

The Role of Realism and Anthropomorphism in the Selection of Avatars

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Abstract

In a project designed to test how viewers evaluate and choose avatars to represent them online, viewers ($N = 261$) evaluated 92 potential avatars that varied along three dimensions – gender of the image, anthropomorphism (humanness), and realism (veridicality). Consistent with the predictions of information processing theory, results indicated that anthropomorphic qualities increased perceived realism and subsequent homophily judgments. As predicted by the uncanny valley hypothesis, viewers preferred avatars with levels of realism and anthropomorphism matched and were more critical of imperfections of avatars with higher levels of anthropomorphism. Image gender and anthropomorphism were found to produce a combination of positive and negative effects on competence ratings and selection of avatars. The theoretical and practical implications of these visible feature effects of avatars are discussed.

1. Introduction

The process of evaluating computer-generated stimuli, such as avatars, follows the same predictable pattern as offline stimuli [1-4]. This is consistent with information processing theory's omnistructure model of message processing [5, 6] which contends that the sequences for evaluating visual information are hard-wired [7]. The universality of these processes lends further credence to the Social Responses to Communication Technology (SRCT) paradigm [4, 8], which holds that viewers use the same process and criteria to evaluate stimuli and avatars online as they use to evaluate objects and people offline [9-15].

Avatars have been shown to increase the perceived social potential of an online partner and can effect communication outcomes, including attention and learning [17, 18]. The avatar's visual characteristics and behavior impact social aspects of communication including disclosure, nonverbal behaviors, and presence [19, 20]. Avatars that appear human or veridical (natural and not morphed) to viewers are evaluated as more anthropomorphic and realistic than less human or realistic avatars. These evaluations lead to assessments of higher credibility and greater liking of the avatar and influence perceptions of the person or information associated with the avatar [2, 9, 12-14, 16].

The findings of past studies suggest two new directions for avatar research. First, although much is known about how viewers rate an avatar selected by others, relatively little is known about how or why social actors choose an avatar to represent self. Users are able to exploit the affordances of a medium to manage their self-presentation, allowing them to control the impressions others are forming of them [21] and it is likely that avatars play a role in this process.

Second, researchers who design studies in which multiple viewers rate multiple images have three choices for unit of analysis [2]. Their unit of analysis can be the individual judgment of an image by a single viewer, the viewer (where judgments are averaged across multiple images), or the image (where judgments are averaged across multiple viewers). Nowak, et al [2] reported the effect of image features on viewer reception variables using judgment as unit of analysis. The present study demonstrates that using image as the unit of analysis provides even greater power to detect effects generated by image features.

2. The Omnistructure Model of Avatar Evaluation

The present study uses image level analyses to examine the omnistructure model of avatar selection shown in Figure 1. The path coefficients shown in Figure 1 were based on judgment-level analysis. By contrast, image-level analyses make it possible to examine a variety of refinements because the effect size of image features on reception and appraisal variables increases as measurement error decreases.

The first data pattern examined concerns the operation of implicit mediating variables. The model shown in Figure 1 proposes that effects of image features on goal-directed thought are mediated by perception variables. Yet the model also predicts several effects that are "direct" in that they appear to be mediated by implicit orienting variables. A review of the literature on message effects provided in the next section explains the origins of the model and compares viewer evaluations of visual images to receiver evaluations of verbal texts. The review suggests viewers' emotional involvement and image dynamism as variables that mediate the effect of image features on assessments of homophily and competence (see Figure 1). Our analysis uses causal modeling to test the viability of these proposed mediating variables.

The second data pattern concerns the role of viewer sex as a moderating variable. The model in Figure 1 proposes that viewer sex interacts with image maleness on homophily, where a portion of that impact is mediated by perceived gender match. The present study's moderator analysis shows that viewer sex moderates much more than just the effect of

image maleness on ratings of homophily. The differences in effect size between male and female viewers were so stark that separate causal models had to be constructed. This is not surprising given previous results showing that users prefer avatars with matching gender, such that men prefer male avatars and females prefer female avatars [12].

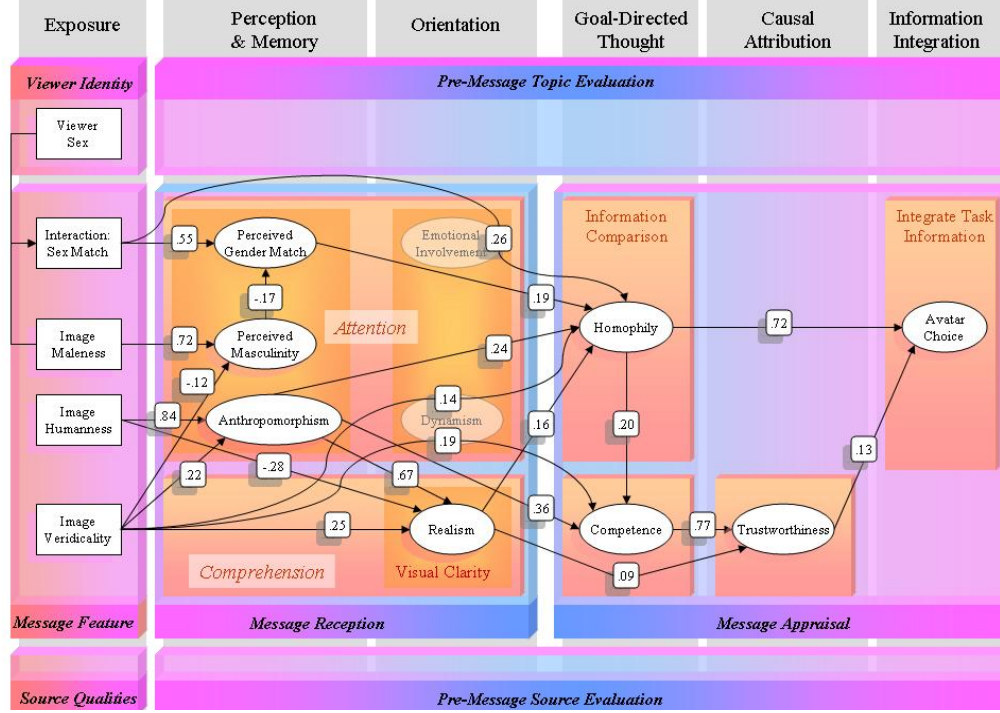


Figure 1 Proposed model with viewer sex as moderator

The third data pattern concerns possible nonlinear effects of image perceptions on viewer appraisal of the image. More intense perceptions or polarized ratings are predicted to be associated with more extreme judgments about the avatar. For gender perceptions, this disambiguation should result in higher homophily ratings when image sex and viewer sex match and lower homophily ratings when image sex and viewer sex do not match. In turn, homophily improves competence ratings. It is possible that overly sex-typed avatars may not be appraised as optimal in their degree of gender representation as discussed below.

A similar pattern may occur for anthropomorphism, where disambiguation should result in higher homophily ratings, with homophily increasing the likelihood of selecting the image as an avatar.

2.1. Phases and Sequences in a General Model of Message Evaluation

The process model of information processing theory [5, 22] was used to develop the omnistructure model of avatar evaluation and choice [2]. The model describes how message evaluation occurs as a series of six phases: exposure,

perception, orientation, goal-directed thought, causal attribution, and information integration. The first three phases pertain to reception of the message and the second three phases pertain to appraisal of the message.

After receiving a message on a given topic, receivers move through these six phases along two parallel tracks or sequences. One of these sequences is concerned with evaluation of topic and the other is concerned with evaluation of source. After exposure to verbal or visual input such as a text or image, the topic and source evaluation sequences interface with one another during message evaluation.

2.2. Premessage and Postmessage Evaluation

As part of the pre-message task evaluation, receivers' identify shapes and activate topic-relevant schema, which triggers accumulated information. This determines receivers' interest in the topic, with involvement polarizing attitude toward topic. Prior exposure to a source or category of sources leads to receivers' pre-message evaluation of source dynamism, with dynamism increasing competence, competence increasing trustworthiness, and trustworthiness

increasing likeability [23, 24]. The linkages among these four variables constitute the essence of charisma [5].

The processes of attention and comprehension operate within the phases of perception and orientation on Figure 1. Receivers orient toward topic and source to varying degrees and this influences the transition from message reception to message appraisal [5]. Attention to topic leads to goal-directed information comparison, ability to cope with new information, and information integration on topic [5, 6]. Attention to source (reflected in dynamism ratings) improves competence ratings, with competence increasing trust, and trust increasing liking. Source and topic evaluation interface when dynamism increases attention to topic [5]. Attention boosts comprehension and message clarity improves competence ratings [5, 6].

3.0. When the Avatar is the Message

An avatar conveys information about the person who choose it, even when there is little or no accompanying interaction or information [11, 25, 26]. That is, the image is the message. Figure 1 shows the message evaluation sequence through six phases. The premessage source and topic evaluation sequences are not articulated in Figure 1 because they were not an explicit part of the present study.

The first set of phases cover how viewers' receive a potential avatar: it covers exposure and orientation to the image as well as perception of the image. The second set of phases cover viewers' appraisal of the potential avatar and whether they are likely to use the image as a representation when interacting with others.

3.1 Message (Image) Reception

As viewers receive a message, they progress from exposure to perception and memory activation, and then on to orientation. As they move from the exposure phase to the perception phase, the features of an image influence their perceptions of it in predictable ways. Two reception processes lend coherence to the progression from perception to orientation: attention and comprehension.

The model in Figure 1 proposes that image gender and anthropomorphism are perceptions influenced by attention processes whereas realism is a variable more concerned with comprehension than attention. Just as attention facilitates comprehension [22, 27], anthropomorphism should increase realism during the orientation phase of avatar evaluation.

3.1.1. Attention: Interest in the image. Human features activate memory structures such as personae [28]—gender schema in particular. That is, human features facilitate the sex typing of avatars. Since inanimate objects do not reproduce, they are much less likely to have sex-typed features. If people do infer the gender of an inanimate object, such inferences are likely to be idiosyncratic and obscure [12, 25]. At the group level, the random nature of these inferences would cancel out, producing null or trivial effects. Although

non-human animals reproduce, our ability to distinguish males from females depends on the extent to which the species is sexually dimorphic. With humans, cultural stereotypes often provide viewers with expectations of what males and females are supposed to look like. Markers such as physical characteristics, clothing, and makeup facilitate the triggering of sex stereotypes [29, 30].

As the number of sex markers associated with an avatar increase, evaluations of its gender should become more polarized. This explains the massive positive effect of image maleness on viewer perceptions of the image's masculinity ($\rho = .72$) obtained in earlier research [2] and predicted in Figure 1. This could also be interpreted as a massive positive effect of image femaleness on viewer perceptions of the image's femininity. Images with more male-specific sex markers should be perceived as more masculine whereas images with more female-specific markers should be perceived as more feminine. By contrast, inanimate objects should be perceived as relatively gender-neutral.

The number of human features of an image should influence perceptions of anthropomorphism and expectations for behavior [11, 25, 31, 32]. This explains the enormous positive effect of image humanness on viewer ratings of the image's anthropomorphism obtained in earlier research [2] and predicted in Figure 1. Human features allow viewers to "connect" with the image at a basic biological level [7] and then identify with it.

The model in Figure 1 holds that markers of humanness elicit anthropomorphism [25, 33] and markers of maleness would be perceived as signaling masculinity. Yet not all receivers pay close attention to message content. Receivers approach or avoid existing knowledge structures, just as they can approach or avoid message content.

3.1.2. Comprehension: understanding the image Comprehension ranges from simple word recognition to complex pragmatic understanding [5], brought about through verbal or visual clarity. An avatar is a symbolic representation of the source who selected it. Avatars with more complex imagery will require more pragmatic inferences from viewers where the visual clarity of the image facilitates such inferences. Hall [34] refers to this clarity as "perceptual persuasion" creating "a compelling visual illusion" that contributes to perceived realism. Images vary along a continuum of heavily manipulated and morphed to those with more naturalness, which tend to be more intact and accurate. Figure 1 predicts that viewers perceive more veridical (intact) avatars as more realistic.

The most artificial avatars are cartoons or computer-generated composites that are least associated with nature or naturalness. These artificial avatars are also likely to be less associated with representing truthful, veridical or real images of things or people. Thus, photographs that have been morphed should be rated as having higher realism than cartoons but with less realism than photographs that have not been morphed. Signs of image modification include blurring, over-enhancement, and implausible juxtapositions of objects.

Thus, the more contrivances apparent in an image make it less natural, meaning viewers should perceive it to be less realistic and veridical. Thus, the features of an image interact with a viewer's memory structures to determine how realistic it appears [35, 36].

Just as attention increases comprehension, avatar features that enhance viewer involvement with the image such as human features [10, 15] should contribute to realism. From the SRCT perspective [4], anthropomorphism should have a positive effect on realism, as predicted in Figure 1.

3.1.3. Incidental confounds in naturalistic images. For each of the straightforward manipulation effects shown in Figure 1, there is another image effect that complicates the progression from exposure to perception. Image humanness had a moderate negative effect on ratings of image realism ($\rho = -.28$), image veridicality had a small negative effect on ratings of image masculinity ($\rho = -.12$), and image veridicality has a moderately small positive effect on ratings of anthropomorphism ($\rho = .22$). Adding to the complexity introduced by these confounds, the three perception variables were not completely independent. Image masculinity was found to decrease the chances of gender match ($\rho = -.17$).

The very process of manipulating avatars and stimuli for studying these processes introduce artifacts and confounds into the process. When sources modify the images they present to others (particularly when they use a computer), they may inadvertently alter more than the features they intend to change. These accidental changes in secondary features can produce effects on two or more perception measures. For example, Figure 1 predicts that the humanness manipulation will influence realism as well as anthropomorphism or that the veridicality manipulation will influence anthropomorphism and perceived masculinity as well as realism. These incidental confounds are inherent in any experimental design that seeks to generate naturalistic stimuli [5], which has implications for the uncanny valley hypothesis described below.

3.2 Message (Image) Appraisal

As receivers engage in message appraisal, they move from goal-directed thought to causal attribution, and then integrate new information into memory structures, as shown in Figure 1. During the message reception phases, receivers orient toward self (an internal topic focus) or others (an external source focus) and receivers differ in the extent to which they orient toward self or others [5, 6]. The motivation to focus on self should result in attention allocated to existing knowledge structures (e.g., stereotypes), leading to an acceptance or rejection of the message during goal-directed thought.

An external focus of attention leads receivers to allocate cognitive capacity to message content, leading to source-related processing. This should increase the correspondence between message features and accurate perceptions.

3.2.1. Information comparison: image similarity. As the receiver engages in goal-directed thought, self-orientation initiates the information comparison process, where receivers compare the old information they have in memory to the new information contained in the message [37]. A smaller discrepancy should improve ratings of message quality.

When undertaking the task of selecting an avatar, many choose an image that most closely resembles the self [25]. Viewers who are judging a potential avatar (as a new image of self) compare it to their self-concept (old image of self or a current identity) in an effort to maximize similarity. For those seeking similarity, the smaller the assessed discrepancy between new identity represented by an image and old identity representing the self, the greater the likelihood that an avatar will be chosen. This explains the massive effect of homophily on avatar choice predicted in Figure 1.

3.2.2. Image credibility. As receivers engage in goal-directed thought, they assess the extent to which the source is capable of providing useful information to accomplish their task. A competent source serves as a resource for the achievement of receiver goals, to the extent that the source holds similar beliefs and attitudes. Meta-analysis indicates that source competence produces a large positive effect on trustworthiness in nearly all contexts [1, 38].

When receivers consider an image as their avatar, they ask themselves "Does the image convey the level of competence that I want to establish with others?" and "Does the image convey the level of trustworthiness that I want to establish with others?" As shown in Figure 1, ratings of avatar competence have a massive positive effect on ratings of avatar trustworthiness. In turn, an avatar that projects the degree of trustworthiness the source desires is more likely to be selected for use in future interactions. This trustworthiness effect is similar to the effect of trustworthiness on postmessage attitudes toward topic in persuasion studies [39].

3.3. Effects of Message Reception on Message Appraisal

Attention and comprehension processes have been found to influence message appraisal related to both topic and source. For example, source dynamism and verbal clarity have been shown to influence ratings of message quality, competence, and trustworthiness [6, 38]. When viewers evaluate images as possible avatars, reception variables (e.g., gender, realism and anthropomorphism) should have an impact on image appraisal.

3.3.1. Effects of gender perceptions on information comparison. The effect of image sex typing and avatar gender on viewers' ratings of homophily should be moderated by viewer sex and partially mediated by gender match, as shown in Figure 1. For male viewers, image maleness and image masculinity should increase homophily. For female viewers, image femaleness and image femininity should increase homophily. That is, image sex and viewer sex should interact, such that a sex-match will increase

ratings of similarity. This gender-discrepancy effect parallels the influence that manipulated message discrepancy has on argument quality in verbal intensity studies [6].

The model in Figure 1 predicts that homophily increases competence, so gender match should have a small positive indirect effect on competence. That is, male viewers should rate more masculine images as presenting a more competent image; female viewers should rate more feminine images as presenting a more competent image.

3.3.2. Hypersexualized imagery. One reason perceived avatar gender may have such a small indirect effect on competence ratings is that the effect is not linear. Images of males that are rated as extremely high in masculinity may be perceived as “hypermasculine” just as images of females that are rated as extremely high in femininity may be perceived as “hyperfeminine.” There is a trend toward hypersexualized avatars in cyberspace [40, 41], although hypermasculine and hyperfeminine imagery has been criticized as aesthetically grotesque within popular culture. Hence, hypermasculine images might be rated by male viewers as less competent than moderately masculine images. Similarly, hyperfeminine images might be rated by female viewers as less competent than moderately feminine images.

The negative effect of hypersexual imagery on competence may indeed be due to aesthetics. Berlyne [42, 43] suggested that aesthetic preference would be a function of arousal in the form of a Wundt curve [44]. Berlyne’s response curve proposes that arousal potential has a nonlinear effect on hedonic value, in the shape of an inverted-U. Consistent with the Berlyne hypothesis and Wundt curve, hyper-gendered imagery may be evaluated as too perceptually intense, making the user appear less socially competent.

Reactions to hyper-gendered imagery may involve more than aesthetics, however. The hypermasculine image may be associated with excessive aggressiveness and the hyperfeminine image may be associated with excessive submissiveness. Because of its “hegemonic” connotations, hypermasculine imagery has been criticized in popular culture more often than hyperfeminine imagery. Generally, viewers are less fond of androgynous avatars than avatars that are sex-typed [12, 25] because ample gender cues disambiguate the sex of the avatar. This overall preference for sex-typed (male or female) avatars is due to an interaction between image sex and viewer sex on homophily.

3.3.3. Effects of anthropomorphism on appraisal. Anthropomorphism has been found to have a moderately large positive effect on viewers’ ratings of avatar competence [2, 12, 25]. This effect parallels the influence that perceived intensity has on competence in verbal intensity studies [5]. Figure 1 predicts that anthropomorphism will have a positive effect on homophily, as in previous research. This effect parallels the influence that perceived intensity has on argument quality in verbal intensity studies [5].

Avatars that appear highly realistic and anthropomorphic may fall within a perceptual region known as the “uncanny

valley” [45, 46], where the less than exact emulation of human characteristics makes the avatar seem eerie. Images that are only moderately anthropomorphic may therefore have greater appeal to viewers. However, the uncanny valley hypothesis predicts that viewers prefer avatars where appearance and behavioral attributes have equal levels of anthropomorphism and realism. Any level of inconsistency on these variables has a stronger influence on perceived communication quality than type of avatar [9, 47].

The effect is predicted to be particularly noticeable when highly realistic and anthropomorphic avatars are manipulated in obvious ways [2, 46]. The empirical evidence on uncanny valley is mixed, reflecting a possible restriction in the range of anthropomorphism present in the images used from study to study or simply the problem encountered when using computer generated stimuli as discussed above.

The present study, with its wide range of avatar imagery, provides a direct test of the uncanny valley hypothesis. If predictions of the Uncanny Valley Hypotheses are correct, then images that are close approximations of human characteristics with noticeable imperfections will be less attractive to viewers than images that are loose approximations of human characteristics [46].

Realism should have a positive effect on homophily, an effect obtained in previous research and predicted in Figure 1. This effect parallels, but is somewhat smaller than the effect of message clarity on argument quality observed in verbal intensity studies [6]. The model in Figure 1 proposes that realism enhances avatar credibility.

3.3.4. Effects of orienting on information comparison

Three of the effects of exposure variables on goal-directed thought variables appeared to be mediated by implicit orienting variables. First, gender match of the image had a moderate positive effect on homophily ($\rho = .26$). Suppose that viewers’ emotional involvement with representation of self in online environments had been measured. We suspect that this variable would have mediated this gender match-on-homophily effect such that image sex match would increase emotional involvement with online representation and emotional involvement would have increased homophily ratings. Second, image veridicality had a moderate positive effect on image homophily ($\rho = .14$). Third, image veridicality had a moderate positive effect on avatar competence ($\rho = .19$). Had avatar dynamism been measured, we suspect that it would have mediated these two effects. That is, image veridicality would increase dynamism, with dynamism increasing homophily and competence ratings.

4. Method

Each of the 261 viewers was randomly assigned a set of 10 images to judge, out of a total pool of 92 images, which were nested within rather than crossed by condition. The pool of images was the same one used in Nowak, et al. [2]. The various types of images are illustrated in that study. The images were presented on the top of an online questionnaire.

The viewers were students at a large university in the United States who received a nominal amount of extra credit. Of the 2610 possible judgments, occasional missing data reduced the number of judgments so that each image was rated by 25 to 29 viewers. For each of the seven measures used, the average number of viewers was almost exactly 28.

Viewers evaluated the images on three message reception measures and four message appraisal measures. All items were 7-interval bipolar scales. The specific items used were from [2]. Item quality was assessed with confirmatory factor analysis.

Avatar evaluation measures. The *perceived masculinity* of the avatar was measured with two adjective items (*not masculine* to *very masculine* and *not feminine* to *very feminine*). *Perceived anthropomorphism* was measured with three Likert items (*Does this image look human?*, *Does this image have human features?*, and *Does this image have human-like expressions?*). *Realism* was measured with four adjective (*Real* to *Not Real*, *Cartoon-like* to *photorealistic*, *Natural* to *Artificial* and *Do you think this image could possibly exist outside the computer screen: Possible* to *Impossible*).

Homophily was measured with four items, where responses could range from *Not at All* to *Very Much*. The four items were *this image is similar to me*, *this image is different from me*, *How much do you identify with this image*, and *Does this image represent something in you*. *Competence* was measured with two adjective items (*intelligent* to *unintelligent* and *incompetent* to *competent*). *Trustworthiness* was measured with two adjective items (*reliable* to *unreliable* and *trustworthy* to *untrustworthy*). *Likelihood of selecting the image* as an avatar was measured with an item that ranged from *not at all likely* to *very likely*. Participants indicated how likely they would be to choose the image to represent them in an online interaction.

The reliabilities of the three reception scales ranged from acceptable to high (perceived gender $\alpha = .76$, perceived anthropomorphism $\alpha = .89$) and realism $\alpha = .90$) as did the reliabilities of the three appraisal scales (homophily $\alpha = .95$, competence $\alpha = .87$, trustworthiness $\alpha = .89$).

Manipulated avatar features. The experimental design included three manipulated variables. The features of the potential avatar that were manipulated included: (1) the biological sex of the image (ranging from extremely male, to neuter, to extremely female); (2) the extent to which the image was veridical (free of researcher modification such as morphing); and (3) the extent to which the image had human features. Images included untouched and morphed pictures of male and female humans and non-humans, landscapes and scenery, as well as random shapes.

In addition to the internal consistency of the items that were indicators for each of the scales, the degree of agreement between viewers judging images was estimated for each of the seven measures. In order to calculate the reliability of a single judgment for each measure, a Case 1 intraclass correlation coefficient (ICC) was computed (Shrout

& Fleiss, 1979). The ICC values for each of the seven measures were compared. The mean ICC value for the reception measures (.64) was substantially larger than those for the appraisal measures (.19). This difference was massive: $t(5) = 13.20, p < .001$.

The reliability aggregated across 28 viewers was computed using the Spearman-Brown prediction formula. The reliabilities for each of the seven measures were compared next. The mean reliability value for the reception measures (.98) was noticeably larger than those for the appraisal measures (.86). This difference was massive: $t(5) = 7.25, p < .001$. The Spearman-Brown formula was also used to estimate the number of viewers necessary to obtain a reliability of .80. The average n^* value for the reception measures (2.3) was much lower than the average n^* value for the appraisal measures (18.08).

5. Results

The image-level analyses employed sought to detect the mediating, moderating, and quadratic effects proposed as refinements to the omnistructure model shown in Figure 1. Image scores were averaged across the set of viewers that judged them on the seven dependent measures. As a first step, seven univariate analyses were conducted to examine the effects of the three image features and viewer sex on the three reception and four appraisal measures. For each of the seven measures, viewer sex was included as a within-subjects factor in a repeated measures analysis of variance (ANOVA) where image maleness, humanness, and veridicality were between-subjects factors.

The image manipulations were all successful, although each of the three intended perception variables showed influence from one of the other manipulations; this indicates the presence of the anticipated incidental confounds. The F -values from the ANOVAs indicated that viewer sex was a key predictor of image gender, homophily, and avatar choice. In addition to its main effects on these three dependent variables, viewer sex also interacted with veridicality and image maleness on homophily and choice. Veridicality and image maleness had ubiquitous main effects on the dependent measures. By contrast, the impact of humanness appeared limited to a main effect on anthropomorphism.

As a second step, separate multiple regressions were conducted to estimate the size of the veridicality and image maleness effects separately for female viewers and male viewers. Veridicality and image maleness were effect coded and entered in a reduced model without manipulated humanness for the dependent variables homophily and choice. Given that veridicality and image maleness generated such different effects for male and female viewers, separate causal models were constructed. Figure 1 was the template for the two causal models

5.1. Main and Moderating Effects of Viewer Sex

Male viewers tended to rate images as more masculine ($M = 3.90$, $SD = 1.38$) than female viewers ($M = 3.18$, $SD = 1.45$). This assimilation bias could also be restated as female viewers tending to rate images as more feminine than male viewers. Male viewers also tended to rate images as more homophilous ($M = 2.52$, $SD = .78$) than female viewers ($M = 2.33$, $SD = 1.02$). Finally, male viewers were more likely to choose the image as an avatar ($M = 2.62$, $SD = .79$) than female viewers ($M = 2.47$, $SD = 1.02$).

Consider the size of the F -values for the main effects of viewer sex on image gender (52.60), homophily (9.85), and avatar choice (7.72) shown in Figure 2. The size of the effects is diminished proportional to the size of links between the variables in the 2-step chain. Image gender in linked with homophily and homophily with avatar choice (see Figure 1). That is $9.85/52.60 = .19$ and $7.72/9.85 = .78$. In fact, the predicted effect of image gender on homophily in Figure 1 was .19 and the predicted effect of homophily on choice in Figure 1 was .72. Thus, the main effects viewer sex on image gender, homophily, and choice are consistent with the 2-step model proposed in Figure 1.

Regression analysis with female viewers indicated that image maleness decreased homophily ($\beta = -.65$, $p < .001$) and avatar choice ($\beta = -.62$, $p < .001$). By contrast, veridicality increased homophily ($\beta = .33$, $p < .001$) and avatar choice ($\beta = .44$, $p < .001$). Regression analysis with male viewers indicated that image maleness increased homophily ($\beta = .59$, $p < .001$) and avatar choice ($\beta = .55$, $p < .001$). By contrast, veridicality increased homophily ($\beta = .18$, $p < .001$) and avatar choice ($\beta = .27$, $p < .001$).

5.2. Causal Models

Humanness was co-linear with anthropomorphism ($r = .88$) and had little effect on any of the other criterion variables so it was not included in the causal models. The two manipulated variables, three perception variables, and four appraisal variables were correlated separately for male and female viewers. The structure of the models for the female viewers closely resembled that for the male viewers. Regardless of viewer sex, the impact of the three manipulations on the appraisal variables was at least partially mediated by perception variables, as predicted in Figure 1. Nonetheless, given that viewer sex substantially moderated the effect of image maleness and veridicality on homophily

and avatar choice, separate causal models were constructed for male and female viewers.

5.2.1 Male viewers. The model for male viewers had exceptional fit and was largely consistent with the proposed model in Figure 1. The Root Mean Squared Error ($RMSE$) for the model shown in Figure 2 was .03 with $\chi^2(15, 92) = .68$, $p = 1.0$. Avatar maleness had a massive positive effect on perceptions of masculinity ($\rho = .91$) and veridicality had a large positive effect on realism ($\rho = .46$). Veridicality influenced perceived masculinity and realism, as well as the two goal-directed thought variables homophily and competence. Specifically, veridicality reduced perceived masculinity ($\rho = -.12$) but increased homophily ($\rho = .18$) and competence ($\rho = .38$). Stated in reverse, it appears that morphed images were perceived as more masculine and assessed as lower in quality. Paralleling the effect of attention on comprehension, anthropomorphism increased realism ($\rho = .54$).

There were two paths from homophily to avatar choice. Homophily had a massive direct effect on avatar choice ($\rho = .91$). Homophily also had a barely detectable indirect effect (.03) on avatar choice through a 3-step causal chain. In this 3-step chain, homophily increased competence ($\rho = .25$), with competence increasing trustworthiness ($\rho = .76$). In turn, trustworthiness increased avatar choice ($\rho = .16$). Homophily increased with avatar masculinity ($\rho = .25$), anthropomorphism ($\rho = .28$), and realism ($\rho = .29$). Anthropomorphism increased competence ($\rho = .55$), and realism increased trustworthiness ($\rho = .14$). As hypothesized, the manipulated variables had “direct” effects on homophily that appear to be mediated by orienting variables. Image maleness had a “direct” effect on homophily ($\rho = .41$) that was suggestive of the emotional involvement effect proposed in Figure 1. Image veridicality had “direct” effects on homophily ($\rho = .16$) and competence ($\rho = .38$) that was suggestive of the dynamism effect proposed in Figure 1. Consistent with the hypersexuality hypothesis, avatar masculinity had a quadratic effect on competence, in the shape of an inverted-U. Within the causal model, this quadratic effect was indicated by positive and negative antagonistic forces on competence. On the one hand, perceived masculinity had a small positive effect on competence (mediated by homophily); but this indirect positive effect was more than offset by the negative effect of masculinity on competence ($\rho = -.25$).

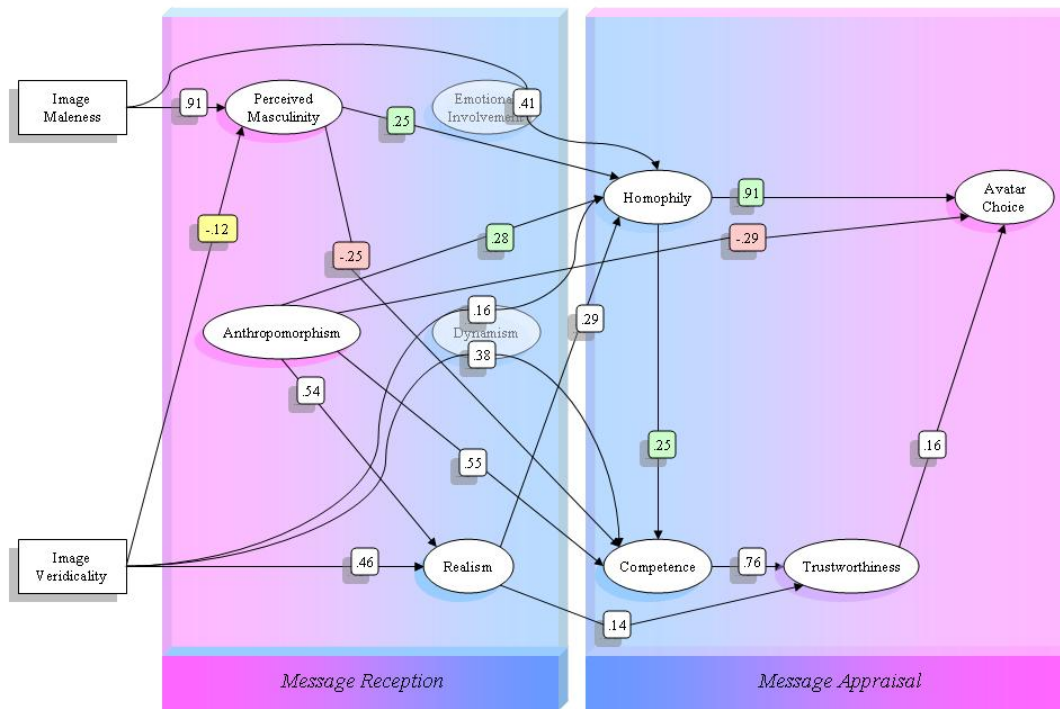


Figure 2 Test of model with Male viewers

Consistent with uncanny valley hypothesis, anthropomorphism had a quadratic effect on avatar choice, in the shape of an inverted-U. Within the causal model, this quadratic effect was indicated by positive and negative antagonistic forces on avatar selection. The positive effects were all indirect and cumulatively moderately large: $.26 + .01 + .07 + .01 = .35$. Anthropomorphism had a direct negative effect on avatar choice ($\rho = -.29$).

5.2.2 Female Viewers. The model for female viewers was also largely consistent with the proposed model in Figure 1, although fit was merely adequate. The *RMSE* for the model in Figure 3 was .09 with $\chi^2(15, 92) = 6.29, p = .97$. Avatar femaleness had a massive positive effect on perceptions of femininity ($\rho = .86$) and veridicality had a large positive effect on realism ($\rho = .40$). Veridicality influenced perceived femininity and realism, as well as the two goal-directed thought variables homophily and competence. Specifically, veridicality increased perceived femininity ($\rho = .23$) but increased homophily ($\rho = .18$) and competence ($\rho = .31$). Stated in reverse, it appears that morphed images were perceived as more masculine and assessed as lower in quality. Paralleling the effect of attention on comprehension, anthropomorphism increased realism ($\rho = .55$). There were two paths from homophily to avatar choice. Homophily had a massive direct effect on avatar choice ($\rho = .94$) and a slight indirect effect (.05) on avatar. In this 3-step chain, homophily increased competence ($\rho = .46$), with

competence increasing trustworthiness ($\rho = .75$) and trustworthiness increased the avatar choice ($\rho = .15$).

Homophily increased with avatar femininity ($\rho = .52$), anthropomorphism ($\rho = .28$), and realism ($\rho = .25$). Anthropomorphism increased competence ($\rho = .60$), and realism increased trustworthiness ($\rho = .22$).

As hypothesized in Figure 1, the manipulated variables had “direct” effects on homophily that appear to be mediated by orienting variables. Image femaleness had a “direct” effect on homophily ($\rho = .18$) that was suggestive of the proposed emotional involvement effect. Image veridicality had “direct” effects on homophily ($\rho = .18$) and competence ($\rho = .31$) that was suggestive of the dynamism effect.

Consistent with the hyperfemininity hypothesis, avatar femininity had a quadratic effect on competence, in the shape of an inverted-U. Within the causal model, this quadratic effect was indicated by positive and negative antagonistic forces on competence. On the one hand, perceived femininity had a small positive effect on competence (mediated by homophily); but this indirect positive effect was offset by the negative effect of masculinity on competence ($\rho = -.22$).

Consistent with uncanny valley hypothesis, anthropomorphism had a quadratic effect on avatar choice, in the shape of an inverted-U. Within the causal model, this quadratic effect was indicated by positive and negative antagonistic forces on avatar selection. The positive effects were all indirect and cumulatively large: $.26 + .13 + .07 + .02$

= .48. Anthropomorphism had a direct negative effect on avatar choice ($\rho = -.18$).

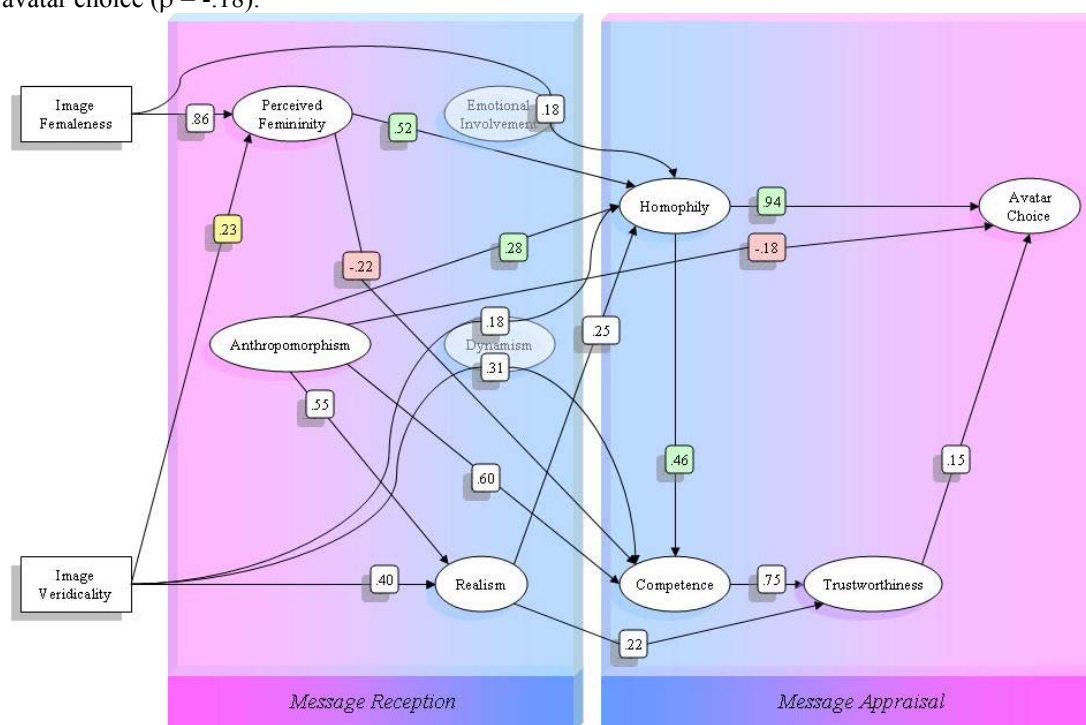


Figure 3 Test of proposed model with Female viewers

Discussion

The objective of the present study was to extend the current model of avatar decision-making based on information processing theory and to test the uncanny valley hypotheses as it relates to perceptions of realism and anthropomorphism. During image reception, perceived gender seemed to have little effect on anthropomorphism, but anthropomorphism did have a very large positive effect on realism.

The three reception-appraisal links proposed in Figure 1 were present in both the female and male viewer data. The results for male viewers generally resembled those for female viewers, with two intriguing exceptions. Both of these exceptions are related to schematized processing. These perception-driven associations imply the existence of schema for the interpretation of avatars. First, matching image sex with viewer sex promoted homophily. The finding that female viewers are more likely to invoke gender schemas than male viewers suggests that gender matching for women should be more predictive of homophily than gender matching for men.

Second, imagery that evoked anthropomorphic perceptions appeared to contribute to competence. This conclusion was based on the assumption that receivers would “connect” with anthropomorphic images in the same way

they connect with dynamic sources. These results are consistent with the uncanny valley hypothesis in that once the degree of veridicality of an image was controlled, markers of humanness led to anthropomorphism with near-perfect accuracy. This was the case regardless of whether the viewer was male or female.

Anthropomorphism had both positive and negative effects on avatar choice, regardless of viewer sex. In both Figures 3 and 4, the positive effect of anthropomorphism on avatar choice was mediated by realism, homophily, competence, and trustworthiness. Anthropomorphism increased homophily, with homophily increasing avatar choice. Anthropomorphism also enhanced trust, with trust increasing avatar choice.

Third, more realistic images were more likely to be trusted. That is, contrived images seemed to trigger distrust. Viewers appear to infer that a doctored image is a “fake.” This might lead to further inferences that the user is someone who might engage in deception.

The robust positive effect of anthropomorphism on realism reflected the underlying process of viewers’ attention to humanness features improving their attention to, and comprehension of, visual content. The findings indicate that markers of humanness are the most salient features of an image for viewers, and the least sensitive to individual differences.

The variable with the most influence on likelihood to choose an avatar was homophily, which was predicted by image sex and naturalness, as well as all three perception variables. Image maleness had a direct positive effect on homophily for male viewers; image femaleness had a direct positive effect on homophily for female viewers.

As viewers, women were more likely to invoke gender schema than men. In contrast to the greater relevance of gender schema for female viewers, male viewers were more likely to invoke realism schema. Thus, in assessing homophily women were more likely to invoke gender schema whereas men were more likely to invoke realism schema.

Hypersexualized imagery effects were evident for both male and female viewers. Essentially, image gender had a direct negative effect on competence. The female viewer model shown in Figure 2 shows that image femininity influences competence in two ways. First, femininity increases homophily, with homophily increasing competence. For women, a more feminine image allows greater identification, which leads viewers to see similarity between self and other. This similarity would then drive up competence ratings. The indirect positive effect of femininity on competence mediated by homophily (.23) is almost exactly offset by the negative effect (-.22). These negative effects are "antagonistic" in that they work to diminish the impact of the positive effects. This pattern of antagonistic effects is consistent with a quadratic function, in the shape of an inverted-U.

The gender variable for the male viewer model shown in Figure 3 exhibited the same pattern the female viewer model -- but in reverse. Among male viewers, perceived masculinity had the expected positive effect on competence by increasing homophily; yet perceived masculinity also had a direct negative effect on competence.

This reflects the fact that femininity and masculinity are at polar ends of a gender continuum. Image masculinity influenced competence in two ways. First, masculinity increased homophily, with homophily increasing competence. For men, a more masculine image allowed greater identification, which led viewers to see similarity between self and other. This positive assessment of similarity would then drive up competence ratings. But this 2-step process for male viewers was noticeably weaker than it was for female viewers.

These results indicate that gender schemas were not as salient for men as they are for women. That explains the more modest effect of masculinity on homophily for male viewers. In addition, the effect of homophily on competence for men is about half of that observed for women. It may be that homophily, as a mediator of the effect of gender on competence, is an indicator of gender identity, which female viewers tended to emphasize more than male viewers.

Image veridicality has direct positive effects on homophily and competence regardless of viewer sex. Similarly, the direct negative effect of masculinity on

competence for male viewers is as large as it is for female viewers. The similarity of the size of this effect, regardless of viewer sex, suggests that it is not driven by gender schema. People tend to identify with and be inspired by extreme positions (e.g., heroes who are passionate about their cause). Yet they may see such extreme positions as maladaptive and not likely to prevail. Gender polarized images (masculine or feminine) are easier to disambiguate and therefore easier to identify with as gender-consistent (or to reject as gender-inconsistent), yet they may also come across as more extreme, with extremity decreasing competence (less adaptive). Viewers may be attracted to media personae like the hyper-masculine Sylvester Stallone or Arnold Schwarzenegger or the hyper-feminine Kate Moss or Mary-Kate Olsen appealing, but see the pragmatic limitations of such characters. Future research should test this hypothesis.

The fact that anthropomorphism had a negative effect on avatar choice implies that while most people seek to maximize the similarity between themselves and their avatars (homophily), some have other goals. Animal lovers may seek to be represented by an avatar that resembles their pet, their favorite wild animal, or a mythical creature. Others may seek a nature scene, a familiar object, or geometric shapes. To those who are misanthropic, any image other than a human one may seem attractive. Future research should identify individual variables and situations that predict the factors influencing this result.

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