Don't look back in anger: the rewarding value of a female face is discounted by an angry expression

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Abstract

The modulating effect of emotional expression on the rewarding nature of attractive and non-attractive female faces in heterosexual men was explored in a motivated-viewing paradigm. This paradigm, which is an indicator of neural reward, requires the viewer to expend effort to maintain or reduce image-viewing times. Males worked to extend the viewing time for happy and neutral attractive faces but to *reduce* the viewing time for the attractive angry faces. Attractive angry faces were rated as more aesthetically pleasing than the non-attractive faces yet the males worked to reduce their viewing time to a level comparable with the non-attractive neutral and happy faces. The addition of an angry expression onto an otherwise attractive face therefore renders it unrewarding and aversive to potential mates. Mildly happy expressions on the non-attractive faces did little to improve their attractiveness or reward potential with males working to reduce viewing time for all non-attractive faces.

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Human faces have profound social and biological relevance with specific characteristics playing a vital role in social interaction. In particular, judgements of facial attractiveness and emotional expression, whether explicitly or implicitly made, mediate approach and avoidance behaviours in the perceiver (Langlois et al., 2000). Negative facial expressions (e.g. anger) encourage avoidance (Marsh, Ambady, & Fleck, 2005), whereas positive expressions (e.g. happiness) convey acceptance and approachability (DeWall, Maner, & Rouby, 2009; Miles, 2009). Similarly, attractive individuals benefit from an often unconscious positive bias (Dion, Berscheid, & Walster, 1972; Jokela, 2009; Langlois et al., 2000; Mobius & Rosenblat, 2006; Rhodes, 2006; Olson & Marshuetz, 2005), and enhanced levels of social interaction (Mulford, Orbell, Shatto, & Stockard, 1998; Prestia, Silverston, Wood, & Zigarmi, 2002).

Attractive faces activate brain regions that are engaged in the processing of rewards such as foods and monetary gain (Aharon et al., 2001; Chatterjee, Thomas, Smith, & Aguirre, 2008; Cloutier, Heatherton, Whalen, & Kelley, 2008; O'Doherty et al., 2003). They can be considered to be rewarding stimuli in themselves, independent of any associated post-experiment gain or pre-experiment deficit state. A behavioural indicator of this neural reward response is provided by the motivated viewing paradigm of Aharon and colleagues (Aharon et al., 2001) where participants actively work by pressing keys to increase or decrease their exposure to different images. People expend effort to increase their exposure to attractive faces (Aharon et al., 2001; Hahn, Xiao, Sprengelmeyer, & Perrett, 2013; Hayden, Parikh, Deaner, & Platt, 2007) and the viewing is accompanied by activation in the neural reward network (e.g., the nucleus accumbens and the orbito-frontal cortex). These effects are markedly more pronounced in males compared to females looking at opposite-sex faces (Cloutier et al., 2008; Ishai, 2007).

Very few studies, however, have explored how the rewarding nature of opposite sex faces is modulated by the perceived approachability of said faces as established through non-verbal facial emotion signals. Preliminary evidence suggests that mildly smiling faces, indicating the potential for a successful interaction, enhance reward related responses in the orbito-frontal cortex for attractive opposite sex faces (O'Doherty et al., 2003), but the evidence remains mixed as to any associated enhancement in perceived attractiveness (e.g., Jones, DeBruine, Little, Conway, & Feinberg, 2006; O'Doherty et al., 2003). In contrast, little is known about the effect a negative facial expression - for example, anger, which indicates avoidance - might have on the rewarding nature of a face. Could an angry expression render an otherwise attractive

opposite sex face unrewarding?

To address this, we employed the motivated viewing paradigm of Aharon et al. (2001) to explore the relationship between facial attractiveness, facial expression and motivated viewing behaviour (as an indicator of neural reward) in male participants viewing female faces. We hypothesised that males would work to extend the viewing time for attractive compared to non-attractive faces and that the presence of a mildly angry facial expression would limit the rewarding nature of those stimuli such that males would work to *reduce* the viewing time for those stimuli. We also aimed to establish if a mildly smiling expression might increase the rewarding nature of the faces.

Methods

Participants

Twenty-one self-reported heterosexual males participated (two were excluded from analysis due to failure to follow task instructions, N=19, mean age 23 years, SD = 2.79). Participants were naive to the purpose of the study and all gave written informed consent in accordance with the ethical procedures of the Department of Psychological Sciences at Birkbeck College, University of London.

Stimuli

Stimuli were 120 grey scale images of 40 female faces each depicting one of three emotional expressions (happy, angry or neutral). Emotional stimuli (happy, angry) were generated from the 40 neutral exemplars by applying a linear transition shape transformation based on prototypical angry and happy faces (Rowland, & Perrett, 1995; Tiddeman, Burt, & Perrett, 2001) optimised to each neutral face image. Expressive prototypes were created by separately averaging the same identities from the Ekman set displaying angry and happy emotions (Young, Perrett, Calder, Sprengelmeyer & Ekman, 2002). In order to render each stimulus anonymous, each individual neutral face exemplar comprised the average of two original images chosen to be either high or low in attractiveness (Hahn, Xiao, Sprengelmeyer, & Perrett, 2013; Lundqvist, Flyckt, & Öhman, 1998). Pilot studies confirmed the attractiveness distinction between the 20 face averages considered to be in the highly attractive class and the 20 face averages in the non-attractiveness class. All stimuli were of the same size, displayed forward head placement and eye-gaze, wore neither glasses nor jewellery and were

normalised for luminance.

Procedure

Stimuli were presented on a black background with a countdown timer bar at the base of the image (see Figure 1). The timer indicated the remaining viewing time for the given stimulus. Participants were instructed to manipulate the viewing time of each image by pressing labelled keyboard keys, with one key increasing the viewing time in 100 ms chunks and the other reducing the viewing time by the same amount for each keypress (based on the procedure taken from Aharon et al., 2001).

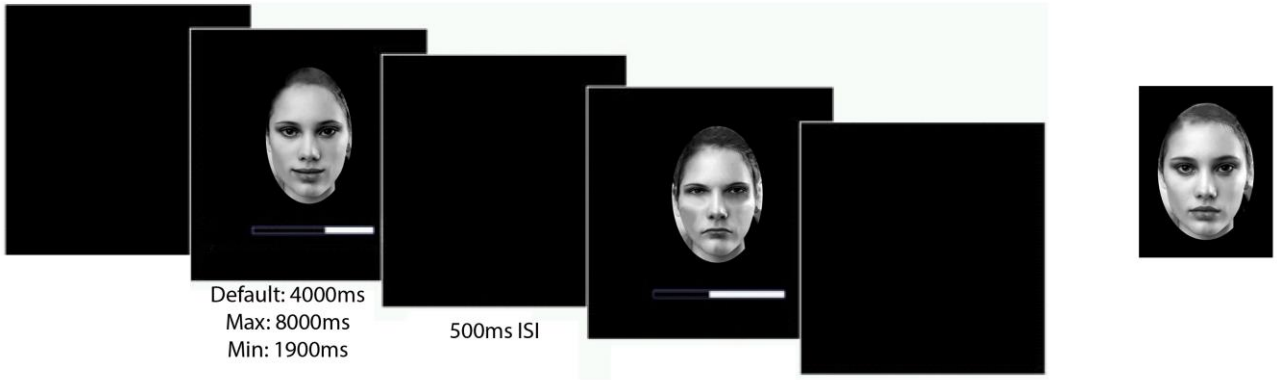
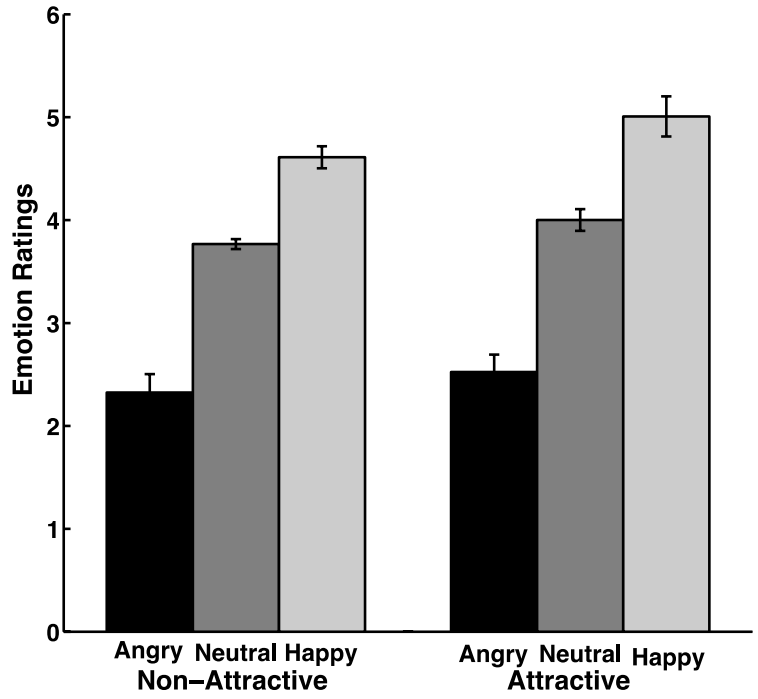


Figure 1. Experimental paradigm showing an example attractive face expressing happiness (left), anger (right) on the main display. The neutral expression of this model is presented (far right) to show a full range of expressions for one model. A time countdown signified the viewing time remaining and the outcome of any keypress.

Default viewing time (with no keypress) was 4000 ms, minimum viewing time was 1900 ms and maximum was 8000 ms. A short trial-run with 20 unrelated images of cars served to familiarize participants with the procedure. Each face stimulus was presented over the course of 120 experimental trials (20 trials per condition). Participants were told that the total time of the experiment was 20 minutes and did not depend on their keypresses. After completion of the keypress task, each stimulus was rated for attractiveness (seven-point Likert-scale: 1 = very low; 7 = very high) and emotion (seven-point Likert-scale: 1 = very angry; 4 = neutral; 7 = very happy).

Results

A 2 (attractiveness) by 3 (emotion) repeated measures ANOVA (Greenhouse Geisser correction applied to the degrees of freedom when sphericity violated) on the behavioural ratings of valence emotion confirmed a main effect of valence emotion (F(1.10, 19.84) = 68.07, p<.001, η^2_p=.79) with all three emotion categories (happy, neutral and angry) differing significantly from each other in their ratings as expected (ts(18)> 7.35, ps<.001, ds >1.68). Attractive expressions were rated as being more happy than non-attractive ones (F (1,36) = 8.72, p=.009, η^2_p=.33) but there was no interaction between attractiveness and emotion of the expressions on the emotion ratings (F(1.72, 30.97) = 1.31; See Figure 2 left).



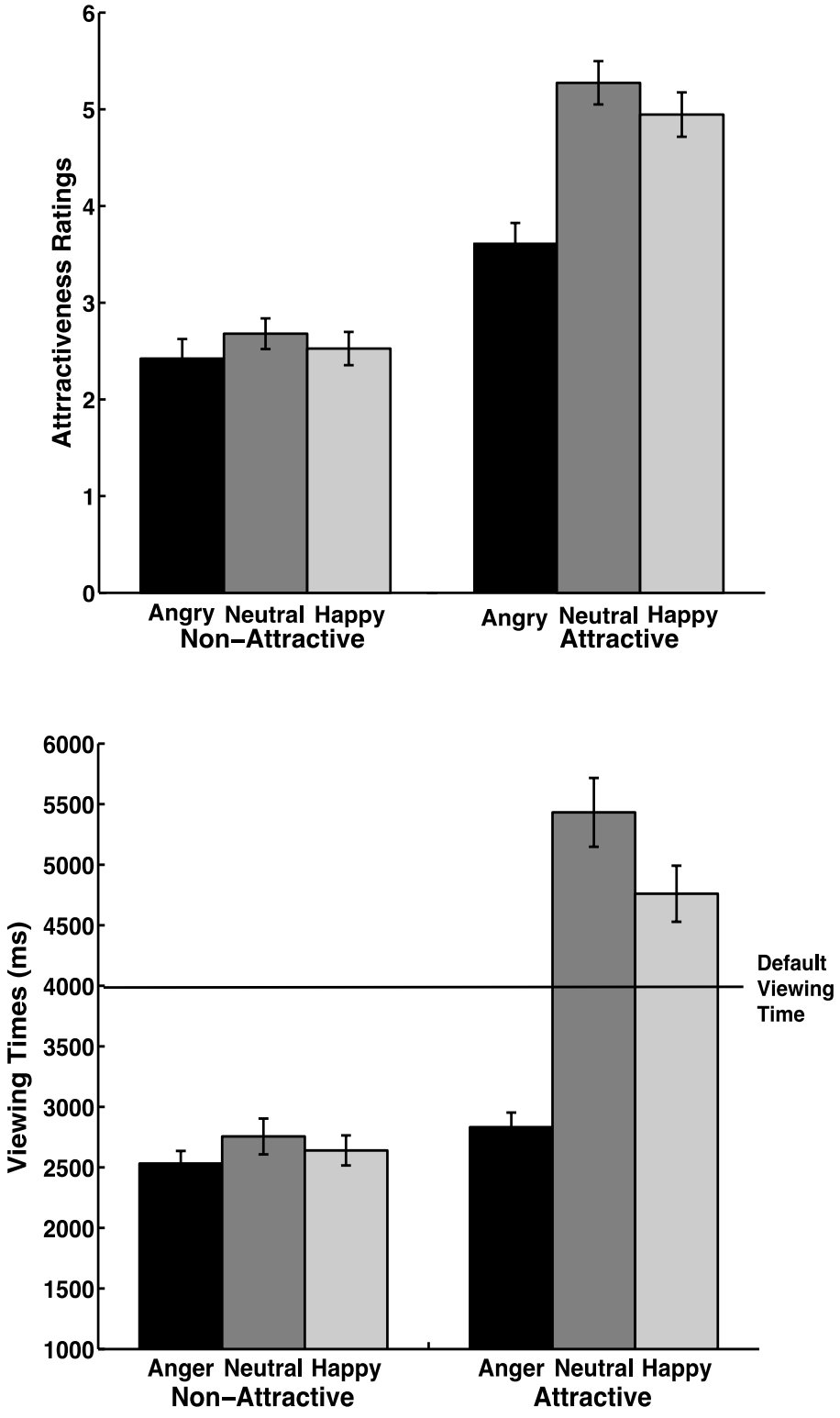


Figure 2. Average emotion ratings (top), attractiveness ratings (middle) and viewing times (bottom) split by attractiveness and emotional category of the stimuli. Error bars represent standard error.

An equivalent 2 x 3 repeated measures ANOVA on the attractiveness ratings confirmed the main effect of attractiveness ($F(1,18) = 65.27$, $p<.001$, $\eta^2_p=.78$) with images in the attractive group rated significantly higher than in the non-attractive group (see Figure 2, middle). There was also a main effect of emotion ($F(1.49, 26.84) = 24.72$, $p<.001$, $\eta^2_p=.58$) and a significant emotion by attractiveness interaction ($F(1.46, 26.35) = 31.19$, $p<.001$, $\eta^2_p=.63$). The interaction reflected the presence of a main effect of emotion on attractiveness ratings for the attractive faces ($F(1.36, 24.51) = 41.47$, $p<.001$, $\eta^2_p=.70$) but absence of any effect of emotion on the non-attractive faces ($F(2,36) = 1.55$, $p=0.23$, $\eta^2_p=.08$). Attractive angry faces were rated as less attractive than both happy and neutral attractive faces (*ts*(18) = 6.01 ,7.35, *ps*<.001, *d* =1.38, 1.69), with neutral being rated as more attractive than happy faces (*t*(18) = 3.04, *p*= .007, *d* = 0.70). Critically, the mean attractiveness rating of 3.62 for the attractive angry faces was significantly higher than the attractiveness rating of the non-attractive angry, happy and neutral faces (*ts*(18) = 4.95, 4.58, 5.08, *ps*<.001, *ds* = 1.14, 1.05, 1.17; means of 2.42, 2.68 and 2.53 for non-attractive angry, neutral and happy, respectively;).

Finally, the 2 x 3 repeated measures ANOVA on viewing times indicated the predicted main effect of attractiveness ($F(1,18) = 62.86$, $p<.001$, $\eta^2_p=.77$) with significantly longer viewing times for attractive compared to non-attractive faces (means of 4341 and 2643ms, respectively; see Figure 2, bottom). There was a main effect of emotion ($F(2,36) = 53.12$, $p<.001$, $\eta^2_p=.75$) and also an interaction between emotion by attractiveness ($F(1.22, 21.94) = 45.80$, $p<.001$, $\eta^2_p=.72$). There were significant differences between attractive and non-attractive viewing times for angry (2832 vs. 2532ms), happy (4761 vs. 2640ms) and neutral faces (5432 vs. 2756ms; *ts*(18) = 3.69. 7.56, and 7.73, *ps*<.01,) with a substantially reduced effect size for the angry (*d* = 0.85) compared with the happy and neutral faces (*d*s of 1.73 and 1.77, respectively). Critically the viewing time of attractive angry faces did not differ significantly from the viewing time of the non-attractive happy and neutral faces (*t*(18) = 1.85, 0.71 *p* = .08, .49, respectively) but was significantly reduced compared with the average viewing time of the happy and neutral attractive faces (*t*(18) = 7.31, 8.16, *p*<.001, *ds* = 1.68, 1.87).

Furthermore, males were willing to work to *extend* viewing times above the default duration of 4000 ms for both attractive happy and attractive neutral expressions (one-sample t-tests: *ts*(18)>3.28, p<0.001, *ds*>0.60; extended viewing time by 761 and 1432 ms, respectively), but they worked to actively *reduce* viewing times from the default for the

attractive angry faces by 1168ms ($t(18) = 9.60$, $p<.001$, $d=0.89$). Males also worked to *reduce* viewing times below the default 4000 ms for non-attractive faces in all emotion categories (for neutral, angry and happy respectively by 1224, 1468, 1360ms; one-sample t-test: $ts(18) = 8.38, 14.10, 10.97$, $ps<.001$, $ds = 0.87, 0.93, 0.91$; on screen viewing times of 2756, 2532, 2640 ms), with no significant difference in viewing times for non attractive happy faces in comparison to angry or neutral ($ts(18) = 1.49, 1.56$, $ps>.15$). It is worth noting that males worked to reduce viewing times for the attractive angry faces to a similar extent as they did for all of the non-attractive faces (all effect sizes are substantial and greater than 0.87), while and at the same time rated them as being significantly more attractive.

Discussion

In summary, despite finding the attractive angry faces to be aesthetically pleasing (rated as more attractive than all non-attractive faces), male participants expend no effort to increase their exposure to the faces, rather they work to limit the time that they spend viewing these angry attractive faces to durations equivalent to those of the non-attractive neutral and happy faces. As far as viewing time in a keypress task can be taken as a direct indicator of the rewarding nature of a stimulus (Aharon et al., 2001; Strauss et al., 2005; Hayden, Parikh, Deaner, & Platt, et al., 2007), these results indicate that the presence of an angry facial expression on an attractive female face serves to render the image unrewarding to males.

An angry facial expression, unlike other negative expressions (e.g., fear and sadness), is an aversive stimulus that may be suggestive of harm and therefore encourages avoidance behaviour in the perceiver (Dimberg, 1986; Strauss et al., 2005; Marsh, Ambady & Kleck, 2005). In the context of the current study, the angry expression may indicate to the viewer that any reward is unattainable and therefore no gain would be possible from extended viewing of the images. In fact, males chose to actively work to decrease exposure below the default level further highlighting the aversive nature of an angry facial expression. It should be noted that facial expressions of anger can be confused with other emotion categories (Du & Martinez, 2011) and future studies should explore a wider range of negative valences.

For the faces rated as being non-attractive, differences in emotion had no significant effect on attractiveness ratings; with happy, neutral and angry faces all rated at similarly low levels. For all emotion conditions males worked to reduce viewing times below the default level indicating that these stimuli did not provide any reward to the participants but were in fact provoking an aversive reaction. Since Darwin, facial attractiveness has been considered

important for mate selection as it provides a key indicator of reproductive fitness and genetic superiority (Jokela, 2009; Perrett 2012; Pflüger, Oberzaucher, Katina, Holzleitner, & Grammer, 2012.). The absence of such beauty in these faces may indicate poor reproductive potential rendering them less rewarding and less worthy of work.

Several studies have shown that activation in the neural reward circuitry increases with the level of attractiveness in the perceived image (e.g., Aharon et al., 2001; O'Doherty et al., 2003; Mende-Siedlecki, Said, & Todorov, 2013; Winston, O'Doherty, Kilner, Perrett, & Dolan, 2007; Chatterjee, Thomas, Smith, & Aguirre, 2009). Furthermore, the dissociation between merely attractive faces and those considered rewarding has also been reflected on a neural level (Aharon et al., 2001). Senior (2003) outlined two distinct pathways governing attractiveness perception: one processing rewarding beauty, activating the nucleus accumbens, orbitofrontal cortex and ventromedial prefrontal cortex; the other is presumed to code merely for aesthetic beauty, marked by deactivation of the nucleus accumbens (Senior, 2003). Our behavioural results would predict a dissociation in activation patterns for attractive angry faces compared to neutral and mildly happy attractive faces – the first being perceived as only aesthetically beautiful, the latter as both attractive and rewarding. Testing this would be an interesting future experiment employing a neuroimaging method.

Generally happy faces are associated with approach behaviour and indicate a heightened possibility of a positive outcome from social interaction, which may render them more rewarding to a viewer. Contrary to this, however, happy facial expressions did not result in enhanced viewing times relative to neutral faces for either non-attractive or attractive faces. Nor did they result in increased attractiveness ratings in comparison to neutral expressions. Previous research has echoed our finding that smiles do not necessarily result in increased ratings of attractiveness (O'Doherty et al., 2003). Furthermore, an increased activation in neural reward structures to subtly smiling faces has been reported previously only in a single study (O'Doherty et al., 2003) in which different identities formed the happy and neutral stimulus groups.

One possible explanation may be that we employed posed and not spontaneous happy exemplars to generate our transforms (Leppänen & Hietanen, 2007). Although this manipulation was highly successful in producing happy faces, as indicated by the valence ratings, it is possible that had we (and others) used pictures depicting naturally generated Duchenne smiles the attractiveness ratings and/or the rewarding nature of the smiling faces would be enhanced. A subsequent study that explores the effect of real vs. posed smiles would

indeed be interesting, particularly in the context of attractiveness, reward and motivated social behaviour. An alternative explanation may be that as females are more naturally associated with a happy expression and males with an angry expression (Becker et al., 2007; Zebrowitz et al., 2010), our valence manipulation had a reduced effect in modulating reward characteristics between neutral and happy female faces than neutral and angry female faces. The angry manipulation may have masculinized the attractive female faces and rendered them less attractive. In addition, the emotion transforms may have resulted in the emotion morphs appearing to be less natural than the untransformed neutral expressions, and this may have contributed to the attractive neutral expressions being rated so highly.

To conclude, we found that although still rated as aesthetically pleasing, attractive females depicting angry expressions no longer encouraged males to expend effort to view them as they did for neutral and smiling faces. Rather males worked to reduce their exposure time to levels akin to those of the non-attractive faces.

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W. Van den Hurk and M. Jaensch conceived the study and collected the data under the supervision of M. L. Smith and A. Richards. D. Perrett was a scientific advisor. M. Dzhelyova, A. Hahn and D. Perrett provided stimuli. M. Jaensch and W. Van den Hurk made an equal contribution to the work and are joint first authors. M. L. Smith and A. Richards analysed the data and drafted the paper, and are joint last authors. All authors provided critical revisions and approved the final version for submission.