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Artistic representations of faces: How averaging
affects attractiveness ratings of portraits

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Abstract

In the scientific research of facial attractiveness, one factor that turned out to be related with attractiveness ratings in most of the studies was averageness. When comparing composite faces to the original faces, the more average face was preferred nearly every time, and the attractiveness ratings increased, as the number of faces included in the composite face increased. By applying morphing techniques to two different representation forms of faces (photographs and artistic portraits) this study should prove, if these two depictions of faces underlie the same regularities. The results support previous findings: averaged faces are perceived as more attractive and the attractiveness increases as the number of faces included in the composite face increases. This was true for both representation forms of faces. Although portraits and photographs show the same effects when morphing techniques are applied to the images, photographs show a higher preference when compared to portraits. Possible explanations for this effect could be the higher familiarity of natural faces and the fact that portraits and photographs differ significantly in their average width- and height-ratios.

Kurzzusammenfassung

Die meisten Studien die sich mit der Attraktivität von Gesichtern befassen fanden heraus, dass durchschnittliche Gesichter die höchsten Attraktivitätsbewertungen hatten. Bei Vergleichen von original Gesichtern mit bearbeiteten Gesichtern die dem mathematischen Mittel entsprachen, wurde immer das Gesicht bevorzugt welches am nächsten zum Mittelwert lag. Wenn Morphing-Techniken angewandt werden um solche durchschnittlichen Gesichter zu erzeugen stieg die Attraktivität an, je mehr Bilder in dem neuen Gesicht enthalten waren. In dieser Studie wird der Einfluss von Morphing auf die Attraktivitätsbewertungen von Fotos und Porträts verglichen um herauszufinden, ob beide Arten der Darstellung von Gesichtern die gleichen Effekte zeigen. Weiters soll dadurch Aufschluss darüber gegeben werden, wie Künstler Gesichter in ihren Porträts abbilden.

Die Ergebnisse dieser Untersuchung konnten bisherige Forschungsergebnisse bestätigen: durchschnittliche Gesichter werden bevorzugt und die Attraktivität stieg an, je mehr original Gesichter in den bearbeiteten Gesichtern enthalten waren. Diese Effekte waren sowohl bei Fotos als auch bei Porträts zu beobachten. Es zeigte sich aber auch, dass Fotos deutlich höhere Attraktivitätsbewertungen hatten als Porträts, was durch eine höhere Familiarität von natürlichen Gesichtern und Unterschiede in den Verhältnissen zwischen den Gesichtsmerkmalen bei Fotos und Porträts erklärt werden kann.

THEORETICAL PART

1. Introduction

The field of face-perception as a topic of visual perception is a very important field for psychological studies because of the great importance of faces for our social interactions. Their faces mainly influence the first impression we get from other people and our behavior towards strangers depends on the information we derive from this first impression.

There are many studies on the influence of attractiveness on our behavior towards others and the attribution of personality traits (e.g. Henss, 1998; Langlois, Roggman & Rieser-Danner, 1990; Langlois et al., 2000).

The field of beauty and attractiveness is not only studied by psychologists but also by philosophers in the field of aesthetics. There is a long tradition in finding the variables that contribute to beauty and also defining what makes an object or a face attractive.

A perceptual model that tries to give insight in these variables was established from Leder, Belke, Oeberst & Augustin (2004).

Studies that focus on attractiveness of faces date back to Galton (1879) who first tried to create average faces by combining several photographs to produce a new face and found out that these averaged faces were more attractive than the originals.

Since then many studies could support his findings that average faces are attractive (Langlois & Roggman, 1990; Langlois, Roggman & Musselman, 1994; Pallett, Link & Lee, 2010).

Most of these studies were conducted with photographs of natural faces.

In this study, portraits are used to find out if the findings of averageness can be replicated with another, an artistic, depiction of faces. By using portraits it can be proved if attractiveness ratings of faces in general underlie special regularities. Further, by comparing portraits to photographs of natural faces, the results can give insight on the techniques that artists use to depict human faces in art.

Do they rely on the ratios and natural properties of faces to give a very realistic depiction of a face, or do they use special techniques (e.g. golden-ratios, symmetry etc.) to make a face look more attractive?

If artist depict faces in a very natural and realistic way, there should be the same effects for portraits as for natural faces and averageness should increase the attractiveness ratings.

If artist try to make their portraits look more attractive than natural faces, averaging shouldn't affect the attractiveness ratings of portraits, because the original portraits already have a very high attractiveness and it is not possible to increase the attractiveness of a face indefinitely (DeBruine, Jones, Unger, Little & Feinberg, 2007).

At the beginning of this paper an overview of the theoretical background of face-perception, aesthetics and facial attractiveness is provided.

Afterwards the intention and the assumptions of the study and the materials used in the experiments are described.

Finally the results are reported and the findings are discussed in order to address the research questions stated above.

Definitions

For a better understanding some definitions of terms used in the following study are provided.

At first it has to be defined that the term *averageness* in this study is used to describe the mathematical mean and has to be distinguished from the meaning of usualness in our everyday speech.

Morphing describes a technique where a new, an average, face is created by using a computer program. By marking important reference points in each original picture, the program calculates the mean of these faces and creates a new face with the average facial features of the original images.

A *composite face* is the computer-generated face that results after the morphing process.

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Attractiveness in this study is measured through a preference task. As the participants were asked to choose the face they find more attractive, these choices or preferences can be interpreted as attractiveness ratings. So the higher the preference of an image, the more attractive it was perceived by the participants.

2. Theoretical Background

a. Visual perception and face perception

The field of visual perception has a long tradition in psychological studies and is very close related to the field of attention. The basic ideas derive from philosophical theories of mind, “a tradition in which it was natural to consider perception as a means of gaining awareness and knowledge of the world” (Bruce, Green & Georgeson 2003, p. 77).

The aim of psychological studies on visual perception is to learn more about the processes involved in transforming and interpreting sensory information and derive some principles for object recognition. Therefore research focused more on the psychological properties of visual experiences instead of the physical properties of light and images (Bruce, Green & Georgeson 2003).

An example for the importance of visual perception in our everyday lives is the field of face-perception and face-recognition. The information we can derive from faces is important for our social interactions. We can distinguish familiar from unfamiliar faces, decide if someone is happy or sad, young or old and even tell to whom or what the attention of a person is directed by following their gaze. All this information influences our behavior towards others in social interactions.

So the field of face perception is not only an important topic in visual perception, but also in social psychology because of the great influence that faces have on social interactions.

Henss (1998) for example states, that we never view faces as neutral objects and that they are from great psychological meaning. The first impression we receive from a person is mainly influenced by the perception and interpretation of their facial expression. Even if the conclusions we draw from this first impression don't fit the truth, they help us to succeed in our social interactions.

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How important the first impression is to our behavior and interaction with others was proved by many studies on the influence of attractiveness to social interactions.

Even children do prefer interactions with attractive people. In an experiment with 12-months old infants, Langlois, Roggman & Rieser-Danner (1990) could show that the interaction time with a stranger wearing an attractive mask or a doll, with an attractive face was significantly longer than compared to unattractive stimuli. But “indeed, these infant preferences for attractive faces may be apparent only for unfamiliar faces: because of the importance of the attachment system to the survival of the infant, attractiveness is not likely to influence infant behavior toward familiar caregivers and parents” (p. 158).

Eysenck and Keane (2005) summarize the findings about face recognition as follows:

It has often been argued that faces are special because they involve holistic or configural processing, there is a brain area (fusiform face area) specifically associated with face processing, and prosopagnosics have recognition problems only with faces. However, the evidence increasingly suggests that faces are not special, and that they only appear special because we have much expertise with them. (p. 109)

But not only perceiving faces can evoke positive feelings, also the perception of other stimuli can influence our feelings and emotions. In very early studies of aesthetics, Wundt (1874) focused on the emotions and affects, which are elicited through visual perceptions. He describes desire and aversion as two values of a continuum just like the colors black and white are. It depends on the intensity and the quality of the visual stimulus which feelings are evoked.

The visual and the acoustic sense feature some special emotions which Wundt describes as aesthetic impressions. While desire and aversion are modulated through the intensity of a stimulus, the aesthetic impression is modulated through the quality of the stimulus. This means that color or luminance of an object are not the main aspects influencing the experience of an aesthetic impression, even though they can enhance it. Crucial for the aesthetic experience is the form or figure of a stimulus which should match mathematical properties to elicit an

aesthetic impression. The most important mathematical properties are symmetry and the ratio of width to height. This ratio is also known as the “golden ratio” in art. Wundt describes these mathematical properties as natural by using the example of the human body: the body is symmetrical across a vertical dimension (left and right side both have one leg, one arm, one eye and so on) and across a horizontal dimension (the two legs correspond to the two arms, the hips to the shoulders and so on). Because of this, all objects that are symmetrical and fit in special width-height ratios are perceived quicker and easier and therefore evoke a positive feeling. The aesthetic impression starts with these qualities of an object and is completed by our own subjective associations and knowledge.

These aspects that Wundt discusses lead to the connection between visual perception and aesthetic experiences.

b. Aesthetic experiences

Similar to Wundt’s description of qualities of the stimulus that evoke the aesthetic experience, Gustav Theodor Fechner could show “that certain abstract forms and proportions are naturally pleasing to our senses” (cited from Bergeron 2011).

There are two different approaches to aesthetics that can be contrasted:

- *Aesthetics from below*: in this approach aesthetic principles are derived from objective knowledge (e.g. Wundt’s and Fechner’s descriptions of forms and proportions of objects that evoke the aesthetic experience).
- *Aesthetics from above*: in this approach aesthetic principles are deduced from introspective analyses (e.g. subjective, individual attributes determine the aesthetic experience)

(Bergeron 2011)

The perception of and the experience with art can be described in a similar way, by using two different approaches.

While some authors try to explain the aesthetic experience by focusing on perceptual aspects, such as structural properties or construction of the artwork (e.g. Arnheim, 1969; Gombrich 1960; both cited from Sullivan & McCarthy, 2009),

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others also include emotional and interactional aspects between the viewer and the art work (Dewey, 1934; Vygotsky, 1971; both cited from Sullivan & McCarthy, 2009). The latter approach is also ascribed to the cultural psychology and can be described as “a psychology of art where the focus is firmly on the dynamic interaction between artist/viewer and the artifact” (Sullivan & McCarthy, 2009, p. 184).

So the aesthetic experience and also what is described as beautiful can be analyzed on two stages: attributes of the person who views an object and structural properties of the object itself.

As can be seen in the model of Leder, Belke, Oeberst & Augustin (2004) which is described below, the stages *explicit classification* and *cognitive mastering* are influenced by very subjective variables like interest, personal taste and domain specific expertise.

On the other hand Wundt (1874) describes how mathematical properties of an object influence the aesthetic impression in a way that symmetry and special ratios enhance positive feelings.

The model of aesthetic appreciation and aesthetic judgment of Leder et al. (2004) is a relatively new approach to aesthetic experiences. This information-processing stage model describes five stages that are involved in the aesthetic experience (Figure 1).

The authors describe the aesthetic experience as “a challenging situation to classify, understand and cognitively master the artwork successfully” (p. 493).

The model is mainly connected to aesthetic experiences in art, so the input usually is a work of art. The five stages that follow a pre-classification of an object as a piece of art involve:

- Perception: at this stage very basic analyses are made (contrasts, complexity, color, symmetry and grouping).
- Implicit classification: at this stage, memory effects can influence the aesthetic judgment (familiarity, prototypicality and peak-shift effects).
- Explicit classification: at this stage the information processing is influenced by expertise and knowledge and classifications made here can be

verbalized. The main aspects analyzed here are content and style of the artwork.

- Cognitive mastering
 - Evaluation
- These two stages are linked and build a feedback-loop.

➔ The last two stages influence whether the information processing was successful and is finished (which is expressed in a satisfying understanding of the piece of art), or if the processing is redirected to a previous stage and starts again.

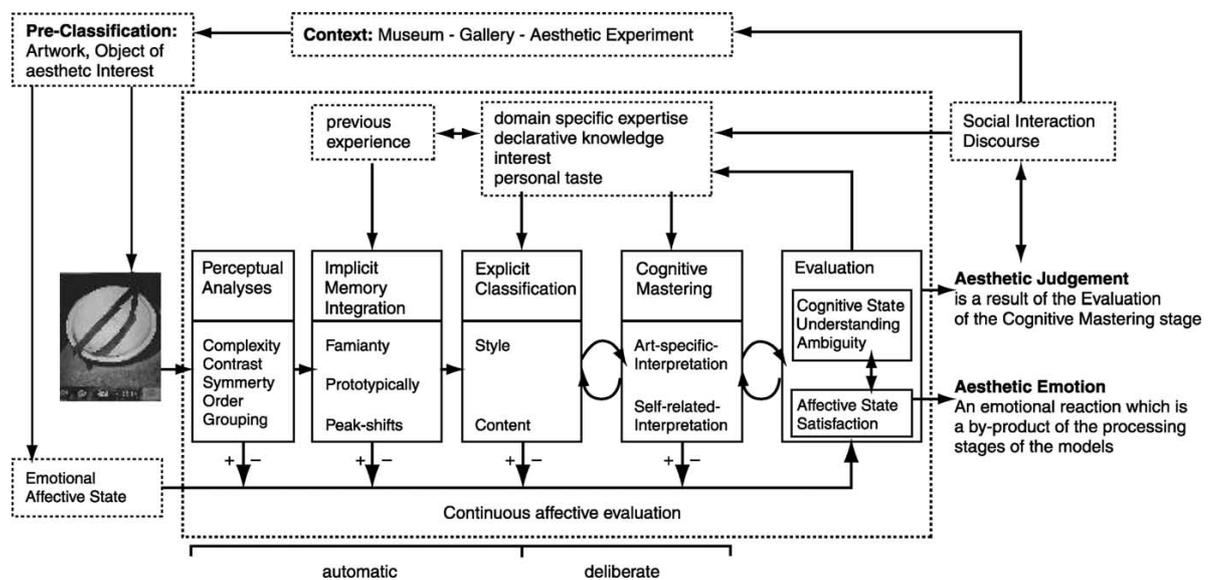


Figure 1 Model of aesthetic experience (Leder et al 2004, p. 492).

The two main outputs of the model are an aesthetic judgment (positive vs. negative) and an aesthetic emotion (pleasure vs. dislike). Leder et al. (2004) assume “cognitive and affective experiences to be linked reciprocally” in the aesthetic experience (p. 493). Although the authors focus mainly on visual arts, the mechanisms “should also be transferable to aesthetic experiences with other forms of art” (p. 490).

c. Neuroaesthetics

Another new branch of aesthetic sciences was created by studies, which examine the neuronal processes that underlie the aesthetic experience: the neuroaesthetics.

These studies should give insight in how the brain perceives beauty and find neuronal correlates of the aesthetic experience.

O'Doherty et al. (2003) examined the activation of the medial orbito-frontal cortex (mOFC) in viewing attractive faces. Their assumption was, that attractive faces function as a reward, and therefore should activate the mOFC. Functional magnetic resonance imaging (fMRI) scans were taken from the participants while they viewed four repetitions of 48 faces in random order and afterwards they were asked to rate the faces for attractiveness.

They found a significant higher activation of the mOFC when viewing attractive faces, compared to unattractive faces. Attractive faces with a happy expression produced a stronger response in the mOFC compared to attractive faces with a neutral expression. But there was no main effect of happiness in the mOFC, so happiness alone does not lead to an activation of the area. Also there was no correlation between a happy face expression and the attractiveness ratings, so not all faces with a happy expression were judged as attractive.

Ishizu & Zeki (2011) also focus their study on the cognitive aspects of aesthetic experiences. Again, by using fMRI they want to detect special brain areas, associated with the experience of beauty.

Their hypothesis was "that there would be a single area or set of areas whose activity would correlate with the experience of beauty, regardless of whether it was derived from an auditory or visual source" (p. 1). Their stimuli were 30 musical excerpts and 30 paintings which the participants pre-classified into three groups ("beautiful", "indifferent" and "ugly"). While the participants rated the stimuli a second time, fMRI scans and some other physiological measures were taken.

Results showed that the common area which was activated during exposure to beautiful stimuli of both sources (music and paintings) was the mOFC. Beside the

activation of the mOFC they found an activation in two other areas: the visual and auditory cortex, depending on the stimulus, and the caudate nucleus, which was only active during the experience of visual beauty. The authors conclude that the activation of the caudate nucleus emphasizes the theory, that there is a relation between love and beauty, because this area of the brain has been found to correlate with the experience of romantic love.

The findings of these two studies support the assumption that beauty depends on the perceiving subject, but Ishizu & Zeki (2011) note that this doesn't mean "that objects may not have characteristics that qualify them as beautiful" (p. 8).

Both studies found one brain area correlated with the experience of beauty and attractiveness: the medial orbito-frontal cortex. This general activation of one specific brain area for different kinds of stimuli can be seen as a proof of a biological component of the aesthetic experience.

So besides the subjective factors that are mentioned in the model of Leder et al (2004), the brain activation of the perceiving subject plays also an important role for the aesthetic experience.

d. Attractiveness of faces

Many studies have focused on the topic "What makes a face attractive" and tried to find a common sense in attractive faces.

Because no influences of gender, age, culture or social status on attractiveness ratings could be found, Henss (1998) concluded that there has to be an objective or physical property that constitutes to the beauty of a face. In accordance to the findings of Wundt (1874) discussed above he describes the "golden ratio", averageness and symmetry as main properties that may influence the beauty of a face.

The findings of preferences for attractive faces, regardless of the gender, age or culture are supported by a study of Langlois, Ritter, Roggman, & Vaughn (1991). They showed infants white male, white female, black female and infants faces and in each condition the attractive face was preferred over the unattractive face.

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These results support former findings, that even young infants can discriminate between attractive and unattractive faces, but more important they show, that “infants treat attractive faces as distinctive regardless of the sex, age, and race of the stimulus face, even though most of the infants had little experience with some of the types of faces they viewed” (p. 82).

The fact that stable preferences for attractive faces appear very early in life can be seen as proof, that the exposure to media is not an adequate explanation of these preferences.

Rubenstein, Langlois & Roggman (2002) come to the same conclusion in their paper, summarizing studies about preferences for attractive faces. “Studies showing that preferences for attractive faces are evident early in life and studies showing near universal preferences for attractive faces in adults seemingly eliminate the gradual socialization perspective” (p. 4).

Langlois & Roggman (1990) summarize the findings of cross cultural studies:

Taken together, the cross-cultural and infant data suggest that there may be universal stimulus dimension of faces that infants, older children, and adults cross-culturally view as attractive. The ability to detect these stimulus dimensions may be innate or acquired much earlier than previously believed (p. 115).

While cross-cultural agreement on the attractiveness of faces has been proven by some studies (Langlois, Ritter, Roggman, & Vaughn, 1991; Rubenstein, Langlois & Roggman, 2002) in other aspects of attractiveness no cross-cultural stability was found.

For example Ford & Beach (1951) found differences in preferences “for different body weights, hip shapes, and breast sizes” for different societies (cited from Cunningham, Barbee & Philhower, 2002, p. 199).

To explain these differences, Cunningham and his colleagues established the Multiple-Fitness model, which should provide a theoretical framework for the perception of physical attractiveness (see Cunningham, Barbee & Philhower, 2002). In this model, physical attractiveness is defined as “complex and multidimensional (Cunningham, Barbee & Philhower, 2002, p. 199) and the attention of the perceiver is drawn to different facial or physical features, depending on the kind of relationship he or she is looking for. So “the meaning of

facial qualities remains relatively constant, but individual trade-off decisions may fluctuate slightly, depending on motive and need” (p. 214).

This is how the model explains preferences for different types of attractiveness cues, depending on personality, hormones or mood, suggesting that there are several aspects of beauty that can “serve as indicators for different types of desirable qualities” (p. 226).

In their meta-analysis of several studies on facial attractiveness Langlois et al (2000) focus on three main questions:

- How do participants judge attractive or unattractive people they don't know vs. people they know?
- How do participants interact with attractive or unattractive people they don't know vs. people they know?
- How do attractive or unattractive people behave and can these behaviors be ascribed to the judgments they received from others?

The authors used three maxims of beauty as a starting point for their research:

- “Beauty is in the eye of the beholder” (everybody has his or her own definition of beauty)
- “Never judge a book by its cover” (people shouldn't be judged by their looks)
- “Beauty is only skin-deep” (the external appearance is not correlated with the personality of a person).

“In contrast to the three maxims, both general socialization and social expectancy theories (behavioral confirmation and self-fulfilling prophecy) and fitness-related evolutionary theories (good genes, mate selection, and parental investment) predict that attractiveness should and does have a significant impact on the judgments and treatment of others by perceivers and on the behaviors and traits of targets” (Langlois et al. 2000, p. 391).

They collected studies that examined facial attractiveness and summarized the results of these studies to answer the three questions stated above.

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According to the first question about the judgment of attractive and unattractive people, their analysis showed that “both within and across cultures, people agreed about who is and is not attractive. Furthermore, attractiveness is an advantage in a variety of important, real-life situations” (p. 399).

Also for their second question about the treatment of attractive vs. unattractive people they could show, that attractiveness increases the chance of a positive treatment.

Similar findings could be shown for the last question, the behavior of attractive vs. unattractive people. Attractive people “behaved more positively and possessed more positive traits than unattractive” ones (p. 402). But the collected data didn’t allow to draw conclusions if these differences can be addressed to the fact that attractive people receive more positive feedback and therefore behave in a different way as unattractive people.

No significant effects of familiarity could be found, so the authors suggest that the “effects of attractiveness are as strong when agents and targets know each other well as when they do not” (p. 403).

To summarize the results of this meta-analysis, the findings not only support the cross cultural stability of attractiveness ratings, but also the great influence of attractiveness on social variables.

In contrast to Langlois et al (2000), Eagly, Ashmore, Makhijani & Longo (1991) found only moderate effects of attractiveness on social variables, which were limited to only a few aspects of judgments. They conducted a meta-analytic-review on the *beauty-is-good stereotype*, which describes the connection between physical attractiveness and the attribution of positive personal qualities. They only included studies where participants had to judge people they don’t know and focused on ratings of physical attractiveness.

Their findings show, that the impact of attractiveness is very variable and depends on the measures and the settings of the studies. Therefore they summarize two main results:

The fact that physical attractiveness had its strongest impact on social competence supports our contention that the core of the physical attractiveness stereotype is sociability, popularity, and similar attributes. ... Physical

attractiveness had little impact on integrity and concern for others; potency, adjustment, and intellectual competence showed intermediate impact (p. 121).

As we saw now that there is a great effect of the attractiveness of a face on judgments and behavior of others, it is now important to address the question what contributes to the attractiveness of a face.

Similar to Wundt's findings of the preference for symmetrical and average objects, these aspects are also important for faces.

The question of what makes a face attractive is not only important to study the *beauty is good* stereotype, but also to understand why it influences our social interactions, how it is formed and when it is used as a reference when judging other people.

i. Symmetry

Studies on the effects of symmetry on the attractiveness of faces vary in their results. Some found an effect of symmetry on attractiveness (Perrett et al. 1999) while others couldn't support these findings (Langlois, Roggman & Musselman, 1994).

Komori, Kawamura & Ishihara (2009) used a very new technique to create symmetrical faces and found that symmetry and averageness only had an effect on the attractiveness of male faces, while for female faces only averageness had an effect on the attractiveness ratings.

A possible explanation for the different findings of the effects of symmetry is the use of different methods to create symmetrical faces. As Komori, Kawamura & Ishihara (2009) conclude in their study "average faces seem more attractive because they represent the mean tendency of a population, rather than because they are symmetrical" (p. 141).

It could be shown, that average faces are also high in symmetry, which indicates a relationship between averageness and symmetry, but although there is a relation between the two factors, symmetry alone is not essential for facial attractiveness.

“Although a mathematically averaged face will be symmetrical, a symmetrical face is not necessarily highly attractive or close to the mathematical average of a population of faces. Furthermore, a highly attractive face is not necessarily highly symmetrical” (Rubenstein, Langlois & Roggman, 2002, p. 16).

ii. Averageness

Studies on averageness date back to Galton (1879). He wanted to “extract the typical characteristics” (p. 132) from photographs of different persons and create a new face which possesses the average features and can be seen as “the portrait of a type and not of an individual” (p. 133). He combined several photographs of criminals to create *the criminal* face but was surprised by the new face he produced.

It will be observed that the features of the composites are much better looking than those of the components. ... All composites are better looking than their components, because the averaged portrait of many persons is free from the irregularities that variously blemish the looks of each of them (p. 135).

Langlois & Roggman (1990) could support the findings of Galton (1879) and even broaden the argumentation with their finding, that the attractiveness of the averaged faces increases with the number of faces that are entered into the composite face.

Further they could show that neither the attractiveness of the individual faces, nor the order in which they are entered into the composite have an effect on the attractiveness of the composite face.

In a following study Langlois, Roggman & Musselman (1994) could show, that the increase in attractiveness of average faces cannot be addressed to youthfulness, symmetry or artifacts of blurring and smoothing, which are byproducts of the morphing technique.

They couldn't find any correlations between youthfulness or symmetry and attractiveness and by producing a composite face of different photographs of the same face, they could prove that blurring or smoothing also don't affect the

attractiveness, because this composite was not rated more attractive than the single photographs.

Palsett, Link & Lee (2010) wanted to describe the influence of spatial relations between facial features on the attractiveness of faces and therefore varied two ratios:

- Length-ratio: this ratio describes the distance between the eyes and the mouth and influences the perceived length of a face.
- Width-ratio: this ratio describes the distance between the pupils and influences the perceived width of a face.

They found that “when the face’s eye-to-mouth distance is 36% of the face length and interocular distance is 46% of the face width, the face reaches its optimal attractiveness” (p. 152). Further they could show that these ratios represent the ratios of an average female Caucasian face.

So again, the preferred ratios were those for an average face.

Perrett, May & Yoshikawa (1994) compared the attractiveness ratings of composite faces that were derived from a set of different faces (average) to attractiveness ratings of a composite face derived from the most attractive faces of the same set (high). If attractiveness is caused by averageness, the ratings of the two composite faces should not differ, because both composite faces represent the average.

Their results show “that attractiveness is not averageness: first the high composite was preferred over the average; second, when the high composite was caricatured to increase the differences from average, the attractiveness increased” (p. 241).

DeBruine et al. (2007) oppose these findings about averageness in their comparison of two possible hypotheses:

- Averageness hypothesis: because of the fact that average faces are closer to the mental prototype of faces, they are processed more easily and therefore found more attractive. If this hypothesis is true, “the magnitude, but not the direction, of change from the average influences attractiveness”

(p. 1421). So even altering some facial features in a way that makes them more attractive (exaggerating attractive features) should make the face more unattractive, because it is moved away from the average.

- Contrast hypothesis: attractiveness depends “on contrast from average, such that exaggerated traits in one direction increase attractiveness and exaggerated traits in the opposite direction decrease attractiveness. ... In other words, varying face shape along an attractiveness dimension increases attractiveness even if it simultaneously decreases mathematical averageness.” (p. 1421).

In their experiments they collected normality and attractiveness ratings of 25 images that varied along an attractiveness dimension. Although the image that represented the middle of the continuum was perceived to be the most average one, it was not rated the most attractive one. When two images were presented, in all cases the one with the larger value on the attractiveness dimension was preferred. Only when the face with the higher value on the attractiveness continuum was perceived as less normal the more average face was preferred.

These findings support the contrast hypothesis and suggest that “averageness and the attractiveness dimension make independent contributions to attractiveness” (p. 1424).

So attractiveness can only be increased within a plausible range for human face shape, and “increasing the value on the attractiveness dimension of a face indefinitely will not increase its attractiveness indefinitely” (p. 1429).

iii. Approaches to describe attractive faces

There are two possible explanations, why average faces are attractive (Langlois & Roggman 1990):

- Evolutionary Biology: based on Darwin’s theory of natural selection, average values should be preferred to extreme values because “individuals with characteristics ... that are close to the mean for the population should be less likely to carry harmful genetic mutations” (p. 116).

So the preference for average faces here can be described as a preference for healthy and safe individuals, especially when it comes to reproduction.

- Cognitive Psychology: this approach focuses on the aspects of forming concepts and abstracting prototypes. A prototype can be seen as the average of all members of a category “by possessing the average or mean value of the attributes of that category” (p. 116). These prototypes should help to recognize new exemplars of that category. On the other hand the responses to a prototype are highly familiar, even if it was never seen before.

Following these findings an average face is attractive because it resembles the prototype of faces that we have stored in our memory, and therefore is perceived as familiar.

A study that tries to address the question which of these two explanations is more plausible was conducted by Halberstadt & Rhodes (2003).

The *direct selection hypothesis* explained the preference for average faces as a solution for the problem of finding healthy mates. This assumption is similar to the evolutionary biology approach and if these two hypotheses explain the preference for average faces, then average exemplars of non face stimuli should not be preferred over other stimuli of the same category. In their study the researchers examined attractiveness ratings of birds, fish and automobiles with manipulated averageness.

Their results again replicated the findings that averageness was correlated to attractiveness, even when the effect of familiarity was partialled out. A preference for averageness is evident even in non-face stimuli, so “the effect that averaging manipulations have on attractiveness is not specific to faces, therefore, cannot be used as evidence to support a direct selection account” (p. 155).

Another way of examining if the biological approach is true, is to look at the relation between attractiveness and health. Because the evolutionary approach explains the preferences for average features as a preference for healthiness, there should be a positive relation between attractiveness and health. However, studies that examine this relation are very rare and report mixed results.

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Rubenstein, Langlois & Roggman (2002) summarize the findings of some of these studies.

The results range from a moderate relation between attractiveness and visits to the students' health center (Reis, Wheeler, Nezelek, Kernis & Spiegel, 1985) to a relation between attractiveness and blood pressure (Hansell, Sparacino & Ronchi, 1982) but also include results indicating a negative correlation between facial attractiveness and objective health scores (Kalick, Zebrowitz, Langlois & Johnson, 1998).

The two most important factors that favor the biological approach over the cognitive approach, are the findings that there is a great cross-cultural agreement about the attractiveness of faces and that preferences for attractive faces are present very early in life (see Rhodes, Harwood, Yoshikawa, Nishitani & McLean, 2002).

In their experiment the authors tested the cross-cultural agreement of attractiveness ratings between Chinese and Non-Chinese participants.

If average faces are attractive because they represent the central tendency of a population, then expertise with that population should be required for average configurations to be attractive. Alternatively, if people are responding to absolute properties of average images, then expertise should not be needed to find the average configurations attractive (p. 41).

In their experiment the participants rated 60 images of Chinese young adults for attractiveness and distinctiveness and completed a forced choice task in which they had to choose the more attractive picture when the composite images were presented in pairs.

The results showed that the attractiveness increased with the number of faces increased in the composite face for both groups, Chinese and Non-Chinese raters. In the forced choice task, both groups of participants, preferred the more average image.

This study again confirmed, that expertise with a population is not required for preferring the more average face and raters do not respond "to averageness per se, but to absolute properties of the images" (p. 53).

A different way of proving the biological determination of preferences for attractive faces is to test if these preferences are innate. "If preferences for attractive faces are *not* present at birth, evolutionary mechanisms cannot be ruled out because many innate characteristics are not expressed until later in development" (Rubenstein, Langlois & Roggman, 2002, p. 23).

Because studies could show that newborns prefer faces over nonfacial patterns (Morton & Johnston, 1991), infants prefer attractive faces over unattractive faces (Langlois, Ritter, Roggman & Vaughn, 1991) and that infants even show different interactions with attractive vs. unattractive strangers (Langlois, Roggman & Rieser-Danner, 1990), preferences for attractive faces can be seen as present very early in life and even influence infants interactions.

This is the point where the evolutionary approach can be linked to the cognitive psychological approach. It could be shown that newborns reacted to averaged faces as if they were familiar, even if they've never seen them before (Walton & Bower, 1994), so even infants seem to be able to form cognitive representations of faces and encode facial features very similar to adults.

To address the question whether the prototype account can serve as an explanation for the preference of average faces in general, or if it only is true for adult attractiveness preferences, Rubenstein, Kalakanis & Langlois (1999) conducted a study on infant preferences of attractive faces.

Their results show that 6-month old children do prefer averaged faces and that they are able to form a prototype of naturalistic faces. The authors conclude, that "rather than being the result of slow acculturation, attractiveness preferences are the result of a basic cognitive process that is present extremely early in life" (p. 853).

To get an idea of how early infants are able to perform these cognitive processes, Langlois et al. (1987) compared the preferences of 2-3 month-old infants to those of 6-8 month-olds. When the faces were presented in contrasting pairs (attractive/unattractive) younger and older infants looked longer at the attractive face. When the pairs contained of faces with similar attractiveness levels, only the older infants looked longer at the more attractive face. These differences may be caused by the different developmental competences of the two age groups.

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Older infants are more able or willing to look away from visual stimuli in this type of experimental situation. Younger infants, on the other hand, are less able to release their attention to visual stimuli ... Younger infants, therefore, may find even an unattractive face interesting when no better alternative is available (p. 366).

Thornhill & Gangestad (1999) collected studies that examined the influence of attractiveness, symmetry and secondary sex characteristics on facial attractiveness. For facial symmetry they again report contradictory findings: symmetry was correlated with attractiveness in some studies, but in others the effects were described as a by-product of the visual system, which perceives symmetry more readily. For averageness the authors report similar findings and studies as described in this paper, but they connect it with studies of secondary sex traits, because some features are preferred when they are non-average. For example do women's preferences for males change during their menstrual cycle and also with their intention to engage in short-term vs. long-term relationships. On the other hand highly feminized female features, such as large eyes and small noses, are preferred in female faces.

Rubenstein, Langlois & Roggman (2002) summarize the studies testing both approaches as follows:

The work showing that averaged faces are attractive, together with the work showing that infants form prototypes (averages) of faces, suggest that cognitive averaging may be the proximal ontogenetic mechanism underlying preferences for facial attractiveness. ... Mathematical averageness is a necessary and fundamental characteristic of perceived attractiveness in the human face and the concept of averageness has theoretical roots in both evolutionary and cognitive psychology (p. 27 f.).

e. Portraiture: Representation of faces in art

When it comes to art, Ramachandran & Hirstein (1999) state that "artists either consciously or unconsciously deploy certain rules or principles ... to titillate the visual areas of the brain" (p. 17). So art shouldn't just represent reality but enhance it to elicit a pleasing feeling or even an aesthetic experience. Following

these assumptions we would expect that when artist paint a portrait they not only create a realistic representation of the original face, but use special principles to make the face look more beautiful and pleasing to the perceiver.

Hayes & Milne (2011) define the aim of portraiture “to produce a life-like representation of an individual’s unique facial features” (p.149). But there are some aspects that influence the final portrait, most of all perceptual abilities of the artist, but also the fact that the face of a living person has to be translated into a 2D portrait. So the fact that the facial shapes of the sitter are manipulated in a certain manner are “unintended side-effects of the processes involved in visual perception” (p. 151).

In their study the authors wanted to find out how artists change facial features or the shapes of a sitter’s face during the process of creating a portrait. For this purpose they compared three three different methods of measuring the face:

- Visual assessment (groups of volunteers rated both, photographs and portraits, for head pose, likeness of portrait and the accuracy of depicting facial features)
- Anthropometric measures (works with facial landmarks and recording of proportional indices)
- Geometric morphometric analysis (is more complex than anthropometric measures and includes inter-landmark distances and facial angles)

When analyzing the three different methods of measurements, the authors came to the following conclusions:

The anthropometric measures discriminated between the portraits and the photographs in the depiction of head canting and turning, but were less successful in assessing the extent of head pitching. Geometric morphometric analysis was better able to deal with the complex changes to facial shape occurring with head pitch; however, both the anthropometric measures and geometric morphometric analyses agreed with averaged visual assessments. (p. 161)

So the sitters faces were depicted quite accurately in the portraits, but because of the fact that all three measurements underestimated the extent of the head

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pitching, “it can be inferred that the artist tend to see the sitter’s pose as being more upright” (p. 162).

Further the analyzation of the visual assessments showed, that the viewers rated the portraits as having too small and too close set eyes, the noses were judged as too long and narrow and placed too close to the mouth and the mouth was described as too wide and located too close to the chin.

The authors couldn’t find a relation between the likeness judgments and the portraits accuracy, even though there was a trend, that portraits with higher ratings of accuracy were judged also with a better likeness, but no significant effects could be found.

A study that examined what contributes to the ability of accurately depict a realistic scene in an artwork was conducted by Kozbelt, Seidel, ElBassiouny, Mark & Owen (2010). They summarize two approaches that try to explain artists’ advantages in realistic drawing over non-artists:

- Bottom-up approach: artists have a superior visual perception over non-artists and therefore can overcome perceptual biases, which leads to a more accurate representation of the scene or object they are drawing.
- Top-down or knowledge-driven approach: artists have a bigger knowledge of the structure of certain objects and therefore a better understanding of the composition of a scene or an object. This advantage in knowledge results in a more accurate depiction of the object or scene.

In their experiments they compared artists’ and non-artists’ ability in depicting faces with a given number of small segments of tape. By limiting the amount of lines (in their case the number of tape segments provided) each participant can use, they “expect that if artists are superior at making wise representational decisions, then their drawings will be judged as more accurate than those of nonartists” (p. 95).

The results showed, that artists’ drawings were rated more accurate, indicating that artists are superior in selecting important features. Another interesting finding was, that artists depicted more of the facial features, whereas non-artists focused more on the outlines and contours of the face.

In other words, artists tended to build drawings from inside out, whereas nonartists tended to build them from outside in. This pattern resulted in artists capturing the signature features necessary to recognize the face, whereas nonartists produced more generic depictions (p. 99).

Another aspect that influences the accuracy of a depiction of a natural scene or an object in an artwork is the fact, that “the possible range of luminances is much smaller for paintings than it is for natural scenes” (Graham & Field 2007, p. 151). Because of the limitations of paint, artists have to apply special processes to make a natural scene look realistic on canvas because otherwise the artwork would appear very dark. Graham & Field (2007) call this process “a type of nonlinear luminance control” (p. 157).

In a recent study about artistic representations of faces, Graham & Meng (2011) found out, that participants can discriminate faces from non-face stimuli in paintings and natural images, even for very short presentation times (12ms). Even manipulations of the stimuli, such as contrast negation and up-down inversion had only little effect on the discrimination performance of the participants. These two forms of manipulation alter the global intensity distribution, and because of the minimal effects to the performance, the authors conclude that this sort of information is not crucial for the face detection.

To get an idea how these manipulations alter the looks of the original images, the stimuli that were used in the experiment are shown in Figure 2.

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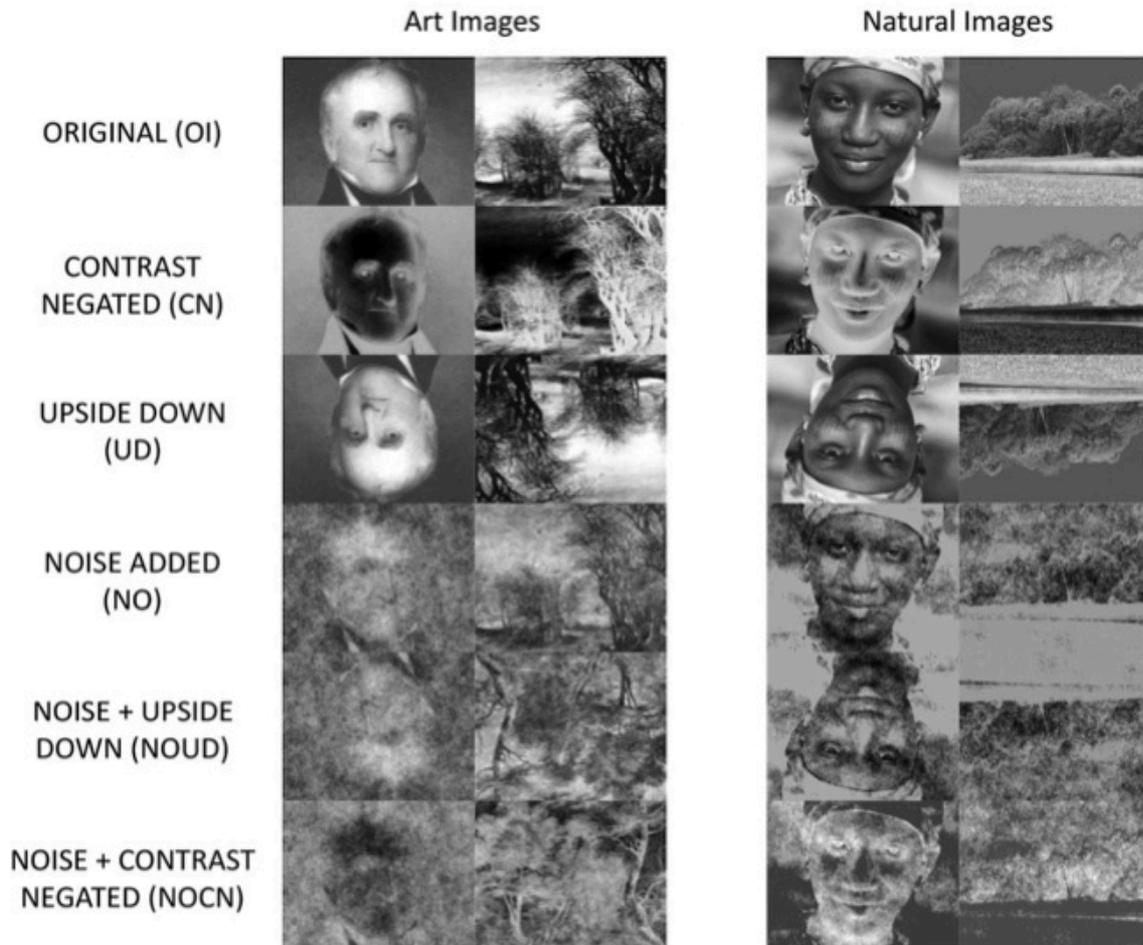


Figure 2 Original and manipulated images used in the study of Graham & Meng 2011 (p. 3).

On the other hand when noise was added to the images, global and local intensity distributions are altered, which resulted in a significant lower discrimination performance for art images, but not for natural images. So artists are able to depict a face in their artworks in a way, that the human brain can easily or similarly process it as if it was a real face.

In other words, a painting can perhaps be seen as a natural scene that has been in a sense “optimized” for the *human* visual system but which yet retains statistical regularities to which *mammalian* visual coding is efficiently adapted. ... the idea that efficient representations of key facial features – and not necessarily representations of global form or global statistics – are the most critical features for rapid face detection in art (p. 7).

Another study that was concerned with face recognition and also attractiveness ratings was conducted by Olson & Marshuetz (2005). They examined how fast

facial attractiveness can be perceived and found similar effects as Grahm & Meng (2011).

Even at very low viewing time of 13ms their participants gave very accurate responses to the level of the attractiveness of the faces, although they reported not to have seen the face properly.

These studies lead us back to the topic of face-perception as a research field of visual perception. Humans are very accurate in recognizing faces, even at a very low viewing time, but moreover they are also very accurate in judging the attractiveness of faces, even if the participants are not conscious of the attractiveness of the face.

These findings may be an argument for the assumption that faces are special to our visual-perception system.

EMPIRICAL PART

3. Intention of the Study

This study is concerned with the question, how representations of faces in art are related to natural faces and on how artists create their portraits.

There are two possibilities to depict a face in an artwork: either the artist relies on the natural features of the face and tries to give a very realistic representation, or he uses artistic techniques (e.g. golden-ratios) to make the face look more attractive.

When following the description of Ramachandran & Hirstein (1999) we would assume that artists try to enhance the attractiveness of a face, because the aim of art is to elicit an aesthetic feeling and not merely to represent reality.

To gain insight in the composition and the aesthetic judgments of both representation forms of faces, photographs of natural faces and portraits are used in this study. Based on the former studies about facial attractiveness discussed above and the known influence of averageness on facial attractiveness ratings, for both types of faces composite faces were created by using morphing software. This made it possible to compare the originals to the averaged faces and also photographs of natural faces to artistic portraits.

All former studies on how morphing affects attractiveness ratings have been conducted with photographs of natural faces, this study uses portraits to find out how averaging portraits influences attractiveness. By using this stimulus material we can not only see if these two different representation forms of faces underlie the same regularities, but also address the question how artist depict faces in their portraits.

If it is true, that artist use special principles that make the face look more attractive, we would expect that averaging has no great influence on the attractiveness rating. This assumption can be derived from the findings of DeBruine et al. (2007), who state that attractiveness can be seen as a continuum and it is not possible to increase the attractiveness of a face indefinitely.

If the portraits already show a face, that has a very high value on the attractiveness continuum, then averaging cannot increase this value very much. So the attractiveness ratings of the original portraits should be close to the attractiveness ratings of the composite portraits, if it is true that artists make the faces in their portraits look more attractive than natural faces.

If artist on the other hand paint very realistic depictions of faces, then we would expect, that averaging should have the same influence on attractiveness ratings of portraits as it has on photographs. So the attractiveness ratings for the composite portraits should be higher as for the original portraits, and further the attractiveness ratings should also increase with the number of faces included in the composite portrait.

a. Hypotheses

On basis of the discussed literature and the intention of the study, the following two hypotheses have been deduced:

- Averaged portraits are perceived as more attractive as the original portraits
- The attractiveness of averaged portraits increases as the number of portraits used to create these averaged portraits, increases.

These hypotheses are tested in two experiments, one that only used the original and morphed portraits and a second one that compared the averaged photographs of natural faces to the averaged portraits.

4. Materials and Methods

a. Stimuli

16 images of frontal portraits of female faces and 16 photographs of natural female faces were used for the following experiments. The software MorphMan v.4 (© 1994 - 2010, STOIK Imaging) was used to create average faces, by combining two, four, eight and sixteen original faces.

Each original image was marked with 83 reference points (Figure 3) to define relevant features for the averaging process (e.g. the outline of the face, pupils, tip of the nose). Only the main features of the face were marked, excluding the ears, hair and other surroundings.

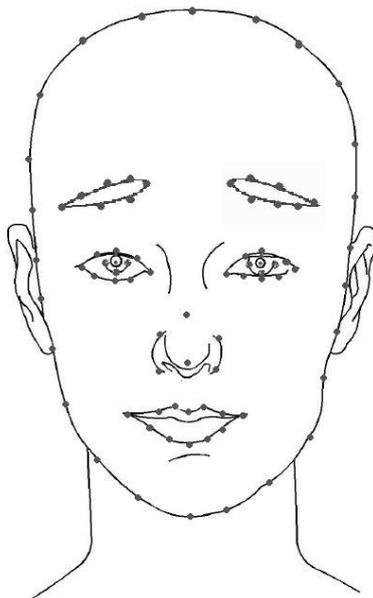


Figure 3 Draft of a face with 83 reference points

- The final set of faces consisted of 31 portraits and 31 photographs. Each category contained 16 original faces, 8 two-face-morphs, 4 four-face-morphs, 2 eight-face-morphs and 1 sixteen-face-morph.

All images were approximately the same size (300x400 pixels) and in colour.

The original images of the portraits were collected from art books and differed in artistic style and period. The detailed list of all portraits

used can be found in the appendix.

The photographs of natural faces were provided by Kang Lee, and were collected from female American college students.

To eliminate most of the surroundings and allow the participants to focus on the presented face, an oval cut-out which included only the face was made for each portrait and photograph. These oval images were used in the second experiment

where the portraits were compared to the photographs. These images were used in the second experiment to reduce the differences between the two representation forms and make sure that the participants focus on the faces when making their decision.

There are several reasons why only female faces were used in this study. First we wanted to assure that the effects can be ascribed to the averageness of the faces and not to the gender, because there may be differences in judgments of same-sex faces vs. opposite-sex faces. Most of the previous studies also used female faces so the results can be compared more easily. Finally because attractiveness in females is more valued in society, there is more agreement about the attractiveness of females than for males (Langlois et al., 2000).

b. Procedure

The study was conducted at the computer lab at the University of Vienna and the code for the experiments was written in MATLAB (© 1994-2012 The MathWorks, Inc.).

Two images were presented at a time in the center of the screen on black background. The brand of the screen used was iiyama ProLite B19065 with a resolution of 1280 x 1024 pixels.

For Experiment 1 only the 31 portraits were used which resulted in 465 pairs of images. The order in which the pairs were presented and the placement of each image (either on the right or the left side) was randomized for each participant.

For Experiment 2 only the averaged portraits and the averaged photographs were used. Each pair consisted of one portrait and one photograph, which resulted in 225 pairs. Again the order in which the pairs were presented and the placement of each image was randomized for each participant.

The comparison of the averaged portraits to the averaged photographs was at first tested with the original images in color and a second time with grayscale images.

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These grey-scale images were created using the SHINE-Toolbox from MATLAB, which normalizes the contrast and luminance of the images. After this procedure all averaged portraits and photographs had the same mean in luminance and contrast.

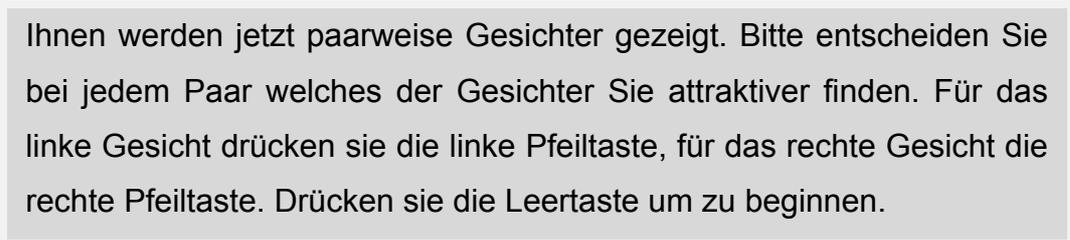
Participants were recruited through an online system at the University of Vienna and received course credits for participating. Each participant had normal or corrected-to-normal vision and signed a consent form.

The participants received a short instruction in German (Figure 4), which told them, that they are going to see pairs of faces and that they have to decide, which one they find more attractive. They should give their answer by pressing the corresponding key on the keyboard: the left-arrow key for the left face, the right arrow key for the right face. The participants started the experiment by pressing the space bar.

The first two images were presented and participants had to choose which one they find more attractive by pressing the corresponding key on the keyboard (left or right arrow). After their decision the next pair of images was presented and so on.

The distance from the participants to the screen was approximately 0.5 meters.

Participants were given as much time as they needed for each judgment.



Ihnen werden jetzt paarweise Gesichter gezeigt. Bitte entscheiden Sie bei jedem Paar welches der Gesichter Sie attraktiver finden. Für das linke Gesicht drücken sie die linke Pfeiltaste, für das rechte Gesicht die rechte Pfeiltaste. Drücken sie die Leertaste um zu beginnen.

Figure 4 Instruction presented to the participants.

5. Results

a. Experiment 1

As described above, this experiment should test the hypothesis that morphed portraits are judged more attractive as the original portraits and that the attractiveness increases as the number of portraits included in the composite image increases.

In this experiment all 31 portraits were used, originals and averaged ones.

Eighteen female students at the University of Vienna participated in this study (Age: $M = 22,1$; $SD = 3,2$) and rated all 465 pairs of the 31 portraits.

Recorded data was the preference (which image the participant chose) and the reaction time until a decision was made after the two images appeared on the screen.

The responses were combined across all participants and the preferences for each portrait were summed across the participants. Using this procedure resulted in one preference score for each portrait which could range between 0 (never preferred) and 540 (preferred every time it was presented by all the participants). The summed preferences are shown in Figure 5.

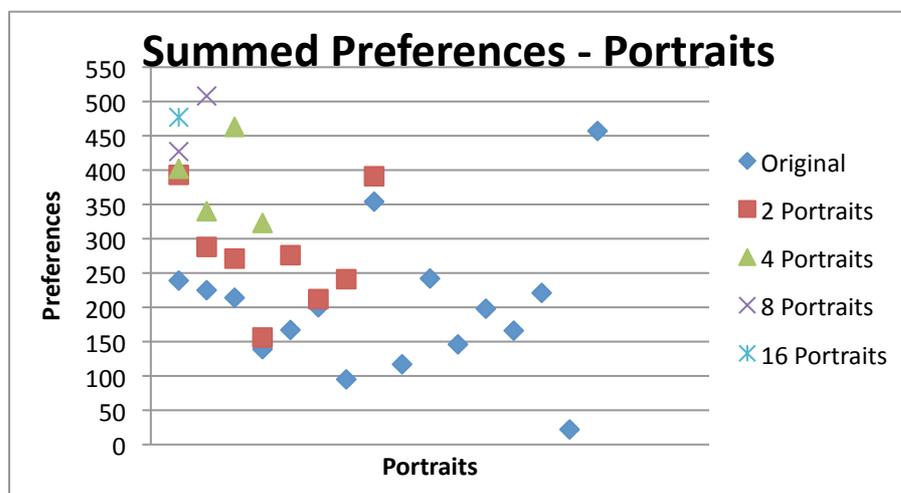


Figure 5 Summed preferences for portraits (N = 18)

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As can be seen, the higher morphed portraits (8 Portraits and 16 Portraits) have very high preferences. The highest preference score had one of the 8-Portraits-Morph (508), indicating that this portrait was preferred nearly every time it was presented. There are two original portraits, that also have a very high preference (354 and 457), and one original portrait with a very low preference (22).

To get a better idea of the differences between the groups of portraits, the mean preferences for the originals, 2 Portraits, 4 Portraits, 8 Portraits and 16 Portraits were calculated.

Figure 6 shows these mean preferences summed over all eighteen participants, the mean preferences and standard deviations are summarized in Table 1.

Number of Portraits	M	SD
Original	200,125	25,232
2 Portraits	278,5	28,895
4 Portraits	382	31,893
8 Portraits	467,5	40,5
16 Portraits	477	0

Table 1 Mean preferences of portraits (N = 18).

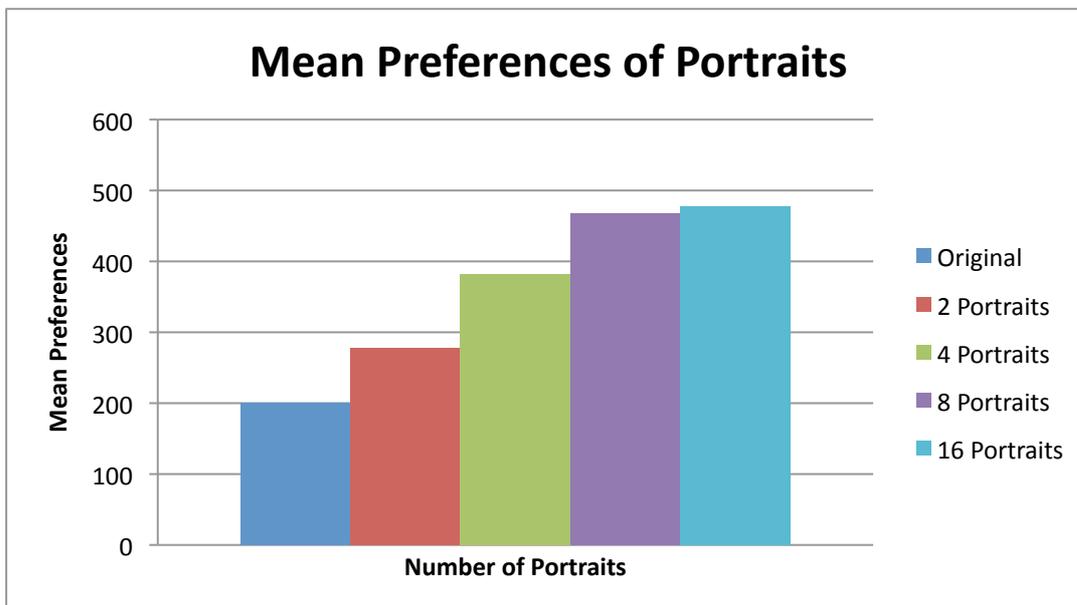


Figure 6 Mean preferences of portraits (N = 18)

The data shows that the preferences increase as the number of faces used in the portraits increases. Because the participants were asked to choose the face they

find more attractive, the preferences can be interpreted to represent the attractiveness of a face. These results support the assumptions that composite portraits are judged more attractive and that the attractiveness increases as the number of faces included in the composite face increases.

T-Tests were conducted to test if the differences between the mean preferences are significant. Analyses revealed that the mean preference of the original portraits differed significantly from the mean preferences of 4, 8 and 16 portraits: originals vs. 4 Portraits $t = .003 < .05$; originals vs. 8 Portraits $t = .002 < .05$; originals vs. 16 Portraits $t = .018 < .05$ ($N = 18$).

Also a Spearman-Correlation between the number of portraits and the mean preferences was conducted. The linear fit is shown in Figure 7.

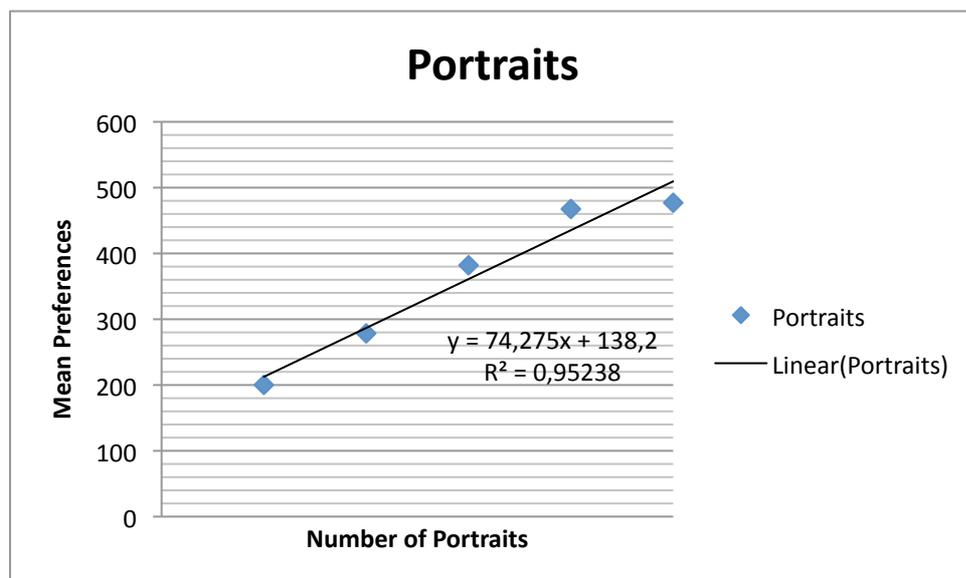


Figure 7 Linear correlation between number of portraits and preference ($r = .705 < .001$ $N = 18$)

There is a significant linear correlation between the number of portraits and the preference $r = .705 < .001$ ($N = 18$). The linear model shows, that 95.24% of the variance of the preferences can be explained by the number of portraits included in the composite face. Again these results confirm the assumption that the attractiveness of the portraits increases as the number of faces included in the image increases.

b. Experiment 2.1

This experiment compared the averaged portraits to the averaged photographs. If the presumption, that average faces are preferred over the original faces is true, there should be the same linear trend as in experiment 1 for both types of faces. Furthermore the differences between portraits and photographs should decrease, as the number of faces in the composite pictures increases.

Twelve students (9 female, 3 male) at the University of Vienna participated in this experiment (Age: M = 22,8; SD = 3,3) and rated all 225 pairs of the morphed portraits and photographs.

Recorded data was the preference (which image the participant chose) and the reaction time until a decision was made after the two images appeared on the screen.

Again, the preferences were summed over all participants, the results are shown in Figure 8.

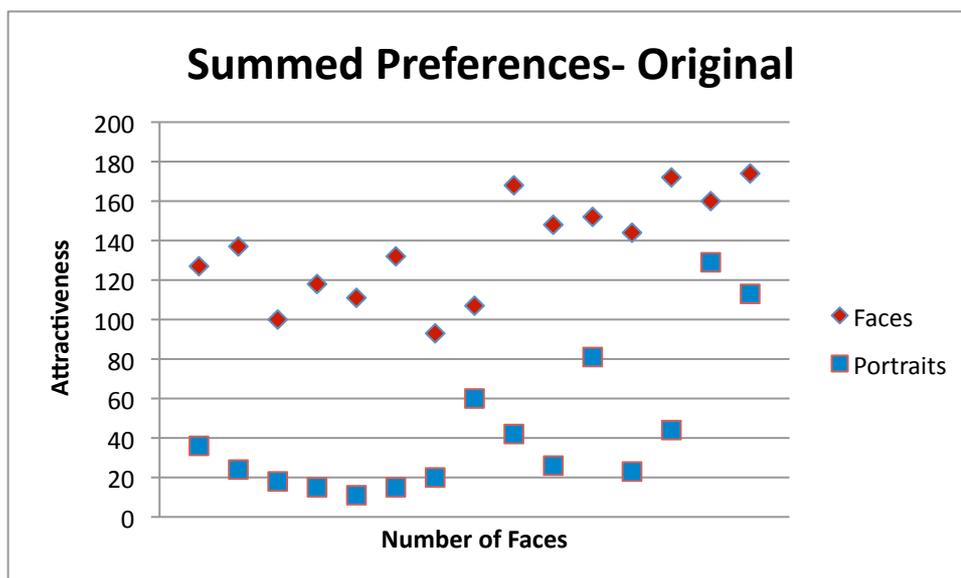


Figure 8 Summed preferences for portraits vs. photographs, presented in color (N = 12).

As can be seen, the photographs have a much higher preference, irrespective of the number of faces included in the composite picture, but the more faces are included in the composite portrait, the closer the preferences get to those of the preferences for the photographs. It seems that the increase of preferences is steeper for the portraits than for the photographs.

To analyze the differences between the groups, again mean preferences were calculated summed over all twelve participants. The results are shown in Figure 9 and the data is reported in Table 2.

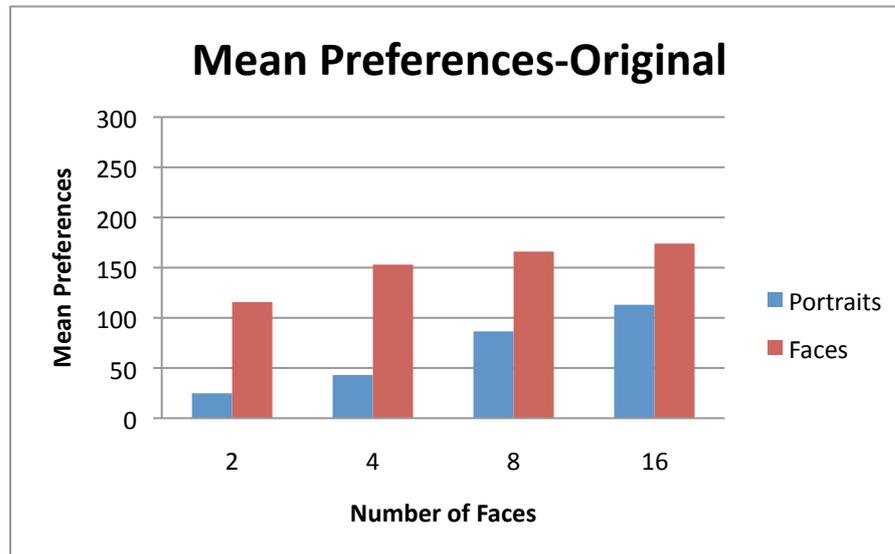


Figure 9 Mean Preferences of the original faces vs. portraits (N = 12).

Original		
Number of Faces	M	SD
2 Faces	115,625	15,638
4 Faces	153	10,52
8 Faces	166	8,485
16 Faces	174	0
2 Portraits	24,875	16,11
4 Portraits	43	26,671
8 Portraits	86,5	60,104
16 Portraits	113	0

Table 2 Mean preferences of the original faces vs. portraits (N = 12).

The data shows that the preferences for faces increase as the number of images included in the composite image increases. This can be shown for portraits as well as for natural faces. So far our data supports previous findings of the preference for averaged faces.

Because of the big differences in the preferences between the two types of images, the experiment was conducted a second time with the same images but with normalized luminance and contrast. As described above, to create these normalized images the SHINE-Toolbox of MATLAB was used. Therefore these normalized images were named SHINE for the analyzation.

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Because the photographs of natural faces were taken in a very standardized surrounding, the range of colors and facial expressions was very low. The portraits in contrast, had a very high range in the colors that were used and were not standardized to look very similar. Maybe these differences influenced the preferences when both types of images are compared.

To control for these effects of color and contrast, the experiment was conducted again with normalized images.

c. Experiment 2.2

Twenty-one students (19 female, 2 male) at the University of Vienna participated in this study (Age: $M = 22,2$; $SD = 4,9$) and rated all 225 pairs of the normalized morphed portraits and photographs.

Recorded data was the preference (which image the participant chose) and the reaction time until a decision was made after the two images appeared on the screen.

The preferences for each image were again summed over all 21 participants. The results are shown in Figure 10.

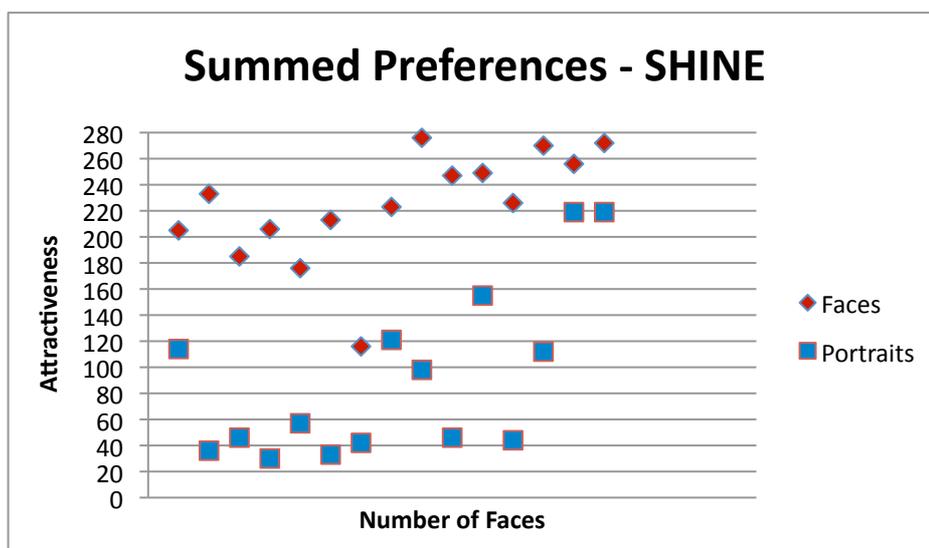


Figure 10 Summed preferences for normalized averaged portraits and faces (N = 21).

The differences between the photographs and the portraits do decrease a little bit, but still the photographs are preferred over the portraits nearly all the time.

Figure 11 shows the preferences of the normalized images summed over all 21 participants and the mean preferences and standard deviations are summarized in Table 3.

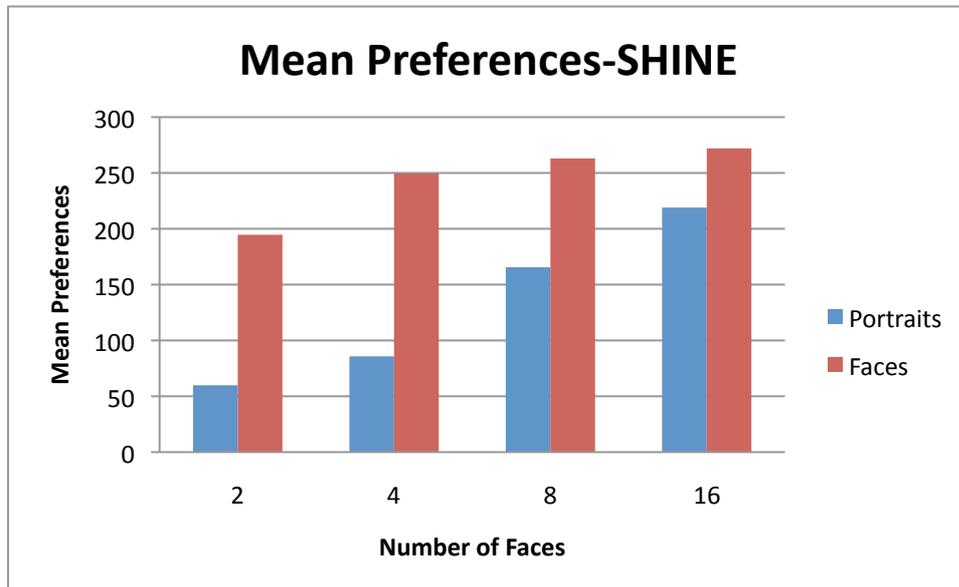


Figure 11 Mean preferences of the normalized faces vs. portraits (N = 21).

Shine		
Number of Faces	M	SD
2 Faces	194,625	36,789
4 Faces	249,5	20,502
8 Faces	263	9,9
16 Faces	272	0
2 Portraits	59,875	36,588
4 Portraits	85,75	52,5
8 Portraits	165,5	75,66
16 Portraits	219	0

Table 3 Mean preferences of the normalized faces vs. portraits (N = 21).

Again the data shows that the preferences for faces increase as the number of images included in the composite image increases. This can be shown for portraits as well as for natural faces.

To proof if the use of the SHINE-Toolbox really had affected the preferences of the images, the mean preferences of the original images were compared to the mean preferences of the normalized images. Because of the different number of participants in both experiments, both data sets were standardized by dividing

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each mean by the number of participants, to allow a comparison of the two data sets.

The change in preferences between the original images (Original) and the normalized images (SHINE) is shown in Figures 12 and 13.

There were no significant changes, neither for the photographs, nor for the portraits. The only trend that could be observed was that the preferences for the photographs decreased a little bit, while the preferences for the portraits increased a little after the use of the SHINE-Toolbox. This effect is mainly what we hoped to achieve, because the two types of images assimilate to each other.

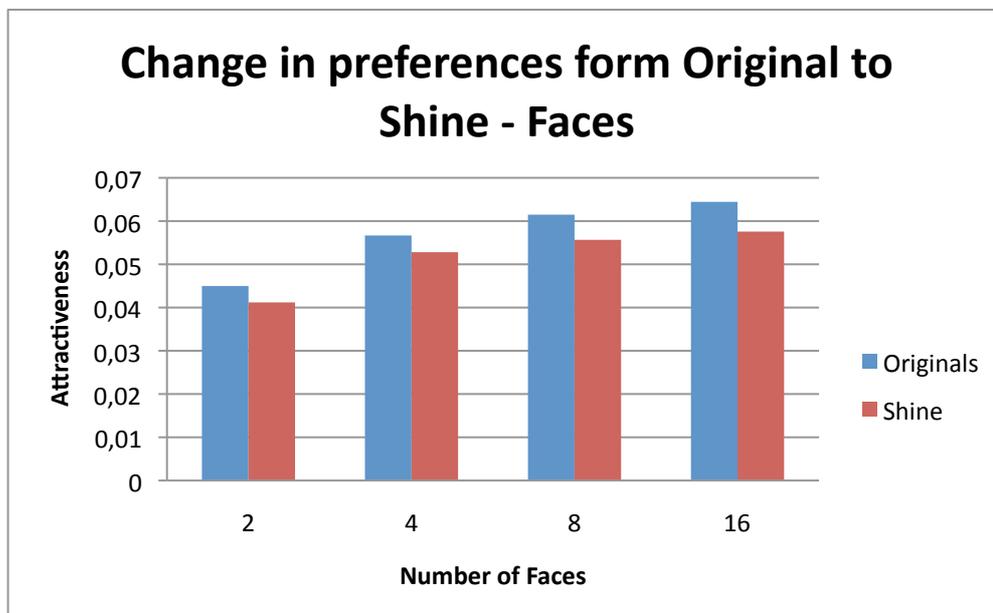


Figure 12 Change in preferences of photographs original vs. normalized

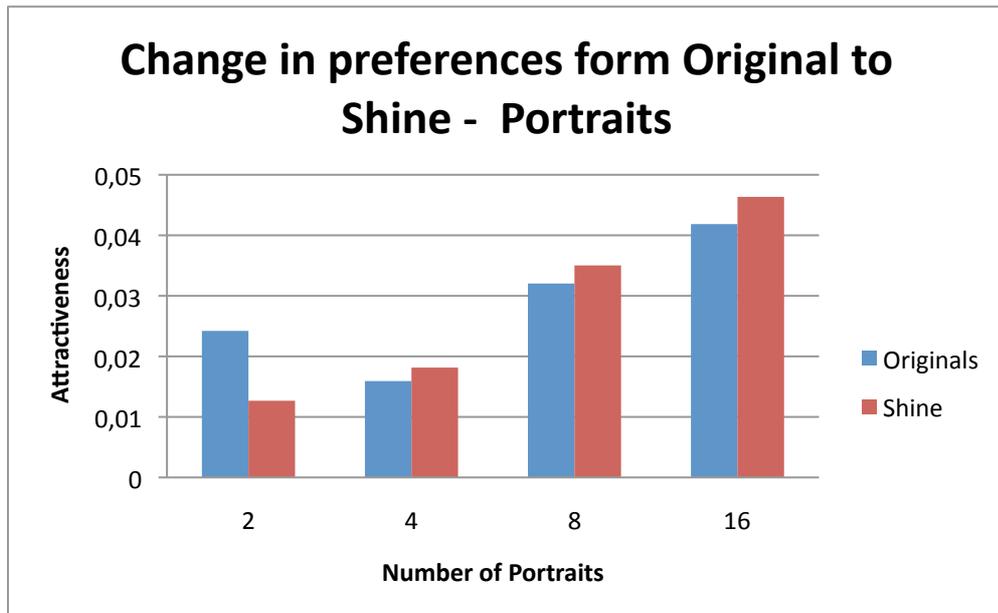


Figure 13 Change in preferences of portraits original vs. normalized

Again, because of the linear increase of the preferences as the number of faces included in the images increased, a Spearman-Correlation between the number of portraits and the mean preferences was conducted. The linear fit for is shown in Figure 14.

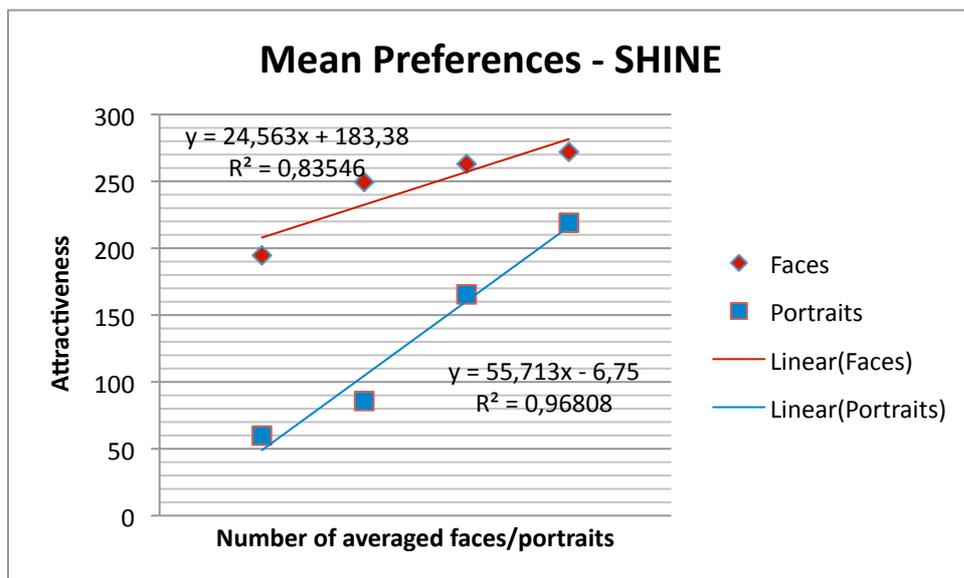


Figure 14 Linear correlation between number of portraits and preference ($r = .604 < .005$) and number of photographs and preferences ($r = .847 < .001$) (N = 21)

There is a significant linear correlation between the number of portraits and the preference $r = .604 < .005$ (N = 21). The linear model shows, that 96.81% of the

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variance of the preferences can be explained by the number of portraits included in the composite portrait.

There is a significant linear correlation between the number of photographs and the preference $r = .847 < .001$ ($N = 21$). The linear model shows, that 83.55% of the variance of the preferences can be explained by the number of photographs included in the composite face.

6. Discussion

To summarize the findings, it can be said, that portraits show the same effects as photographs of natural faces when morphing techniques are applied to the images. For both types of images averaging had an effect on the attractiveness ratings: average faces are preferred over original faces, and the preference increases as the number of faces included in the composite face increases. This effect can be observed for photographs as well as for portraits.

So the two hypotheses that were stated at the beginning of the study can be confirmed:

- Averaged portraits are perceived as more attractive as the original portraits
- The attractiveness of averaged portraits increases as the number of portraits used to create these averaged portraits, increases.

The second question of the study was, if artists rely on the natural compositions of facial features when they create a portrait, or if they use special artistic principles to increase the attractiveness of their portraits. According to the results of this study it can be concluded that artist do rely on the natural compositions of facial features and create very realistic depictions of faces.

This can be derived from the fact that portraits show the same effects of morphing as photographs of natural faces do. This indicates that the facial features share similar characteristics. If artists used some artistic techniques to make their portraits look more attractive, the effects of averaging should not be true for artistic representations of faces. According to DeBruine et al. (2007), attractiveness can be seen as a value on a continuum and therefore it is not possible to make an attractive face more attractive.

On the other hand, when portraits are compared to photographs of natural faces, the natural faces have much higher preferences than the portraits. But never the less, the effects of averaging can still be observed for both types of images.

One possible explanation for the higher preferences of the natural faces can be made according to the cognitive psychological approach. This approach describes the preference for average faces as a result of forming concepts and

mental prototypes. Because our mental prototype of a face is created by all the faces we perceive in our everyday lives, the photographs of natural faces resemble this prototype more than the painted portraits. Also our experience with photographed faces is much higher than the experience with portraits. We see photographs in magazines, newspapers, online and many other media, whereas painted portraits are mainly associated with art and museums. Photographed faces are therefore more familiar to us than painted portraits.

In a deeper analysis of the stimuli used in this experiment, Graham, Pallett, Karesch, Meng & Leder (2012) found another possible explanation for the higher preferences of photographs.

When measuring the width and height ratios of portraits according to the procedure from Pallett, Link & Lee (2010), it could be shown, that the average ratios for portraits were significantly different from the average ratios for natural faces.

The average length-ratio of the portraits was .37, SD = .02, the average width-ratio was .49, SD = .03. The average length-ratio of natural faces was .36, SD = .017, the average width-ratio was .046, SD = .02. These ratios differ significantly $t(65) = 3.34$, $p < .001$ for the length-ratio and $t(65) = 4.20$, $p < .001$ for the width-ratio. So natural faces and portraits differ in their structural properties and therefore the average portrait differs significantly from the average natural face.

This finding could explain the big differences in the preferences for portraits and photographs: for both representation forms of faces the more average face is preferred, which is in line with the results of the experiments described above. But because the averages differ significantly, the preferences also differ. More than this, the findings also support the conclusion that artists don't use special principles or artistic techniques to make their portraits look more attractive. They don't apply the most attractive ratios of natural faces to their portraits.

So portraits and natural faces share the same important facial features and structures, the only difference that could be observed through the data collected in the studies were the different width- and length-ratios.

An interesting finding of the comparisons of the width- and height-ratios revealed, that the average length ratio of the portraits did not differ significantly from the

classic golden length ratio, $t(29) = -1.93$, $p = .065$. The average width ratio of the portraits however differed significantly from the golden width ratio, $t(26) = 19.31$, $p < .001$.

In the classic golden ratio, the width- and length-ratio is the same: .38. As stated above, the average length-ratio of the portraits in this study was .37, the average width-ratio was .49.

So artists don't apply the most attractive ratios to their portraits to enhance the attractiveness of their images. They don't apply the classic "golden ratios", only the length-ratio is the same. And they don't apply the most attractive ratios of natural faces. These findings support the conclusion that artists don't enhance the attractiveness of their portraits, but never the less there are some differences between the two representation forms of faces.

Using the assumption, that the perception of the artist influences the composition of the image can serve as an explanation for the observed differences.

Previous studies could show that observers overestimate the eye-mouth distance of faces (Hayes & Milne, 2011). When artists base their portraits on their perception of the sitters face, this overestimation is also produced in the portraits. This could be a possible explanation for the structural differences between the photographs and the portraits in this study. Because of this perception bias, the width- and length ratios of photographs and portraits differ significantly.

It could also be possible that there are two different approaches to beauty: maybe beauty in a biological way, including attractiveness, is based on other assumptions or aspects as beauty in an artistic way. Maybe the artists' intention is not mainly to paint a copy of a beautiful or an attractive face, but to create a piece of art that can be described and analyzed on aesthetic principles.

The results of the study could in a way be interpreted as a comparison of these two aesthetics and when participants have to choose, the biological cues seem to be more important than the cognitive cues when deciding on the attractiveness of faces. This is why the natural faces are preferred over the artistic representations of faces in art.

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The portraits used in this study were collected from different artists and represented different artistic styles to make sure the results are not limited to one specific artistic period or style.

When looking at the summed preferences for the portraits of experiment 1 (Figure 5) it can be seen, that the original portraits have a very high range of preferences (22 to 457). These differences could be ascribed to the artistic style, because the portrait with highest preference score is the one that shows a very realistic depiction of a face. But when looking at the summed preferences for the averaged portraits, the differences get smaller, indicating that morphing portraits of different artistic style can decrease the influence that style has on the attractiveness ratings.

Of course there are some limitations of the study.

One is the small sample size in each experiment, but never the less, some significant results could be reported. Further the sample only consisted of psychology students, so future studies should include more participants, with a broader range of social economic variables.

The second limitation concerns the lack of male participants, which is why no conclusions about gender effects can be derived from the results. It could be possible that male participants judge portraits of female faces different from female participants. This question could also be addressed by future studies.

Another aspect that would be interesting to examine in future studies is the difference between artists and non-artist or experts and non-experts. Maybe the judgments of artist or experts differ in some aspects from the judgments of non-artists. It could be possible that people with a higher experience in art use special references when judging the attractiveness of artistic representations of faces.

When trying to explain the results on the basis of the model of Leder et al. (2004) the focus of this study lies on the stage of *implicit classification*. By conducting the study again with artists vs. nonartists as participants, and maybe also adding a questionnaire about the reasons why they preferred one face over the other, the interpretations can be broadened to the stage of *explicit classification*, giving

insight in the subjective variables that influence the attractiveness ratings of portraits.

Another possibility to get more detailed information and gain deeper insight about the differences between photographs and artistic representations of faces would be to use the same faces as stimuli. By making photographs of natural faces and letting artists draw the same faces in their own style, the preferences of the two types of images can be compared better and the differences can be ascribed to the different representation forms. This would also allow a more reliable comparison of the width- and height ratios of both depictions of faces.

7. Conclusion

To summarize the most important findings of the study, it can be said, that portraits and photographs of natural faces share similar characteristics in depicting facial features. Therefore the effects that averaging has on both of them are the same: averaged faces are perceived as more attractive and the attractiveness increases as the number of faces included in the composite face increases. This is true for photographs as well as for portraits.

But the two depiction forms of faces differ in their structural properties, which can be seen in different width- and height-ratios of photographs and portraits. In sum these finding indicate that artist don't apply special techniques when painting portraits to make them look more attractive. Maybe artists use special processes to make a face look realistic on canvas, similar to the findings of Graham & Field (2007), which could account for the observed differences between photographs and portraits.

Never the less future studies are necessary to interpret the differences between photographs of natural faces and portraits more detailed. The most important aspects that should be added would be the comparison between artists and nonartists as participants and the use of the same faces as photographs and portraits as stimuli for the experiments.

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9. Appendix

c. German Summary

Ursprünglich wollte Galton (1879) durch das Zusammenfügen einzelner Fotos von Kriminellen zu einem neuen Gesicht *das* kriminelle Gesicht erzeugen. Doch er war vom Ergebniss überrascht, dass er nicht nur den Durchschnitt eines bestimmten Typs von Gesicht erhielt sondern, dass das neue Gesicht deutlich attraktiver war als die einzelnen Bilder.

Weitere Studien (Langlois & Roggman, 1990; Langlois, Roggman & Musselman, 1994) konnten diese Ergebnisse bestätigen und sogar um einen Aspekt erweitern: die Attraktivität des Durchschnittsgesichts steigt an, je mehr einzelne Bilder darin enthalten sind.

Kritiker jedoch meinten, dass die erhöhte Attraktivität nicht aufgrund der Nähe zum mathematischen Mittelwert zustande kommt, sondern nur ein Nebeneffekt der höheren Symmetrie, Jugendlichkeit und des glätteren Hautbildes ist, welche durch die Technik des Morphens entstehen. Langlois, Roggman & Musselmann (1994) konnten allerdings zeigen, dass weder Jugendlichkeit noch Symmetrie mit Attraktivität korrelieren und fanden weiters keinen Anstieg in den Attraktivitätsbewertungen wenn mehrere Bilder des gleichen Gesichts zu einem Durchschnittsgesicht gemorpht wurden.

Auch kulturübergreifende Studien konnten die Ergebnisse bezüglich Durchschnittlichkeit und Attraktivität bestätigen (Langlois, Ritter, Roggman & Vaughn, 1991; Rubenstein, Langlois & Roggman, 2002).

Zwei Ansätze versuchen die Präferenz für und die höhere Attraktivität von mathematisch gemittelten Gesichtern zu erklären (vgl. Langlois & Roggman, 1990):

- Evolutionspsychologischer Ansatz: Dieser Ansatz geht von der Annahme aus, dass Individuen deren Eigenschaften nahe am Mittelwert einer Population liegen eine geringere Wahrscheinlichkeit haben genetische Mutationen zu tragen und deshalb in der Partnerwahl bevorzugt werden.
- Kognitionspsychologischer Ansatz: Dieser Ansatz basiert auf der Fähigkeit, Prototypen zu abstrahieren. Prototypen enthalten die

durchschnittlichen Eigenschaften aller Objekte einer Kategorie und können durch ihre erhöhte Familiarität leichter wahrgenommen werden. Durchschnittliche Gesichter werden nach diesem Ansatz deshalb bevorzugt, weil sie uns bekannt vorkommen und dem Prototyp der Gesichter entsprechen, die wir abgespeichert haben.

Welcher der beiden Ansätze die bessere oder treffendere Erklärung bietet konnte anhand von Studien nicht eindeutig geklärt werden. Rubenstein, Langlois & Roggman (2002) fassen die Erkenntnisse allerdings zusammen und meinen, dass die höhere Präferenz und Attraktivität von durchschnittlichen Gesichtern wohl ihre Wurzeln in beiden Ansätzen hat.

Bisherige Studien die sich mit dem Thema Attraktivität und Durchschnittlichkeit beschäftigten arbeiteten immer mit Fotos von Gesichtern.

In dieser Studie werden sowohl Fotos von Gesichtern als auch Porträts aus der Kunst verwendet um herauszufinden ob beide Arten der Darstellung von Gesichtern die gleichen Effekte zeigen wenn Morphing-Techniken verwendet werden. Weiters soll die Analyse der Porträts darüber Aufschluss geben, wie Künstler ihre Porträts gestalten. Werden die Gesichter in Porträts durch das Verwenden bestimmter künstlerischer Techniken attraktiver dargestellt als in der Realität oder sind sie realistische Abbilder eines natürlichen Gesichts?

Wenn Künstler bestimmte Techniken anwenden um die Gesichter in ihren Porträts attraktiver darzustellen ist zu erwarten, dass die originalen Porträts bereits eine sehr hohe Attraktivität besitzen und das Morphing hier keinen großen Einfluss auf die Attraktivitätsbewertungen der neu generierten durchschnittlichen Gesichter hat.

Wie DeBruine et al. (2007) in ihrer Studie zusammenfassen ist es nicht möglich die Attraktivität eines Gesichts unendlich zu erhöhen. Sollten also Künstler ihre Porträts attraktiver gestalten ist nicht zu erwarten dass diese die gleichen Effekte nach Anwendung von Morphing-Techniken zeigen wie Fotos in den bisherigen Studien. Sollten Porträts aber tatsächlich realistische Abbildungen von Gesichtern sein, müssten sich die gleichen Effekte wie in den oben angeführten Studien zeigen lassen.

Anhand dieser Überlegungen wurden zwei Hypothesen formuliert:

- Durchschnittliche Porträts die durch das Bearbeiten mit Morphing-Techniken generiert wurden werden attraktiver bewertet als die original Porträts die in diesem neuen Bild enthalten sind.
- Die Attraktivität der durchschnittlichen Porträts steigt an, je mehr original Porträts darin enthalten sind.

Stimulusmaterial waren 16 Fotos weiblicher Gesichter und 16 Porträts weiblicher Gesichter von unterschiedlichen Künstlern aus unterschiedlichen Stilen. In jedem Originalbild wurden 83 Referenzpunkte gesetzt um relevante Stellen für das Morphen zu markieren. Das endgültige Stimulusmaterial bestand aus 31 Porträts und 31 Fotos, jeweils 16 original Bilder, acht Bilder die aus zwei Originalen bestanden, vier Bilder die aus vier Originalen bestanden, zwei Bilder die aus acht Originalen bestanden und je ein Bild, das alle 16 Originale enthielt.

Die beiden Hypothesen wurden anhand von zwei Experimenten geprüft.

Für das erste Experiment wurden nur die 31 Porträts verwendet, woraus 465 Bildpaare entstanden. Für jedes Bildpaar musste die Versuchsperson entscheiden welches der präsentierten Gesichter sie attraktiver fand. An diesem Experiment nahmen 18 weibliche Versuchspersonen teil (Alter: MW = 22.1; SD = 3.2).

Im zweiten Experiment wurden nur die gemorphten Porträts und Fotos verwendet, woraus 225 Bildpaare resultierten, welche aus einem Porträt und einem Foto bestanden. Für jedes Bildpaar musste die Versuchsperson entscheiden welches der präsentierten Gesichter sie attraktiver fand.

Dieses Experiment wurde zwei mal durchgeführt. Einmal mit den Bildern in original Farbe und Kontrast und einmal mit bearbeiteten Bildern in Graustufen und mit standardisiertem Kontrast. Am ersten Durchgang mit den farbigen Bildern nahmen zwölf Versuchspersonen teil (9 Frauen, 3 Männer; Alter: MW = 22.8; SD = 3.3). Die standardisierten Bilder bewerteten 21 Versuchspersonen (19 Frauen, 2 Männer; Alter: MW = 22.2; SD = 4.9).

Die Ergebnisse zeigten, dass Porträts die gleichen Effekte nach Anwendung von Morphing-Techniken aufwiesen wie Fotos: durchschnittliche Porträts hatten höhere Attraktivitätswerte als die original Porträts und die Attraktivität nahm mit

steigender Anzahl enthaltener Originale zu. Somit konnten die bisherigen Forschungsergebnisse, die anhand von Studien mit Fotos gewonnen wurden, bestätigt werden.

Allerdings zeigte sich auch, dass Fotos eine deutlich höhere Präferenz hatten als Porträts, unabhängig davon ob es sich um Originale oder mathematisch gemittelte Bilder handelte. Auch die Durchführung des Experiments mit den Bildern in Graustufen und standardisiertem Kontrast änderte an den unterschiedlichen Präferenzen nichts. Eine mögliche Erklärung hierfür könnte der oben beschriebene kognitionspsychologische Ansatz bieten. Da die Fotos von natürlichen Gesichtern eher unserem mentalen Prototypen eines Gesichts entsprechen als Porträts, werden diese leichter und schneller verarbeitet und erzielen daher höhere Attraktivitätsratings.

Eine genauere Analyse zeigte auch, dass die beiden Darstellungsarten von Gesichtern strukturelle Unterschiede aufweisen, die das Längen- und Weitenverhältnis des Gesichts beeinflussen. Diese Unterschiede kommen möglicherweise dadurch zustande, dass bei der Abbildung des Gesichts in einem 2D Bild bestimmte Transformationen erforderlich sind um das Gesicht realistisch abbilden zu können.

Wie bereits erwähnt kann die Tatsache, dass durchschnittliche Porträts ebenfalls attraktiver bewertet werden als die Originale, als Hinweis dafür gesehen werden, dass Künstler keine speziellen Techniken anwenden um ihre Porträts attraktiver zu gestalten. Wenn dies der Fall wäre sollten sich die Längen- und Weitenverhältnisse der Porträts nicht von den durchschnittlichen Verhältnissen der natürlichen Gesichtern unterscheiden, da diese ja als besonders attraktiv gelten und somit von den Künstlern kopiert werden müssten um ihre Porträts diesen Attraktivitätsstandards anzupassen.

Allerdings gibt es aufgrund des geringen Stichprobenumfangs auch einige Einschränkungen der Studie. Durch die geringe Anzahl männlicher Teilnehmer konnten keine Rückschlüsse auf Gender-Effekte gemacht werden. Weiters könnten für folgende Studien auch Künstler und Laien als Versuchspersonen verglichen werden, da sich die Wahrnehmung und Einschätzung von Porträt zwischen diesen beiden Gruppen möglicherweise unterscheidet.

Um die strukturellen Unterschiede zwischen den beiden Darstellungsformen von Gesichtern genauer zu interpretieren sind ebenfalls weitere Untersuchungen nötig. Hilfreich wäre es hierzu vielleicht die gleichen Gesichter als Stimulusmaterial zu verwenden, also Fotos und Porträts der gleichen Gesichter anfertigen zu lassen und diese von den Versuchspersonen bewerten zu lassen.

d. List of Portraits

068 François-Hubert_Drouais_rotated_cropped_noear.jpg

François-Hubert Drouais, 1754, "Lady Amelia Darcy, 9th Baroness Conyers",
1754-1784

081 Augustin_Christian_Ritt1_rotated_cropped_hairline_adjusted_s1.jpg

Augustin Christian Ritt, 1798, "Charlotte Yulmana Ritt"

091Pierre_Subleyras_-_Portrait_de_Mme_Subleyras_rotated_cropped.jpg

Pierre Subleyras, 1740, "Portrait supposed Mrs Subleyras"

092 Rembrandt_Harmensz._van_Rijn_080_rotated_cropped.jpg

Rembrandt van Rijn, 1642, Portrait of Agatha Bas

095 self-portrait-frontal_cropped.jpg

Paula Modersohn-Becker, 1897, Self Portrait, Frontal

Elizabeth_I_in_coronation_robcs_cropped.jpg

Unknown Artist, 1600, Elizabeth I in coronation robes

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Marie-Louise -Elisabeth Vigee-Lebrun, 1797, "Countess Golovin", 1797-1800

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Max Beckmann, 1922, "Dr. Heidel"

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Christian Schad, 1926, "Baroness Vera Wassilko"

painting109_cropped_rotated.tif

Gino Severini, 1936, "The Painter's Family"

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Adrien Carpentiers, 1748, Portrait of a Lady Holding a Letter

Vargas1939AnnSheridan_cropped_rotated_englarged.jpg

Alberto Vargas, 1939, "A portrait of Ann Sheridan"

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Edgar Degas, 1858, Die Schwester Marguerite de Gas (Madame Henri Fèvre)

pifr1719_rotated_cropped_hairline_adjusted.jpg

Picabia Francis, 1940, Imperia argentina

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Picabia Francis, 1943, Portrait de une actrice

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Neal Tait, 2001, In the Shadow of

e. Curriculum Vitae

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1993 – 1997: Elementary School, Wilhelm Kreß Platz, 1110 Wien
1997 – 2005: Secondary School, Boerhaavegasse, 1030 Wien
2005 – 2011: Undergraduate studies at University of Vienna,
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2005 to date: Studies at University of Vienna, “Psychologie”

Skills:

Training as Peer-Mediator
Driver’s license
Good knowledg of MS Office Programs (Word, Excel, Power Point)
Adequate knowledge of Italian and French

Job experiences:

October 2006 – May 2008: Bäckerei Ströck, part-time job
Since May 2008: InTime Media Services, subscription agency, part-time
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