions of familiarity, facial familiarity and familiarity with image context, are manipulated. Our investigation consisted of three studies: the first two address how morphing technology can be used to convey meaningful familiarity, and the third studies the effect of such familiarity on users' sense of interestingness. Four levels of person familiarity varying in degree of person knowledge, and two levels of context familiarity varying in frequency of exposure, were considered: Self, Friend, Celebrity, and Stranger in Familiar and Unfamiliar contexts. Experimental results showed significant main effects of context and person familiarity. Our findings deepen understanding of the critical element of familiarity in HCI and its relationship to the interestingness of images, and can have great impact for the design of media-rich systems.

Keywords: Interestingness, Familiarity, Images, Media, Personalization, Morphing,

1. INTRODUCTION

Interestingness signifies the "power of an object to awaken responses other than those called forth by its aesthetic form ... Interestingness generates a certain kind of significance. Form gives beauty; *interestingness gives emotional or conceptual meaningfulness*"[18]. Interfaces that are 'interesting' may better engage users. People want interesting avatars in games, interesting *Powerpoint* slides in classrooms, and interesting pictures to look at on *Facebook* and *Flickr*. And thus interestingness is a worthy concept to explore in HCI. But what makes an interface interesting? Researchers have looked at designing for attention, usability, effectiveness, and satisfaction. We look at design for interestingness.

Previous research on interestingness has focused on how general features or aesthetic properties of interface elements like composition, color, etc. can impact interestingness. It is often thought however that factors deeper than general principles of attractiveness are too subjective to study. An exception is research in culturally-relevant or -situated technology (e.g. Hatley, 2011[1]) that argues for a customization of technology to the values, practices, and cultural knowledge of the target group. But ultimately, interest has personal dimensions. We propose familiarity as a dimension that occurs at an *individual* and *personal* level for the *meaningful customization* of interfaces to generate interestingness.

In this paper, we focus on one of the key elements of a multimedia interface, namely images, to study how the inherent familiarity that people gain with others and places in everyday life may impact interestingness. Of course, perceived interestingness is likely to vary across individuals, but we believe that there may be sufficient agreement on what makes a personalized image interesting across individuals to enable us to contribute to general design theory for media-rich interfaces. We consider two main components of images: people and context. We present a sequence of studies that help us to advance guidelines to convey facial (person) and contextual familiarity within images:

Study 1: How do you manipulate and convey facial familiarity tailored to each individual? We employ a technique of morphing an unfamiliar *base* face with familiar faces as a means of manipulating facial familiarity. We investigated the percentage parameters necessary to enable morphing to convey a minimum visual similarity for viewers to begin having a sense of familiarity with face images.

Study 2: How consistently is visual similarity seen across face images? We tested the consistency of perceived visual similarity of faces across variations in morphed photos.

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Study 3: We studied how manipulated image familiarity of the person and context in an image may affect its level of interestingness as experienced by individual viewers.

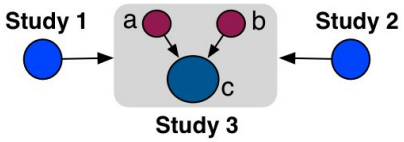

Figure 1. Structure of studies conducted

The first two studies, which framed the last study, were smaller investigations of how a sense of facial familiarity may be conveyed. The third larger study, which we shall describe in greater detail, relates familiarity with interestingness in visual content, and is actually a set of three studies, comprising of two preparatory studies and a main study. Figure 1 shows the structure of studies conducted. For each study, we first discuss its theoretical rationale, and proceed to describe the study proper and its results. For all three studies, participants were balanced for gender and photography expertise. They were all aged between 45-60, had a four-year college degree or higher, and were employees of a large company.

2. CREATING FAMILIARITY IN IMAGES

We see a face in a crowd that reminds us of a loved one – we take a further look. Familiarity seems to be a commonplace and trivial concept, but in its triviality, it is what enables us to function in the world. The world would be a persistently bewildering place were we not embodied beings who have the ability to become familiar through our daily experiences [2]. It is through this familiarity that we can in turn perceive and recognize things. Heidegger uses the term "being-in-the-world" to explain how familiarity functions as the basis of human understanding, and how it provides a background that makes focus possible in our actions.

In defining familiarity, it is helpful to distinguish between recollection and familiarity. While recollection makes use of our episodic memory and is about consciously 'remembering' an item, familiarity spurs a form of associative recognition. According to the Jacoby model, familiarity arises when "fluent processing of an item is attributed to past experience with that item"[3]. In HCI research, familiarity is often understood from the perspective of Johnson-Laird's mental models and metaphors. One builds a cognitive representation of something with which one is familiar[4]. In categorization research, familiarity has been defined and measured in two ways: familiarity with an *item's meaning*, involving the amount of perceived knowledge one has about an item or its meaningfulness to the person, and familiarity with regards to frequency of exposure, that is, the frequency with which one encounters an item[5].

For our purpose, we define familiarity as *a sense of knowing that brings about meaning based on previous experiences*. Familiarity thus does not entail straightforward recognition, i.e., viewers should think the face looks familiar to them, and not that they blatantly know the person in the photo. More specifically, we operationalize a familiar item or situation as one having *just enough visual similarity* to previously known items or situations that then triggers access *to associated semantic knowledge* for the viewer. Our theoretical model is illustrated in Figure 2.

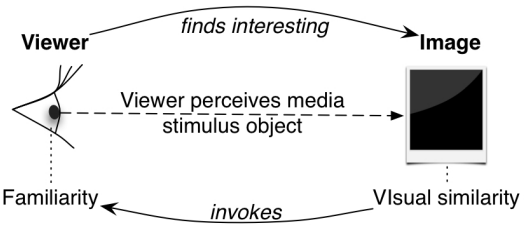

Figure 2. A model for meaningful personalization of media

2.1 Study 1: Morph Level to Convey Familiarity

Familiarity, as we have defined it, is a challenging concept to convey artificially. Repetitive exposure of images is a common method used to induce image familiarity (e.g. Dubois et al., 1999[6]). However, this method often results in surface-level familiarity that is purely visual, since the stimulus may or may not trigger associated semantic knowledge or meaning for the subject. Embodied experience, such as scheduled visits of sites, has been used to allow subjects to become familiar with particular environments to be later tested (e.g. Hammit, 1979[7]). Although this method may allow the stimulus to become meaningful to the participant, it is impractical with regards to person or facial familiarity. We are interested in investigating naturally-occurring familiarity, "true familiarity that develops over years of varied interpersonal experiences"[15], instead of artificially or experimentally induced familiarity from in-lab repeated exposure, or learning or priming, as is commonly done in the 'mere exposure effect' studies.

To test familiarity, many studies focus on memorability and recollection, which warrants the use of identical test stimuli or test stimuli with perfectly matched visual similarity (e.g. Dubois et al., 1999[6]). We want to test familiarity that **does**

not cross into identity. We opted to use face morphing as a way to manipulate facial familiarity. Facial morphing was first used by Etcoff and Magee[8] in their study of category perception of facial expressions. Many others in neuroscience have adopted the method (e.g. Rotshtein & Magee, 2005[9], Angeli et al., 2007[10]), but the method has not been as well exploited in HCI. The reasons for our choice of morphing are threefold: 1. We are looking at meaningful customized media, in which familiarity needs to be tailored to each particular individual so as to bring about relevant meaning; 2. It is a flexible technique that allows us to control the degree of visual similarity (through morph % adjustments) and familiarity (through choice of 'base photos' for morphing) that we want to convey; 3. It allows for repeatability and consistency of the manipulations.

Face Morphing Process

The main goal of Study 1 was to determine the minimum morph percentage for facial images that would generate visual similarity that is just enough to convey a feeling of familiarity in viewers. We used the off-the-shelf software *FantaMorph*[11] to perform morphing. The morphing procedures were as follows: Photos of the two faces to be morphed (hereafter referred to as the 'base face' (BF) and the 'face of interest' (FoI)) are loaded into the software. The morphing is done through the method of feature specification, in which one indicates the correspondence between pairs of feature primitives. These key points placed on important features of each face are used to interpolate to average points using linear triangulation[12]. At least 100 correspondence points were specified on each face. After an automatic feature detection process by the software, manual point placement was done until the morphed face looked smooth and most oddities in the 50% morph image were erased. Checks were made that all morphs along the continuum were smooth as well. Morphed faces at every 10% interval were then generated. Only morphs at certain percentages were selected and used for the study. In this paper, specifying a morph of 30% for example would mean 70% of the 'base face' and 30% of the 'face of interest'.

Because of the complexity of describing a morphing procedure, we employ the following notation to facilitate discussion. We denote the set of A FoIs that are the focus faces as $\{a_i \in A,\ i = 1...N\}$, where N is the number of FoIs. We denote the second set of K faces that function as BFs, faces that are used only for the sake of the morphing process, as $\{b_j \in B,\ j = 1...K\}$. We define the morphing function that describes the application of a level or degree of morph (M) of value, ϕ, between faces a_i and b_j as: $M(a_i, b_j, \phi)$.

Study Description

Our Study 1 goal was to determine the minimum value of ϕ, given a constant b for a set of a_i, at which participants experience a sense of familiarity with the resulting morphed face. We denote this minimum level of morph at which familiarity is experienced as ϕ_F. This study employed a set of eight celebrity faces (actors and/or singers, i.e., N = 8), four male and four female, as a_i across all participants. We began with three values for ϕ, ($\phi = \{25\%, 30\%, 35\%\}$). Each a_i was morphed with the constant b at the three morph levels, resulting in a set of morphed faces: $M(a_{1...8}, b, \phi_{25,30,35})$. We added a pool of random distractor faces d_k, (k = 1 … 10) for the test. Each d_k was morphed with b at the same three morph levels, producing 30 distractor faces. The participant was shown each $M(a_i, b, \phi)$ along with three randomly picked morphed distractor faces (matched for ϕ value). Hence, each participant was exposed to a total of 24 sets (8 celebrity × 3 morph levels) of 4 images each.

The study was conducted as follows: participants were presented with all series of four faces, one at a time, in random order. Face photos were printed on standard photograph stock paper of 2 × 2 inches. The task of the participant was to identify the face that they think look most similar to the celebrity in question among the four faces presented in each series. For the first two celebrities of each gender, participants were explicitly told the name of the celebrity. For the other two celebrities of each gender, participants were simply asked to state whether any of the three faces looked familiar to them, without mentioning any names to them. If they could not name any celebrity, they were told the name of the celebrity and allowed to proceed with the task.

Study Results

All the three morph levels tested proved insufficient for participants to either detect visual similarity or obtain a feeling of familiarity that would reliably enable them to identify a morphed face beyond chance. Subsequently, we tested two higher morph levels at 40% and 50% with two additional participants by morphing the same set of celebrity photos. We

found that the participants could start to correctly identify the most similar faces in the series reliably and to feel a sense of familiarity only at the morph level of 50%. In about 10% of the cases however, no feeling of familiarity was conveyed and participants still made the wrong pick. Based on our findings therefore, we suggest that a morph level of 60% may be appropriate to consistently convey a sense of familiarity in most cases.

2.2 Study 2: Impact of Varying Base Faces on Visual Similarity in Face Morphing

To personalize digital images for individual interest, not only would the 'face of interest' inevitably change at each instance of application, but the 'base face' may also vary. Obviously, it is then possible that the 'face of interest' resembles the 'base face' to a greater or lesser degree. The main purpose of our second study was to investigate whether morphing with different 'base faces' would influence how viewers objectively perceive the resulting morphed face. That is, would viewers rate a FoI morphed with 'base face 1' the same on a visual similarity scale as the FoI morphed with 'base face 2', even if morphing for both sets of faces is done at the same morph level? In Study 2, we tested whether the perceived visual similarity of a morphed face is consistent at the fixed 60% morph level across viewers.

Study Description

Adopting the same notations used in the description of Study 1, Study 2 can be described as follows:

Each male participant $\{i_1^M \ldots i_3^M\}$ was first shown a set of FoIs, $a_i = \{a_1, \ldots, a_{40}\}$. We morphed each a_i with a set of varying male BFs, $b_j = \{b_1, \ldots, b_4\}$, amounting to a total of 80 (40×4) male morphed faces. Each female participant $\{i_1^F \ldots i_3^F\}$ was first shown a set of FoIs, $a_i = \{a_1, \ldots, a_{44}\}$. We morphed each with a set of varying female BFs, $b_j = \{b_1, \ldots, b_4\}$, amounting to a total of 88 (44×4) female morphed faces. The FoIs used were the faces of the participants who had been recruited for Study 3, and BFs consisted of random strangers and celebrities. Based on his or her gender, a participant was only tested with the male or female set of faces.

In the study, the participant was first presented with a 'face of interest' (FoI). She was then shown the four morphed faces associated with that FoI one at a time in a randomized order while still seeing the FoI. As in Study 1, all face photos were printed on 2 × 2 inches standard photograph stock paper. The task of the participant was to rate, on 100-point scales (0, Not at all similar – 100, Very similar), each morphed face (i.e. $M(a_i, b_j, 60)$) with regards to the unmorphed FoI a_i on: (i) feature-based similarity (i.e. how much they perceived the morphed face to be similar to the face of interest by comparing facial features) and (ii) a more gestalt-based similarity (i.e. how much of the face of interest do they perceive in the morphed face). Participants were given precise instructions not to pay attention to any attributes not related to the features of the faces, e.g., color, size of faces and the quality of the images. We compared participants' ratings of similarity between $M(a_i, b_j, 60)$ and a_i across b_j.

Study Results

We found no significant difference in the degree of perceived gestalt-based visual similarity across 'base faces'. There was more variance in the reported degree of feature-based visual similarity across 'base faces', but differences remained insignificant. It can be concluded that even with the variations introduced by the use of different 'base faces', a morphed 'face of interest' can generally be perceived to be visually similar to the original FoI.

3. FAMILIARITY AND INTERESTINGNESS

The purpose of our last study was to evaluate the impact of familiarity as a personalizing dimension on the perceived interestingness of images. Other perceptual empirical studies have looked at other variables such as memorability[13], preference[14], attraction[15], arousal and valence[16], but we have found none explicitly on interestingness. Interestingness has been interpreted as the attribute of an item, as the response of a user to an item, as an emotion, or simply as a psychological or behavioral reaction. Interestingness has routinely been simply equated to attention.

Because of its abstract nature, measurement of interestingness has also found no consensus. On social networking sites like *Flickr*, the extent of interestingness of an image is assessed based on features such as number of clickthroughs, users' comments, number of times 'favorited', and tags. Interest in still images has been assessed by tracking human eye movements, as the user looks at the image[17], and by recording the amount of time spent on the stimulus. However, many empirical works have also consistently employed self-reports to measure interestingness.

3.1 Link between Familiarity and Interestingness

Few studies have investigated the relationship between interestingness and familiarity directly. For context, we summarize possible reasons gathered across the literature on why familiarity may lead to greater interestingness or to other positive affect attributes, and why the same result may be caused by unfamiliarity instead. There is no clear consensus on the effect of familiarity, notably because of differing conceptualizations of the term and the wide range of attitudes and emotions that are studied.

The Familiar as Interesting: Possible reasons for familiar objects to be judged as more interesting include the object triggering: a sense of personal connection[18]; curiosity[19]; perceptual fluency[20]; stronger cognitive response in episodic memory, aspects of consciousness and self reflections[21, 22]); or the feeling of security[23].

The Unfamiliar as Interesting: It is possible that unfamiliar objects instead may cause greater interest because of two main reasons: the stronger stimulation of memory and emotions when novel faces are seen as compared to visually familiar faces[21]; and the biased competition hypothesis, which states that novel stimuli elicit attentional biases (i.e. novelty attracts attention) and induces preference[24].

3.2 Impact of Differing Levels of Familiarity

Of major interest to our study is the work by Gobbini et al.[25], who studied people's reaction to the recognition of familiar faces. They made distinctions among different levels of person knowledge with familiar faces. They posited that person knowledge in the form of "stronger emotional attachment, knowledge about personal traits and associated biographical information" plays a role in familiar face recognition. Their results showed that people significantly react more slowly to personally familiar faces than to stranger faces, but recognition reaction times did not differ significantly for famous faces from either personally familiar or stranger faces. They also found that personally familiar faces were judged as significantly more 'positive' and 'arousing' than both famous familiar faces and stranger faces. Famous familiar faces were in turn evaluated as more 'positive' and 'arousing' than stranger faces. They argue in their paper that personal familiarity with immediate family and long-term friends differs from impersonal familiarity with celebrities in that it activates a neural network related to knowledge about the person's personality, attitudes and intentions, as well as to episodic memories and emotional responses associated with him[25, 26].

A second study of interest by Park et al.[14] found that people prefer familiar or novel things differently depending on object categories. Faces elicited familiarity preference. For natural scenes, new stimuli were preferred over old ones. Geometric figures produced no strong preference bias in either direction. In the experiment, familiarity was operationalized as repeated exposure to faces or natural scenes.

3.3 Study 3: Evaluating Interestingness From Personalized Familiarity

Study 3 was a controlled in-lab study with familiarity of images as the independent variable (IV). Taking cue from the study results of Park et al.[11], we divided familiarity into two dimensions, as shown in Figure 3:

1. *Familiarity of person:* Following Gobbini et al.[25], we manipulated familiarity of person at four levels, varying along the degree of meaningfulness: a. *Personally familiar* person (e.g. friend, colleague); b. *Impersonally familiar* person (e.g. celebrity); c. The *self* (i.e. the viewer him/herself); and d. *Unfamiliar* person (i.e. stranger).
2. *Familiarity of context* (wrt content depicted in the image): Familiarity of context was manipulated at two levels: a. *Familiar* context; b. *Unfamiliar* context. For this study we varied contexts in terms of frequency of exposure, estimating that such operationalization is adequate for manipulating context familiarity according to our definition: *a sense of knowing that brings about meaning based on previous experiences.*

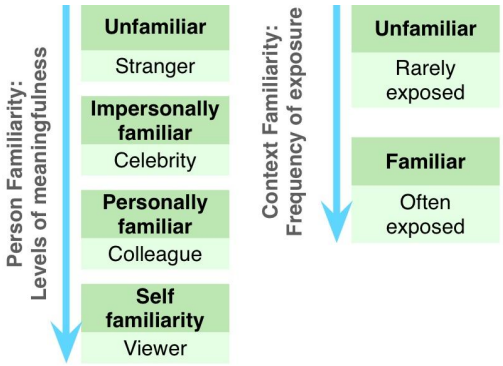

Figure 3. Levels of Person and Context Familiarity

The study thus followed a 4 (person familiarity) × 2 (context familiarity) within-subjects design.

Study Preparation

Two small separate studies (3a and 3b in Figure 1), with nine and eight participants respectively, were conducted to help us prepare appropriate materials for Study 3c. The different factors that were investigated in these smaller studies to prepare and validate study materials were:

Initial base photos stimulus set: To obtain the image stimulus set for the main study, photos were selected from typical consumers' cameras, *Flickr* and *Picasa Web* albums. The following requirements were set for image selection: 1. Only photos with a single adult were considered; 2. The photos are medium or wide medium shots, with the person facing mostly forward; 3. The person has a casual or smiling facial expression; 4. The photo depicted a scene that fits into a context of interest. All photos were edited to a fixed size (3600 × 2400 or vice-versa), for brightness and contrast, and were color-balanced. A total of 28 photos were selected. The photo set included seven different contexts of varying familiarity that we selected based on our intuition (e.g., beach, train station, kitchen, office).

Choice of familiar contexts: Each context of the selected images in the initial stimulus set had four scene variations (e.g. four similar scenes of context type 'kitchen'). We confirmed the visual similarity of scenes within each context, and determined people's general sense of familiarity with each context. Procedures used for the test were:

All photos from the initial set were given to the participant in a stack. He/she was asked to sort the stack of photos into piles based on the overall visual scene similarity of photos to each other. He/she was then asked to focus on the contexts only and rate each pile of photos on several dimensions, namely frequency of exposure, familiarity, attractiveness (attention-grabbing) and liking. Out of the seven contexts, we selected the four (see Figure 4) that had average scores for attractiveness and liking. Two of the contexts selected had high familiarity and frequency of exposure ratings ('Kitchen' for females, 'Office' for males, 'Birthday celebration' for both females and males), and the other two contexts had low familiarity and frequency of exposure ratings ('Train station' for females, 'Car show' for males, 'Game arcade' for both females and males). We note that there was a significant positive correlation (r = .71) between context familiarity and frequency of exposure scores, supporting our operationalization of 'familiarity' for contexts.

Choice of familiar celebrities: To determine suitable celebrities to use as base faces (BFs) for the *impersonally familiar* condition, we surveyed participants as to their level of familiarity with 20 celebrities, who included singers and actors, using publicly available face photos of the celebrities from the Internet. We avoided politicians although they may be more familiar to most because of the potentially strong and contradicting reactions that may be associated with them. Procedures used were as follows:

The participant was given a stack of face photos of celebrities and was asked to sort the celebrities into high popularity, medium popularity and low popularity piles. He/she was then asked to rate each celebrity in his/her high popularity pile on a scale of 0 to 10 based on frequency of exposure, familiarity, attractiveness (attention-grabbing), beauty, and liking. It should be noted that other categories of people, apart from celebrities, could also have been used for this level of *impersonally familiar* IV, such as people whom one routinely meets but does not really talk to (e.g., the bus driver). From the participants' scores, the two celebrities, one male (Harrison Ford) and one female (Julia Roberts), who were rated high in popularity, frequency of exposure and familiarity but average in attractiveness, beauty and liking were selected for use in the main study.

Choice of 'friends' for study participants: We made a conscious decision to use work colleagues for the *personally familiar* condition. It should be noted again that there are many other categories of people, e.g., more casual friends, who are *personally familiar* to a person. Requirements that we used to select 'friends' were that the participant has to meet the friend face-to-face on a regular basis, both of them should have at least one current point of contact such as a common project, and the 'friend' has to be of the same gender as the participant. Using access to the participants' calendars publicly available on the company's intranet, we identified a 'friend' for each participant of the main study. We also obtained face photos of the 'friends' either from the company's open database or by inviting the 'friend' to a photo-taking session. In the later scenario, the 'friend' was specifically told not to share any details about the photo-taking session with the participant.

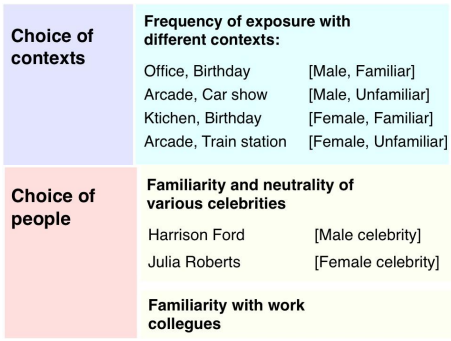

Figure 4. Results for contexts and people tests

Study participants: 42 participants were recruited for the main study 3c: 22 males and 20 females averaging 52.7 in age, 19 participants describing themselves as advanced and 23 as casual photographers. Self-photos of the participants were obtained by inviting them to a photo-taking session, as an information gathering, months before the study.

Personalized Photo Sets

From the preparatory studies 3a and 3b, we had 16 base photos for each gender to be used in the morphing procedure. The base photo set for each gender consisted of two familiar and two unfamiliar contexts, each having four scene variations. We had two celebrity face photos, one of each gender, front and profile (self) face photos of each participant of the main study, and front and profile face photos of their chosen 'friend'.

For each context, we randomized the morph pairings of the different 'faces of interest' (the FoIs): Self (Se), Friend (Fr) and Celebrity (Ce), with the four stranger faces (the BFs) in the base photos of the scene variations. All morphs were done at the fixed 60% morph level that was determined to be appropriate in Study 1, using the same morphing software, *Fantamorph*[11], and process that we used in Study 1 and 2. We integrated the morphed faces into the base photos using layers and multiple tools (e.g. blend, blur edges) in *Photoshop CS3 Extended*. If the set of stranger photos/BFs for each context is represented by $C_i^F = \{S_1, S_2, S_3, S_4\}$, where $i = \{1,2\}$; (i is a context, e.g. office), and F stands for *Familiar Context*, and $C_i^{UF} = \{S_1, S_2, S_3, S_4\}$, where UF stands for *Unfamiliar Context*, one personalized photo group for participant X could be for example:

$\{M = (S_1, Se, 60); M = (S_2, Ce, 60); M = (S_3, Fr, 60); S_4\}$, and the set for participant Y could be:
$\{M = (S_1, Fr, 60); M = (S_2, Se, 60); M = (S_4, Ce, 60); S_3\}$.

Each participant thus had a personalized set of 16 photos in total (4 person familiarity variations per scene × 2 context familiarity variations × 2 contexts). Figure 5 shows a sample of the type of photos selected for the study. In total for Study 3c, we morphed and integrated 352 faces ((2 contexts × 2 context familiarity variations × (1 self-face + 1 'friend' face) × 42 participants) + 16 celebrity faces).

Figure 5. Sample of selected photos for Study 3

Photo quality: To account for possible small variations in image and editing quality due to facial morphing and integration, we conducted preparatory study (3b) with a separate group of participants. Participants were asked to rate on 100-point scales all the 16 base photos, after size and color editing, on *overall image quality* (a general evaluation of how well the photo was taken), *technical quality* (an evaluation of how good the photo was in terms of factors such as color saturation, depth of field, focus, etc.) and *aesthetic quality* (an evaluation of the photo based on factors such as composition, perspective, colorfulness, etc.). The participant was then presented one at a time with all the morphed photos of all the main study participants combined who were of the same gender (around 200 photos in total for each participant of this study 3b). She was explicitly told that some of the faces in the photos had been edited in some way, and was tasked to rate how plausible the person in each photo looked and, on 5-point Likert scales, the extent to which facial editing was visible.

There were no extreme values in terms of photo quality, although some variations were observed. We recorded these scores as covariates for analysis of the main study data.

Study Description: Study 3c was conducted in a laboratory setting with the participant viewing images on a 30" high-resolution LCD NEC monitor, while sitting at approximately 35" away. A custom application (see Figure 6) was developed to display the images on the screen as they progress through three rating tasks record collect participants' responses. A participant viewed only images with people of his/her own gender. The study lasted on average 1.5 hours.

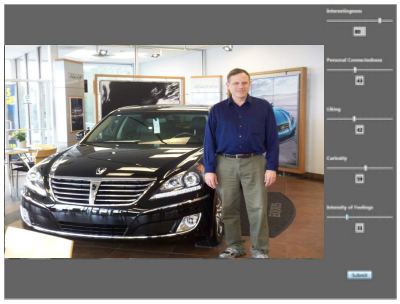

Figure 6. Screenshot from the custom evaluation

As shown in Figure 7, participants were first asked to fill in a Personal Feeling survey[27] that consisted of 45 adjectives to determine their current emotional state. They were then taken to the experiment room. Participants viewed all of the 16

photos from their personalized stimulus set individually, with two practice photos at the start, in a free viewing session with no time limit (see Figure 7). Photos were presented in a randomized order. In between the viewing of each photo, the participant was asked to fixate on a cross in the middle of a gray screen, presented for 2 seconds. After clicking on a photo, participants were presented with a 100-point scale to rate the photo based on how interesting they perceived it to be. Our application also tracked the amount of viewing time spent on each photo prior to rating by marking the time of display of a photo and the mouse click required to begin rating.

Pre-questionnaire	Personal feeling survey
Experiment	1. Absolute (individual) photo ratings 2. Relative ratings within contexts across person familiarity levels 3. Relative ratings across contexts within person familiarity levels
Interview & Post-questionnaire	1. Familiarity with contexts 2. Familiarity with celebrity and friend 3. Recognition of people 4. Personal interests

Figure 7. Actual procedures of Study 3c

After the evaluation session, participants completed a post-experiment questionnaire, containing questions about their degree of familiarity with the contexts used, the 'friend' selected for them, and the celebrity chosen for the study. We also asked for a list of their personal interests, which could potentially have affected their interestingness evaluation of the photos. Last but not least, in a semi-structured interview, we asked them to specify how familiar they felt the people in the photos were, if so who the person reminded them of, and whether they could actually recognize any person by name. Participants were also asked to manually indicate, with reasons, which of the photos they rated as highly interesting on printouts of their photo stimulus set.

Study Results: Data from the study were obtained from logs of the custom application and printed questionnaires. Data coding for vested personal interests was done in the following way: for each photo, a participant was assigned a score based on the number of listed personal interests that were relevant to items in the photo. E.g. a participant listing books and computers as interests would obtain a score of 2 for the 'office' photo. A composite score was calculated for emotional state from the personal feeling survey through averaging; a higher average score indicated a more positive state and a lower score a more negative one. All data were transferred to a spreadsheet and data analysis was done using the JMP statistical software.

Validation tests: For validation purposes, a t-test using the context familiarity scores from the post-questionnaire of the study confirmed that participants were much more familiar ($F_{3, 668} = 44.40$, $p < .00$) with the 'Kitchen', 'Office' and 'Birthday celebration' contexts than with the 'Train station', 'Car show' and 'Arcade' contexts. Pairwise comparisons showed that "Kitchen" and "Office" could be grouped together as "Familiar contexts," and 'Train station' and 'Arcade' as 'Unfamiliar' contexts. 'Birthday' however stood as a separate group, and was therefore not included in future interestingness analyses. 'Familiarity with friend' scores showed that nearly all participants were very familiar with their 'work colleague' and with the celebrities chosen. In the post-experiment interviews, even when prompted, participants did not report observed resemblances between morphed faces and themselves, celebrities and their colleagues. This suggests familiarity effects, in which we are interested, instead or conscious recognition effects.

Analysis of interestingness: A repeated measures ANOVA was conducted to examine the effects of person and context familiarity on the interestingness scores. Fixed factors in the model included person familiarity levels, context familiarity levels, participant gender and photography expertise, quality of photo editing, technical and aesthetic photo quality scores, and perceived visual similarity of morphed faces (obtained from Study 2). The participant's emotional state was added as a random effect.

There were statistically significant main effects for both *context familiarity* ($F_{1, 620.1} = 92.36$, $p < .00$) (Figure 8) and *person familiarity* ($F_{3, 620.6} = 4.28$, $p < .01$) (Figure 9), as well as a significant interaction effect of *Context familiarity* × *Gender* ($F_{1, 618.3} = 10.20$, $p < .005$) (Figure 10). No significant interaction was found for *Person familiarity* × *Context familiarity*, as well as for *Person familiarity* × *Gender*. Participant photography expertise, emotional state, and perceived similarity of morphed faces were insignificant covariates. Quality of editing ($F_{1, 635.7} = 19.27$, $p < .00$), aesthetic quality ($F_{1, 626.7} = 7.57$, $p < .01$) and technical photo

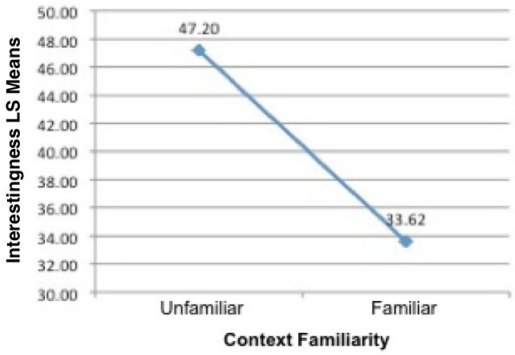

Figure 8. Main effect of context familiarity

quality ($F_{1, 619.5} = 4.83$, $p < .05$) appeared to provide a small significant contribution to interestingness scores. Inclusion of these factors in the statistical model allowed to account for these effects, with the main familiarity effects remaining significant.

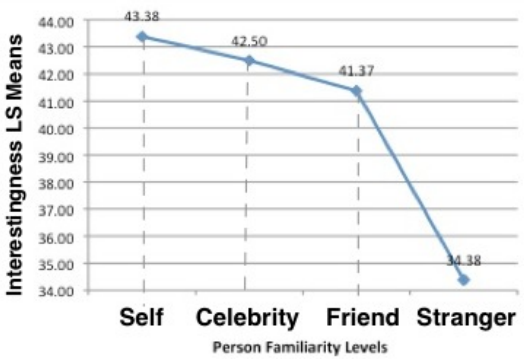

Figure 9. Main effect of person familiarity

Photos with *unfamiliar* contexts ($\mu = 47.20$) were considerably more interesting than photos with *familiar* contexts ($\mu = 33.62$) regardless of gender. However, unfamiliar context photos for males were significantly higher ($p < 0.0068$) than for females. Regarding person familiarity, photos morphed with the *Self* ($\mu = 43.38$) were rated highest in terms of interestingness, before *Celebrity*-morphed photos ($\mu = 42.50$). Next were photos morphed with the '*Friend*' ($\mu = 41.37$). *Stranger* photos were rated as the least interesting ($\mu = 34.38$). Pairwise comparisons showed that Self-morphed, Celebrity-morphed and Friend-morphed photos formed one group (i.e., they were not significantly different among themselves), and Stranger photos stood as a different group (i.e., they were significantly different from all of the rest).

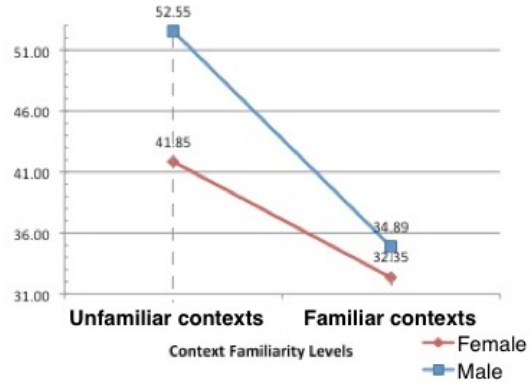

Figure 10. Context familiarity X Gender interaction

4. DISCUSSION

We proposed and investigated familiarity as a possible meaningful dimension to personalize digital images through the use of morphing technology. Our findings have important implications for the design of media-rich interfaces.

Results from Study 1 suggest that a morph level of 60% would be effective to convey familiarity for facial images. This is in line with previous research on paper photos. Perception of person identity along a facial morphing continuum has been shown to occur in abrupt transitions for familiar faces at category boundaries of 33% and 66%[28]. Rotshstein et al.[9] investigated a continuum of morph levels at 30% intervals for morphs between face pairs to study perception of differences among faces (e.g. 40%–70%, 50%–80%). These studies however did not look at morphing as a means of inducing naturally-occurring familiarity with digital images, that was the purpose of our study.

Our Study 1 finding gives guidance concerning the familiarity boundary between a 'base face' and a 'face of interest' when using morphing technology. One can think of gaming avatars or conversational agents that are morphed with the player's face or faces of people significant to the player. Other techniques using the 'Microsoft Kinect' sensor[29] or face processing algorithms[30] have already been proposed to personalize the design of avatars. Busey[31] showed in his morphing experiment that people cognitively classify morphed faces along several dimensions, notably age, race, adiposity, and facial hair. Further research is thus warranted to tease out the effects of such dimensions on the morphing parameters and their influence on familiarity.

In Study 2, we investigated the effect of using varied 'base faces' on the similarity perception for the resulting morphed face at a constant 60% morph level. This study, performed with a large set of stimulus pictures showed that there is no significant difference in how similar our participants perceived the same FoIs morphed with different 'base faces'. Study 2 is a particularly important investigation to inform personalization of many different types of interface elements seeking to convey familiarity. To create personalized avatars and agents, a randomly chosen 'base face' to morph the player's self photo with can result in similar effects. On the Internet where the obvious, intrusive and explicit is not always appreciated, the independence of the level of perceived visual similarity with respect to the 'base face' also means that persuasive media can be generated for any target material as long as the FoI is carefully chosen.

In our introduction, we motivated this paper with questions of how familiarity may affect one's sense of interestingness with media. Study 3 investigated the relationship between familiarity of faces and contexts and perceived image interestingness. We related four levels of familiarity that included self, personal-, impersonal- and non-familiarity to viewer-perceived interestingness of images. Our hypothesis of the positive correlation between the level of

meaningfulness of the familiar face and the perceived interestingness of the image was borne out in our results. We found that at the 60% morph level to a 'base face', self, celebrity, and friend FoIs (in that order) far exceeded stranger FoIs interestingness perceptions of the resulting morphed face. This adds to previous research that has found a positive correlation between familiarity ratings and attractiveness and arousal[15, 25]. The slightly curious result is that morphs using celebrity FoIs were more interesting than those with 'friends'. We hypothesize that this is because we employed work colleagues as 'friends', and that this may be a lower level of 'meaninged relationship' than that of more personal friends. Additionally, the resemblance to celebrities may evoke a positive emotional memory response, which may be lacking for 'friends' morphs.

With regard to familiarity of contexts, our finding that image interest is higher when the image depicts unfamiliar contexts is consistent with the results of Park et al.'s[14] study that novel stimuli are preferred for natural scenes. Both of these results were consistent with our prediction, and complements prior research.

What we could not hypothesize for lack of prior literature is whether there is an interaction effect between the factors of facial and context familiarity. In our study, we did not find any interaction effect. These factors appeared to be independent, at least with data for both genders combined. Our results lead us to therefore suggest that when familiarity of meaningful faces and unfamiliarity of context are combined, the resulting interestingness is the greater of the influence of the two factors. That is, if interestingness owing to facial familiarity is denoted I_F and interestingness owing to the unfamiliarity of setting is denoted I_S, the resulting interestingness I_R can be given by $I_R = \mathrm{MAX}(I_F, I_S)$.

Our results can be understood from the viewpoint of human embodiment. Humans are designed to function in a spatial, temporal, social, and affective world[2]. To deal with the spatial/temporal world, humans have the immense capacity to gain familiarity with an environment so that precious perception, attention, and cognitive resources can be dedicated only to novel (and possibly threatening or rewarding) phenomena. This requires a reward mechanism to gain familiarity with novel settings, and the sense of interest may well serve as that mechanism. Similarly, humans are social beings, and the recognition of social ties and relationships are critical aspects of our being. Hence, positive valuation of familiar faces irrespective of environment may explain the interestingness of familiar faces independent of context.

Our results also showed an interaction effect between context familiarity and gender. We posit that the higher interestingness for unfamiliar contexts for males may be due to the different spatial perception tendencies that males possess as compared to females, as have already been seen for spatial navigation strategies in virtual worlds[13].

We further observe that the familiarization valence is reversed between settings and faces. Increased exposure may reduce context novelty, but have little effect on facial familiarity. Hence, novelty of settings of images will have to be periodically refreshed to maintain interestingness.

These findings can inform the design of personalized elements across many domains, such as in teaching materials that make use of imagery to sustain students' attention, photo sorting in online albums on social networking sites and in one's own local photo folder, the design of avatars for the elderly who may have affinity towards more personalized virtual objects, in personalized notification systems, and for digital narratives aimed at creating personal and community awareness about public issues and events.

Yet, the findings from Study 3 must be seen within certain constraints. The use of morphing might have introduced some elements of bias into how the faces were perceived. Morphed faces may for instance appear more typical to the viewer than unmorphed faces[31]. We made use of specific photos that were chosen through a careful selection process to eliminate bias as far as possible, but further research is needed to determine the generalizability of our study results to a broader set of media. Additional analysis may also help to tease out possible interaction effects that we did not find in this study for different genders and scene types.

On the whole, enabling personalization through familiarity as meaningfulness in education, entertainment, health, community awareness, marketing and politics may prove more challenging in many ways as it may require access to users' personal media, but it will provide for a more motivating and enriching interaction experience for users.

5. CONCLUSION

The main goal of this research was to investigate the use of familiarity as meaningfulness as a potent factor that can be used to personalize interface elements such as images, avatars and agents. We conducted three studies that explored the use of face morphing to convey familiarity and to understand the relationship of familiarity to perceived image

interestingness. Our study results, which showed that personally familiar faces and unfamiliar contexts are deemed more interesting, would certainly be of use as interaction design increasingly becomes media-rich. We have opened up many possible research directions, but a particularly exciting avenue may be to investigate how meaningful familiarity conveyance can be applied to other types of media, such as audio.

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