Face inversion increases attractiveness

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ABSTRACT

Assessing facial attractiveness is a ubiquitous, inherent, and hard-wired phenomenon in everyday interactions. As such, it has highly adapted to the default way that faces are typically processed: viewing faces in upright orientation. By inverting faces, we can disrupt this default mode, and study *how* facial attractiveness is assessed. Faces, rotated at 90 (tilting to either side) and 180°, were rated on attractiveness and distinctiveness scales. For both orientations, we found that faces were rated more attractive and less distinctive than upright faces. Importantly, these effects were more pronounced for faces rated low in upright orientation, and smaller for highly attractive faces. In other words, the less attractive a face was, the more it gained in attractiveness by inversion or rotation. Based on these findings, we argue that facial attractiveness assessments might not rely on the presence of attractive facial characteristics, but on the absence of distinctive, unattractive characteristics. These unattractive characteristics are potentially weighed against an individual, attractive prototype in assessing facial attractiveness.

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1. Introduction

Faces are special in various ways and are probably the most outstanding visual object category for humans (Bruce & Young, 2012). In the course of evolution, we have become experts in processing the visual nuances of human faces. We can easily identify familiar faces (Jenkins, White, Van Montfort, & Burton, 2011), read subtle emotional expressions (Ekman & Oster, 1979), make reliable social inferences based on facial appearance (Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015), and can readily assess whether we like a face or not (Olson & Marshuetz, 2005; Willis & Todorov, 2006). All of these aspects occur in a fast and effortless manner, leading to the argument that face processing is a hard-wired and partially innate part of our visual system (Bruce & Young, 1986).

We focus on facial attractiveness, which is a ubiquitous and inherent aspect of face processing (Thornhill & Gangestad, 1999), and is one of the most encountered and most frequently assessed forms of beauty in general (Little, 2014). Evidence that facial attractiveness assessments are hard-wired, and are the product of evolutionary adaptions, ranges from cross-cultural comparisons (Cunningham, Roberts, Wu,

Barbee, & Druen, 1995), to physiological studies (Gerger, Leder, Tinio, & Schacht, 2011) and brain imaging (Cloutier, Heatherton, Whalen, & Kelley, 2008; Winston, O'Doherty, Kilner, Perrett, & Dolan, 2007). Behavioural studies also support these assumptions, suggesting that assessing attractiveness seems to be an automatic (Olson & Marshuetz, 2005; Willis & Todorov, 2006) and difficult to inhibit (Sui & Liu, 2009) act. Attractive faces capture more attention and are looked at longer by both adults (Aharon et al., 2001; Leder, Mitrovic, & Goller, 2016; Leder, Tinio, Fuchs, & Bohrn, 2010; Maner et al., 2003; Mitrovic, Tinio, & Leder, 2016; Shimojo, Simion, Shimojo, & Scheier, 2003) and by infants (Langlois, Ritter, Roggman, & Vaughn, 1991; Langlois et al., 1987; Slater, Quinn, Hayes, & Brown, 2000), lending strong support to the claim that facial attractiveness perception is a central and automatic process in our perception of faces.

As the human ability to assess facial attractiveness might be the result of evolutionary adaptations developed over millions of years (Buss, 1995; Penton-Voak et al., 2003; Rhodes, 2006; Thornhill & Gangestad, 1999), the upright orientation of a face also should be an important prerequisite. Although faces can be encountered in orientations that are not upright, the upright perception has probably ever been the default and dominant mode in face perception. This is also particularly the case in the pre-modern past, where face-to-face encounters were the only way of perceiving faces. Thus, the hard-wired specifics of facial attractiveness are expected to be tied to faces in upright orientation. Experimentally disrupting this default viewing

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mode has in turn been shown to give insight into the mechanisms of face processing and assessment itself (Leder & Carbon, 2006).

It is now well established that face processing can be affected by inversion (i.e. rotation by 180°) of the observed face relative to the observer. In one of the earliest studies on this topic, it was demonstrated that facial recognition was disproportionally disrupted by inversion relative to other object categories such as horses or houses (Yin, 1969). As a result, it was suggested that faces are somehow 'special' in how they are processed. Since then the *face inversion* effect has been demonstrated in many studies (for reviews see Burke & Sulikowski, 2013; McKone & Yovel, 2009; Valentine, 1988). However, to date, the majority of inversion studies focussed on disruptions in face recognition and identification (Bartlett & Searcy, 1993; Civile, McLaren, & McLaren, 2014; Farah, Tanaka, & Drain, 1995; Leder & Bruce, 1998, 2000a; Rhodes, Brake, & Atkinson, 1993; Rossion & Gauthier, 2002; Taubert, van Golde, & Verstraten, 2016). Only a few studies focused on other aspects like perceptual accuracy (Ostrofsky, Kozbelt, Cohen, Conklin, & Thomson, 2016), grotesqueness (Bartlett & Searcy, 1993; Thompson, 1980), distinctiveness (Leder & Bruce, 1998), or facial attractiveness (Bäuml, 1994; Santos & Young, 2008; Slater et al., 1998).

Regarding attractiveness, in a first study (Bäuml, 1994), moderately attractive faces were presented inverted in pairs or triples, and participants had to choose the more- or the most-attractive face, respectively. The results showed that the discrimination between more and less attractive faces was more reliable for upright faces than for inverted faces. A similar effect was found by presenting infants with more and less attractive faces in upright and inverted orientations. Whereat infants looked longer at the more attractive face in upright orientation, the effect disappeared when faces were inverted (Slater et al., 2000). Another study showed that participants showed less consistency with pre-defined criteria in assessing the attractiveness of inverted faces (Santos & Young, 2008). Together, these studies suggest that face inversion disrupts attractiveness assessments. However, they did not test whether the faces became less or more attractive itself through inversion.

In the current research, we tested if ratings of facial attractiveness systematically change when we present faces in orientations away from upright. The direction of the effect gives rise to different implications on how attractiveness assessment of faces are actually made. We propose two mutually exclusive hypotheses regarding the assessments of *attractive* versus *unattractive* facial characteristics.[1] (1) A decrease would indicate that inversion impairs processing of characteristics that make the face appear attractive in upright orientation. Thus, facial attractiveness assessments would be mainly based on the *presence of attractive facial characteristics*. Each attractive element additively contributes to a general assessment of the whole face. This hypothesis fits the common understanding of facial attractiveness and its use in everyday language. (2) On the other hand, facial attractiveness might increase through inversion. This would indicate that inversion impairs processing of characteristics that make the face appear less attractive in upright orientation. Thus, facial attractiveness assessments would arguably be based primarily on the *absence of unattractive facial characteristics*. Consequently, particularly less attractive faces should gain most from inversion, because they possess more characteristics that are seen as unattractive. This hypothesis would indicate a more holistic and top-down process in assessing facial attractiveness: Such attractiveness assessments are made in reference to an internal prototype of an ideal, attractive face; all characteristics which deviate from this ideal face can best be seen in upright orientation and reduce the overall attractiveness rating. Initial evidence for this hypothesis comes from a study showing that with increasing presentation durations,

attractiveness ratings decreased, especially in low and medium attractive faces (Gerger, Forster, & Leder, 2016). Under short presentation durations, the unattractive characteristics may not be readily perceived and thus low and medium attractive faces are rated as more attractive. Overall, both hypotheses offer a testable mechanism of how facial attractiveness assessments are actually made.

To further test our hypotheses, we included distinctiveness assessments in a second experiment. It has already been shown that inversion reduces the perceived distinctiveness of a face, particularly due to limited access to configural characteristics (Leder & Bruce, 1998). Distinctiveness is generally associated with the recognisability of faces, often assumed to be determined by characteristics that are memorable, such as a particularly long nose, or very bushy eyebrows (Leder & Bruce, 1998; Valentine, 1991). Traditionally, distinctiveness is operationalized as the distance between any two faces in a face space (face-in-the-crowd; Valentine, 1991), but was more recently also operationalized as the opposite of averageness (Wickham & Morris, 2003). Importantly, both operationalisations show—except for highly attractive faces (Alley & Cunningham, 1991; Wickham & Morris, 2003)—a negative correlation with facial attractiveness (Deffenbacher, Johanson, & O'Toole, 1998; Rhodes & Tremewan, 1996; Wickham & Morris, 2003). Thus, as distinctive characteristics are likely to be less attractive, we would expect decreasing distinctiveness ratings through inversion.

In both experiments we also controlled for additional factors shown to be important in facial assessment research. First, while previous studies (Bäuml, 1994; Santos & Young, 2008) asked for a binary categorization ("attractive" or "unattractive") or forced choice decisions, we asked for attractiveness ratings on a five-point Likert scale. This allowed us a finer grained analysis of the effects and to test whether the inversion effects vary with the (pre-defined, in upright assessed) attractiveness of a face. We therefore selected faces which covered a broad range of attractiveness and included their base attractiveness rating as an additional factor. Second, while most studies have examined the effect of face inversion (rotated by 180°), others have demonstrated that face perception is also impaired when faces were rotated 90° to 120° (Schwaninger & Mast, 2005). We therefore presented faces in upright orientation (0°) as a baseline, rotated by 180°, and rotated by ± 90° (to the left or to the right) as an intermediate condition. Third, in the first experiment, we also employed a control condition in which we asked participants to rate the *unattractiveness* of the faces. It has been shown that different brain regions are involved in the processing of attractive and unattractive faces (Aharon et al., 2001), artworks (Vartanian & Goel, 2004), or pieces of music (Altenmüller, Schurmann, Lim, & Parlitz, 2002). Comparing attractiveness ratings with unattractiveness ratings ensures that any effects found in our study are not simply reflecting artefacts in scale use, but reflect real changes in facial attractiveness assessments. If inversion evokes real changes, we expected inverse results in *attractiveness* versus *unattractiveness* ratings.

2. Experiment 1 (attractiveness/unattractiveness)

2.1. Method

2.1.1. Participants

Sixty undergraduate students (48 women; M_{age} = 22.48, SD_{age} = 3.17) from the University of Vienna participated in exchange for course credit. All participants had normal or corrected-to-normal visual acuity, color vision, and stereopsis. Prior to the experiment, all participants gave written consent to participate.

2.1.2. Stimuli

We selected 200 greyscale faces (half female) from our own face database. The faces were shown in frontal aspect, free from occlusions, with a neutral facial expression, without makeup, glasses, or jewellery,

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[1] In this manuscript, the term characteristic refers to all visual aspects of a face, without any specific restrictions or classifications.