How Socially Relevant Visual Characteristics of Avatars Influence Impression Formation

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Abstract. Like in the real world, the first impression a person leaves in a computer-mediated environment depends on his or her online appearance. The present study manipulates an avatar’s pupil size, eyeblink frequency, and the viewing angle to investigate whether nonverbal visual characteristics are responsible for the impression made. We assessed how participants ($N = 56$) evaluate these avatars in terms of different attributes. The findings show that avatars with large pupils and slow eye blink frequency are perceived as more sociable and more attractive. Compared to avatars seen in full frontal view or from above, avatars seen from below were rated as most sociable, self-confident, and attractive. Moreover, avatars’ pupil size and eyeblink frequency escape the viewer’s conscious perception but still influence how people evaluate them. The findings have wide-ranging applied implications for avatar design.

Keywords: avatar, perception, pupil size, eyeblink frequency, viewing angle

Introduction

The use of virtual worlds has become increasingly popular (e.g., Bainbridge, 2007), and a growing part of human interactions in cyberspace include avatars (Miller, 2007). Avatars are used to represent people during a variety of online interactions and can be defined as computer-generated, graphical visual representations of the users (Gerhard, Moore, & Hobbs, 2004; Nowak & Rauh, 2008). Avatars vary from mere pictures to animated user-controlled characters (Bailenson & Blascovich, 2004; Schroeder, 2002). Vasalou and Joinson (2009) describe avatars as a creative platform for identity construction since they provide expressive freedom over an otherwise rather anonymous online presence. Avatars can be differentiated from virtual agents: In contrast to avatars, agents are controlled by the computer and do not represent real persons.

Nowadays, many applications – from online games to instant messaging – allow users to represent themselves by means of an avatar. On the one hand, individuals tend to select or create avatars that share similarities with themselves (Axellson, 2002); on the other hand, however, many applications offer a variety of dimensions to shape the visual appearance of the avatar as desired. In Second Life, for example, there are plenty of options to alter body size, eye color, haircut, etc. Furthermore, the representations do not necessarily have to be anthropomorphic – indeed, the malleability of virtual bodies adds a new dimension to social interactions in virtual worlds (Miller, 2007), and the freedom to create one’s own graphical representation may add to the growing popularity of virtual realities and online interactions. As much as virtual worlds may offer great possibilities to escape from the “real world,” it is interesting to see that people still behave as if they were in real life (Yee, Bailenson, Urbanek, Chang, & Merget, 2007). For example, Donath (2007) suggests that users – just as in real life – infer a number of character traits from the visual appearance of avatars. Therefore, the first online impression a person creates should depend on the appearance of his or her avatar. This question has applied implications. Companies such as IBM hold virtual conferences whereby participants are represented with avatars (Bainbridge, 2007).

Recently, Nowak and Rauh (2008) investigated the avatar’s visible characteristics and found that people who are represented by avatars high on anthropomorphism and low on androgyny are rated as attractive and credible. These findings indicate that avatars should be chosen carefully. However, the ecological relevance of their study may be rather low since it is not very probable that someone would attend an e-conference or an online dating platform as a hammer, a bottle or a representation that is not clearly gendered. The purpose of our study is therefore to identify more subtle ways of how we form first impressions of our avatars. We investigate whether nonverbal cues can influence the perception of avatars as well. To our knowledge, this has not yet been done.
Unlike Nowak and Rauh (2008), we used more naturalistic avatars. In order to address this question, we extensively reviewed the literature on social perception and impression formation in order to apply the results of previous research in the context of perception of human faces on avatars.

When looking at human faces, people immediately draw conclusions about their personality. Thus, within a blink of an eye, we decide whether someone is attractive, likeable, intelligent, authoritarian, competent, or interesting (Ambady & Skowronski, 2008).

Various cues influence first impressions (King & Pate, 2002). Examples are physical attractiveness (Cash, Gillen, & Burns, 1977), clothes (Temple & Loewen, 1993), race (Hart & Morry, 1997), sex (Weibel, Wissmath, & Groner, 2008), similarity (Lydon, Jamieson, & Zanna, 1988), symmetry in faces (Little, Jones, Burt, & Perrett, 2007), skin textures (Jones, Little, Penton-Voak, Tiddeman, Burt & Perrett, 2001), or expressive nonverbal behavior (Riggio & Friedman, 1986). For our study, we chose to focus on three determining parameters: viewing angle, pupil size, and eyeblink frequency. We chose these three factors because they (1) represent nonverbal cues, (2) influence the perception of individuals, and (3) can be applied easily in the design of avatars—not only within this experiment, but also by users in “real life.” Furthermore, pupil size was included because this variable influences impression formation unconsciously (e.g., Laeng & Falkenberg, 2007). The eyeblink frequency was chosen because we wanted to include a variable that can be applied when a setting allows creation of animated avatars. A plethora of studies show that the viewing angle from which we look at someone influences how we perceive this person (e.g., Frey, 1999; Hall, LeBeau, & Coats, 2005; Kepplinger & Donsbach, 1986, 1990; Lobmaier, Tiddeman, & Perrett, 2008; Sontag, 1992). Kepplinger and Donsbach point out that the camera angle of a filmed sequence can determine our own position relative to the opinion expressed by a politician. Moreover, it makes a difference whether we see the communication from above or from below. The latter is associated with decisiveness, self-consciousness, dominance, superiority, and power, whereas the former is rather perceived as inferior and in need of protection (Frey, 1999; Kepplinger & Donsbach, 1986). Furthermore, the full frontal view is associated with trustworthiness, openness, and sympathy (Frey, 1999; Lobmaier, Tiddeman, & Perrett, 2008). We therefore expect that avatars shown from below are perceived as more powerful compared to avatars seen from above or presented in full frontal view. In contrast, we predict avatars presented from a frontal viewpoint to be perceived as most sympathetic.

The influence of the pupil size on how we perceive humans has been investigated by several studies. Thus, previous findings showed that individuals with larger pupils are judged as being more attractive, happier, good-humored, and sympathetic (Hess, 1965; Laeng & Falkenberg, 2007; Tombs & Silverman, 2004; Zakia, 2002). Interestingly, these findings show that pupil size is usually not perceived consciously, but that it still influences judgments about people. Therefore, we except that avatars with large pupils are perceived as more attractive and more sympathetic than avatars with small pupils. Pupil size is controlled by two mechanisms: externally by the ambient light intensity and internally by the sympathetic nervous system. The former process is not informative within social interactions, whereas the latter signals a state of arousal, which is interpreted with regard to the actual situational context (Hess, 1965; Steinhauer, Siegle, Condry, & Pless, 2004). In this study, the context in which the avatar is presented is neutral and certainly not threatening. Thus, it is likely that a larger pupil size will lead to more positive evaluations.

Finally, a high frequency of the eyeblinks is associated with dishonesty, shyness, fearfulness, and anxiety (Frey, 1999; Köhnken, 1994; Wiener, Devoe, Rubinow, & Geller, 1972). Correspondingly, we predict that avatars with an average frequency of eyeblinks will be perceived as more sociable, relaxed, and self-confident than avatars with a high eyeblink frequency.

The above-mentioned findings lead us to the following hypotheses:

**Hypothesis 1:** Avatars with large pupils are perceived as more attractive and more sympathetic than avatars with small pupils.

**Hypothesis 2:** Avatars with a lower frequency of eyeblinks are perceived as more sociable and self-confident compared to avatars with a higher eyeblink frequency.

**Hypothesis 3:** Avatars shown from below are perceived as more powerful compared to avatars seen from above or presented frontally. Avatars presented from a frontal viewpoint are perceived as most sympathetic.

**Method**

**Participants**

A total of 56 participants took part in this experiment, all of whom were students enrolled in psychology (31 females and 25 males). The average age was 22.8 years ($SD = 3.55$). All participants were treated according to the Declaration of Helsinki (World Medical Association, 1991) and received course credit for participating.

**Design**

We applied a 4-factor design. The independent variables of the experiment were Viewing angle (frontal view vs. view from below vs. view from above), Pupil size (big vs. small),...
and Eyeblink frequency (60 eyeblinks per min. vs. 24 eye-
blinks per min). 24 eyeblinks per min. refer to an average
eyeblink frequency of a person, while 60 eyeblinks refer to
a increased eyeblink frequency (Landau, 1993). Furthermore,
the sex of the avatar was varied. The avatar’s sex was
manipulated between participants, the other three factors
were manipulated within participants. Thus, the partici-
pants were exposed to 12 different versions of the avatar
(all combinations of the three within-factors), whereby the
avatar was either female or male.

Stimulus Material and Procedure

For creating a male and a female avatar, we first morphed
with the aid of the program Morpher two male and two
female portraits, each showing a neutral expression. The
morphing increased the averageness of the faces. The mor-
phed faces were then transformed into avatars using the
program 3DmeNow. Afterwards, the avatars were manip-
ulated according to the above-mentioned dimensions (size
of the pupils, eyeblink frequency, and viewing angle). In
line with previous studies on viewing angle (e.g., Lobmaier
et al., 2008), the head was presented slightly sidewise in
the conditions view from below and view from above (in
contrast to the frontal view). Figure 1 shows the resulting
female avatar.

Figure 1. The resulting female avatar (a) from different
viewing angles (left: frontal view; middle: view from
above; right: view from below) and (b) the pupil size of the
avatars (left: small; right: large).

The avatars were slightly moving and animated in terms of
eyeblink frequency. The participants were told that they
will view several avatars with similar but not identical ap-
pearance. They were told that these avatars represent dif-
ferent individuals with whom they would interact in an on-
line environment afterward. Participants were asked to
evaluate each person based on her avatar as spontaneously
as possible and to base their judgment on their first impres-
sion. Each of the twelve avatars was presented for 10 s and
appeared in random order on a computer screen. After each
presentation, the participants had to provide their evalu-
ations. Upon completion of all ratings, the participants were
asked an open question on whether they had recognized the
ways in which the avatars differed.

Measuring Instruments

The participants rated the avatars on several dimensions
Frey (1999) identified as being most likely to capture
judgments based on first impressions. Frey’s bipolar scale
consists of 15 dimensions (competent – incompetent,
sympathetic – unsympathetic, interesting – boring, intel-
ligent – unintelligent, powerful – weak, honest – dishon-
est, modest – arrogant, relaxed – fearful, extraverted – shy,
fair – unfair, sensitive – insensitive, attractive – unattrac-
tive, energetic – lethargic, comforting – threatening, good-
umpered – annoyed). The subjects rated these 15 items on
a seven-point scale with the poles 1 (incompetent, unsymp-
thetic, boring, etc.) and 7 (competent, sympathetic, in-
teresting, etc.).

Results

First, we computed a factor analysis to examine the dimen-
sionality of the rating dimensions. To our knowledge, no
research has yet tested whether the dimensions proposed
by Frey are independent. Factor analysis suggests a 2-fac-
tor solution, and according to Kaiser and Rice (1974) the
MSA criterion is “marvelous” (MSA = .91). The scree test
clearly shows that the 2-factor solution, which explains
64.3% of the variance, is most appropriate. The varimax
rotation extracts a first factor, which explains 32.7% of the
variance and consists of 8 items (sympathetic – unsympa-
thetic, modest – arrogant, relaxed – fearful, honest – dis-
honest, fair – unfair, sensitive – insensitive, good-humored –
annoyed, attractive – unattractive). The items have in
common their reference to empathizing and the ability to
interact. We thus use the term sociability. The second fac-
tor, which explains 31.6% of the variance, consists of 8
items as well (extraverted – shy, competent – incompetent,
energetic – lethargic, powerful – weak, intelligent – unin-
telligent, interesting – boring, comforting – threatening, at-
tractive – unattractive). We named the second factor self-
confidence because the items refer to attributes like
strength, competence, extraversion, or intelligence. The re-
results show that one item (attractive – unattractive) loads
high on both factors. This item was therefore analyzed sep-
arately. For testing the influence of the independent vari-
ables on these three dependent variables (sociability, self-
confidence, attractiveness), we computed repeated mea-
sures ANOVAs. Posthoc comparisons with Bonferroni
adjustments were carried out to analyze the factor viewing
angle.

Regarding sociability, the results reveal three main ef-
ffects. The data show a highly significant main effect for viewing angle, \( F(2, 53) = 51.17, p < .001, \eta^2 = .50 \). Avatars presented from below were evaluated most sociable (\( M = 4.67, SD = 0.082 \)), followed by the frontal view (\( M = 4.00, SD = 0.058 \)). Avatars presented from above were rated least sociable (\( M = 3.68, SD = 0.071 \)). Pairwise posthoc comparisons indicate that the differences are significant between all three conditions (\( p < .01 \)). The factor pupil size turned out to be significant as well, \( F(1, 54) = 3.42, p < .05 \) (one-tailed), \( \eta^2 = .09 \). Higher sociability ratings resulted for avatars with big pupil size (\( M = 4.20, SD = 0.041 \)) compared to avatars with small pupil size (\( M = 4.07, SD = 0.054 \)). Furthermore, slower eyeblink frequencies lead to higher sociability ratings (\( M = 4.18, SD = 0.047 \)) than higher eyeblink frequencies (\( M = 4.05, SD = 0.051 \)), \( F(1, 54) = 4.87, p < .05, \eta^2 = .05 \).

In terms of self-confidence, no main effects resulted for the factors pupil size, \( F(1, 54) = 1.72, p = .11 \), and eyeblink frequency, \( F(1, 54) = 0.06, p = .81 \). In contrast, the viewing angle influenced perceived self-confidence, \( F(2, 53) = 14.21, p < .001, \eta^2 = .36 \). The view from below led to higher self-confidence ratings (\( M = 4.53, SD = 0.083 \)) than the frontal view (\( M = 4.08, SD = 0.072 \)) and the view from above (\( M = 4.07, SD = 0.074 \)). Posthoc comparisons showed that avatars viewed from below were rated significantly more self-confident than those presented in the conditions frontal view and view from above (\( p < .01 \)). The difference between the frontal view and the view from above was not significant. Moreover, the viewing angle interacted with the avatar’s sex, \( F(2, 53) = 11.10, p < .001, \eta^2 = .27 \), showing that in terms of self-confidence, viewing angle has a stronger influence on the female avatar when compared to the male avatar. Accordingly, the posthoc tests show that for female avatars all conditions differ (\( p < .01 \) for comparison between view from below and view from above, \( p < .05 \) for the remaining two comparisons), while no significant differences are observed for male avatars. The interaction is shown in Figure 2.

Three main effects were found for attractiveness. Viewing angle strongly influenced perceived attractiveness, \( F(2, 53) = 35.67, p < .001, \eta^2 = .41 \). Avatars presented from below were perceived as most attractive (\( M = 4.80, SD = 0.096 \)) followed by avatars presented from a frontal view (\( M = 3.98, SD = 0.103 \)) and avatars viewed from above (\( M = 3.84, SD = 0.089 \)). Pairwise comparison showed that view from below led to significantly higher attractiveness ratings than the frontal view and view from above (\( p < .01 \)). Frontal view and the view from above did not differ. Furthermore, avatars with large pupils (\( M = 4.30, SD = 0.073 \)) were judged as more attractive than those with small pupils (\( M = 4.11, SD = 0.069 \)), \( F(1, 54) = 9.59, p < .01, \eta^2 = .16 \). Eye blink frequency also turned out to be significant, \( F(1, 54) = 3.88, p < .05 \) (one-tailed), \( \eta^2 = .07 \). A low eyeblink frequency reveals higher attractiveness ratings (\( M = 4.27, SD = 0.065 \)) than a high eyeblink frequency (\( M = 4.14, SD = 0.075 \)). The sex of the avatar interacts with the viewing angle, \( F(2, 53) = 4.76, p < .01, \eta^2 = .08 \). Thus, the view from above especially decreases the attractiveness of female avatars, \( t(54) = 3.92, p < .001 \) (see Figure 3).

The analyses of the verbal reports showed that the majority of the participants (90%) recognized that the viewing angle was not the same for all avatars, but only 34% of the participants noticed changes in the eyeblink frequency. None of the participants was aware of the changes in pupil size.
Discussion

Existing literature shows the importance of viewing angle, pupil size, and eyeblink frequency on how we perceive other humans (see Ambady & Skowronski, 2008; Frey, 1999). In this study, we created avatars and manipulated these three factors systematically and investigated their influence on sociability, self-confidence, and attractiveness ratings. The avatar’s sex was included as yet another variable.

In line with hypothesis 1, the findings show that slower eyeblink frequency led to higher sociability and attractiveness ratings. This effect is widely unconscious since only one-third of the participants detected eyeblink changes. The second hypothesis was confirmed as well: Pupil size also influenced whether an avatar was judged to be sociable and attractive. In line with previous studies (e.g., Laeng & Falkenberg, 2007), avatars with larger pupils were rated as more sociable and attractive than avatars with smaller pupils. Varying pupil size remained unnoticed by all participants and thus indicates an unconscious mechanism. Unconscious perception of pupil size not only influences the evaluation of others, but recent research shows that it also affects behavior in real life. Tombs and Silverman (2004) showed that females with a preference for large pupils happen to date more dominant men (“bad boys”) with whom they possibly expect to dive into a more exciting lifestyle. While this finding is of correlative nature, it is interesting that neuroimaging studies have revealed a close link between pupil size and activity in the observer’s amygdala, which is involved in emotional responses and reward processing (Demos, Kelley, Ryan, Davis, & Whalen, 2008; Murray & Izquierdo, 2007).

Hypothesis 3 was partially confirmed: We found a strong influence of the viewing angle. When seen from below avatars are judged as more sociable, more self-confident, and more attractive than avatars presented in frontal view. The view from above led to the lowest ratings throughout all dimensions. For attraction and self-confidence, these findings are consistent with studies showing that camera perspective influences the evaluation of causal attributions (e.g., Ambady & Skowronski, 2008; Frey, 1999). According to previous research, we expected that the frontal view would be perceived as most sociable. However, against our predictions, the view from below led to higher sociability judgments compared to the frontal view. This might be caused – at least in part – by the fact that sociability and self-confidence are positively related to attractiveness, which is also positively correlated with self-confidence. In addition, the interaction between viewing angle and sex turned out to be significant for self-confidence and attractiveness. Thus, the view from below increases self-confidence ratings stronger when the avatar is female. In contrast, the view from above reduces the attractiveness of female avatars more than it reduces the attractiveness of male avatars. Previous research suggests that the viewing angle not only influences our impression about other people but also has an impact on behavior and the decisions we make. For example, Kepplinger and Donsbach (1986, 1990) showed that the viewing angle can play an important role in people’s voting behavior.

The results from this study demonstrate that people establish a representation of their interaction partner’s character based on visible aspects of the avatar. The findings are in line with previous research (Donath, 2007; Nowak & Rauh, 2008). However, in contrast to previous research, we showed that not only highly salient factors such as androgyny and anthropomorphism, but also subtle and – at least in part – unconscious nonverbal variables play a crucial role. Our results provide evidence that we evaluate avatars in a similar way as humans – at least in the context of first impressions. First impressions matter in virtual worlds, too. Our study is relevant since it is very likely that in the future more and more human interactions will take place in cyberspace (see Bainbridge, 2007; Miller, 2007). Therefore, the importance of choosing the right avatar becomes obvious. In the context of work-related as well as private computer-based communication, people generally aim to appear sympathetic, intelligent, and attractive. Unlike our offline appearance, the shape of avatars is much more malleable and can be rapidly adapted in more subtle ways. Moreover, it is at least conceivable that nonverbal cues like pupil size exert an even stronger influence in virtual environments where the interactions are less dynamic. We show how to appeal to people without dissembling. Specifically, our findings suggest that avatars seen from below are more efficient in conveying an image that involves power, sympathy, or attractiveness. This turned out to be particularly important for female avatars. Furthermore, in order to appear sociable and attractive, it is beneficial to design avatars with large pupils and a low eyeblink frequency. These findings could be relevant whenever users think about what avatar to choose. Last but not least, knowing more about the effects of visual characteristics of avatars is particularly important because they are subtle and often escape the viewer’s conscious awareness but still influence how people judge and evaluate others.

However, to know more about how these three variables affect interactions in mediated environments, future studies should include behavioral aspects as dependent variables. A possibility would be to assess actual chatting behavior. Furthermore, it could be interesting to investigate whether viewing angle, pupil size, and eyeblink frequency also induce the so-called Protheus effects (see Yee & Bailenson, 2007). A Protheus effect occurs when a transformed self-representation influences the users’ behavior.

Acknowledgment

This project was supported by a Hans Sigrist Fellowship grant from the University of Bern.
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Date of acceptance: October 23, 2009
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