Chapter

# Decoding the Signals of Facial Attractiveness: A Communication Theory Perspective

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## Abstract

The human face is an elaborate communication tool that transmits a large variety of signals such as: identity, gender, ethnicity, age, emotional state, health, and more. Of particular importance is the tendency of human observers to infer social traits (e.g., attractiveness, dominance or trustworthiness) rapidly from faces which, in turn, can lead to a specific action from a wide spectrum of possibilities ranging from mating to violent clashes. Among the social trait signals that are transmitted by the face, the attractiveness signal is outstanding in its robustness against manipulation initiated by the transmitter or interference caused by the physical environment's many aspects. Among these aspects are the robustness of attractiveness to manipulations caused by the physical environment (e.g., viewing distance) or manipulations made by the signaler (e.g., facial movements). To understand what makes a face attractive and the unique role that attractiveness plays as a communication signal, this chapter will use the universal framework of communication systems. Every communication system consists of three key elements: a transmitter, a receiver, and a communication channel. All these three components affect the semantic meaning of every message transmitted in the system and thus shape the outcome following the message reception.

**Keywords:** action units, communication theory, facial attractiveness, social camouflage, social traits, spatial frequency



## 1. Introduction

When the Beatles, way back in 1965, sang the following lyrics of their song "I've just seen a face" [1], they summarized, by these naive lines, some of the cognitive processes and social outcomes related to one of the most culturally and socially important parts of the body (second only to the brain)—the face:

> *"I've just seen a face,*
> *I cannot forget the time or place*
> *where we just met.*
> *She's just the girl for me*
> *and I want all the world to see*
> *we have met..."*

Mankind has developed certain skills allowing for fast and reliable processing of facial information. Humans are able to detect faces: that is, the ability to identify and locate all the present faces within the receptive field ("I've just seen a face"). Humans also have the ability to recognize a face: to judge whether a face has been seen before and in case of positive recognition the ability to retrieve semantic data such as name or context of encounter ("I can't forget the time or place..."). People recognize other people by their face and not, for example, by the palm of their hand. The face plays a crucial role in mate quality appraisal ("She's just the girl for me...," asserts Sir Paul McCartney after only seeing her face), and the preference for facial beauty exists from a very young age [2, 3]. A pretty partner is a status symbol [4], that is, a visible indicator of economic or social status ("I want all the world to see we've met...").

Random social encounters can lead to dramatic consequences ranging from trust and romantic relationships to fear and violent clashes. The decision whether to avoid or approach an unknown person therefore involves a quick risk assessment of potential gains and losses. When there is no prior information, such a decision is in many cases based on outward appearance. Humans quickly infer social traits, such as attractiveness, aggressiveness, dominance, and trustworthiness from the physical properties of the bodies and faces of others [5–7]. When it comes to facial appearance, such social inferences can be made after a very short exposure time and with high levels of interpersonal agreement [8–12] consequently affecting social outcomes [13–17]. One of the most studied face-inferred social traits is attractiveness.

The common notion that "Beauty is not judged objectively, but according to the beholder's estimation" dates back at least to the third century BC (Theocritus, The Idyll as cited in [18]). Even Darwin came to the same conclusion and argued that different cultures showed a diversity of preferences for attributes such as skin color, body hair, and body fat (Darwin as cited by [19]).

Despite cross-cultural and cross-gender differences in judgments of facial attractiveness, there is still a high level of agreement not only between individuals within a particular culture but also between individuals from different cultures or different genders [6, 20, 21]. In a comparison between judgments of 17 different social traits, as inferred from faces, facial attractiveness was found to have the highest interrater agreement and reliability level. The evidence for the existence of universal criteria for facial attractiveness raises two questions:

a. What is the functional role of facial attractiveness?

b. What are the facial diagnostic cues that constitute the criteria of attractiveness judgments?

As an answer to the first question, the evolutionary view suggests that attraction and repulsion to certain faces serve as an adaptive function [22]. Throughout evolutionary history, humans have developed preferences to specific phenotypical cues that lead them to choose mates who will provide the best chance of successful reproduction and survival of their own genes. The evolutionary approach has been based on the premise that an attractive face is a biological signal that provides valuable information about the quality of the signaler. Mate quality attributes may include characteristics such as health, fertility, intelligence, and potential for parental care. However, most research has focused on health ([23]; for review, see [24]).

To answer the second question, many studies have used facial image manipulations to test observers' responses. Some of these studies have suggested that there are several facial diagnostic cues that advertise the biological quality of an individual through the medium of the face. These phenotypical cues include: facial symmetry, averageness (i.e., faces that are not too far from the population mathematical

mean of the geometric structure and texture) and sexual dimorphism (i.e., secondary sexual characteristics; see [25] for meta-analysis).

## 2. What makes a face attractive?

Despite a large body of research and findings, the question of what makes a face attractive is not easy to formalize. Among the reasons for that we can include the following nonexclusive list:

a. The complexity of the human face: the human face is a complex object and requires a high-dimensional data structure to represent and analyze it. Even if we want to represent information about a static non-expressive face, such data structure should include information about morphology (i.e., structure) and texture. Over recent decades, there has been a significant progress in the development of computational tools for the analysis and synthesis of faces [26–28].

b. The effect of the external physical environment: the viewing conditions may have a dramatic effect on the way we infer social traits from a face in general. Such physical conditions may include viewing distance, perspective, lighting conditions etc. It is not clear that the same facial determinants of social traits are identical under different viewing conditions.

c. Facial movements: the face is not a rigid object. A large set of groups of muscles (a.k.a. Action Units [29]) can and do change facial appearance. Many of these facial movements convey social signals such as emotional expressions. As a result, facial movements may affect the social inference from the face and even override the social impression of the default neutral and nonexpressive face. Facial movements add another level of complexity to the representation and analysis of faces; however, computational models for analysis and synthesis of facial movements are already in use [30].

Considering the above challenges, this chapter addresses the essence of facial beauty as a multifaceted question. To this end, we will approach the facial beauty signal as a part of a comprehensive communication system that comprises not only the signaling face as a transmitter but also the receiver (i.e., the observer) and the communication channel (i.e., of the external physical environment).

## 3. Attractiveness within the context of communication theory

All communications systems whether they are electronic, biological, or other comprise three fundamental elements:

a. The transmitter: the source that creates, modulates, and transmits the signals, for example a radio station.

b. The receiver: the agent that obtains the signal from the transmitter using a codebook. The codebook is an abstract list of rules that associates a meaning or reaction to specific messages.

c. The communication channel: the physical transmission medium or pathway that conveys the signals from the transmitter to the receiver; for example, a

broadband fiber optic cable. A crucial point is that the communication channel modifies the transmitted signal. As a result, the signal received by the receiver is, in most cases, not identical to the original signal that was sent by the transmitter. Therefore, the physical properties of the channel determine the capability of the receiver to decode the transmitted signal [31]. In the case of social signaling from a face, the communication channel may have a large variety of characteristics: viewing distance, lighting conditions, the face or body's spatial orientation, partial occlusion, etc. The communication channel thus imposes constraints on the available information, changing the receiver's facial inference strategy. This means the question of what makes an attractive face is context dependent where a major factor that affects the attractiveness determinants is the communication channel.

### 3.1 The face as a signal transmitter

The face is a central communication tool in human social interaction. It transmits a large range of signals that convey social information to which the receiver associates meaning about the transmitter. This meaning whether it is reliable or not may include: gender, age, ethnicity, health condition, mood, intention, and competence. Some social impression signals (e.g., those indicating social traits such as dominance, trustworthiness, and attractiveness) are transmitted involuntarily by the default phenotypic morphology and complexion of the face [6]. However, other signals, such as facial expressions of emotion, can be voluntarily deployed strategically to negotiate social situations. Humans, as highly adaptive social beings and in a similar way to other social animals, can camouflage these involuntary morphology-based signals to boost chances of success within their ecological niche. In practice, humans deploy social-camouflage strategies by using dynamic facial signals to camouflage the involuntary social signals transmitted by static facial morphology [5]. In the latter study, using a computer graphics platform and a data-driven technique, facial action units (AUs, i.e., independent facial groups of muscles; [29]) were correlated with the impression of attractiveness to create a dynamic model of facial expression that elicits the impression of attractiveness. **Figure 1** depicts the facial movements that elicit the strongest and weakest intensities of attractiveness and lists the significant AUs that were combined to produce them. The color-coded heat maps show the movement magnitude of the 3-D vertices that make up each dynamic social signal. Using a similar approach, Gill et al. obtained dynamic models of facial movements that modulate the perception of two additional fundamental social traits: trustworthiness and dominance [5]. The latter study also examined the camouflaging capabilities of the modeled dynamic social gestures (i.e., whether the facial movements that are formalized in the models could override the involuntary default social signals transmitted by static facial morphology of the transmitter). The results revealed that attractiveness was the most difficult of these traits to camouflage. Humans are thus condemned to bear the social consequences of the inherited attractiveness of their faces. By contrast, social camouflage of dominance and trustworthiness is probably commonplace in everyday interactions. Casting directors are probably aware of this inequality. An attractive character will require an actor with attractive morphology; however, social camouflage can help an actor fake a dominant or trustworthy character.

### 3.2 Viewing distance as a communication channel

Social encounters may start at varying viewing distances. Based on the available information, individuals decide about their next action—whether to approach or avoid the other person. The face transmits a variety of social signals to receiving

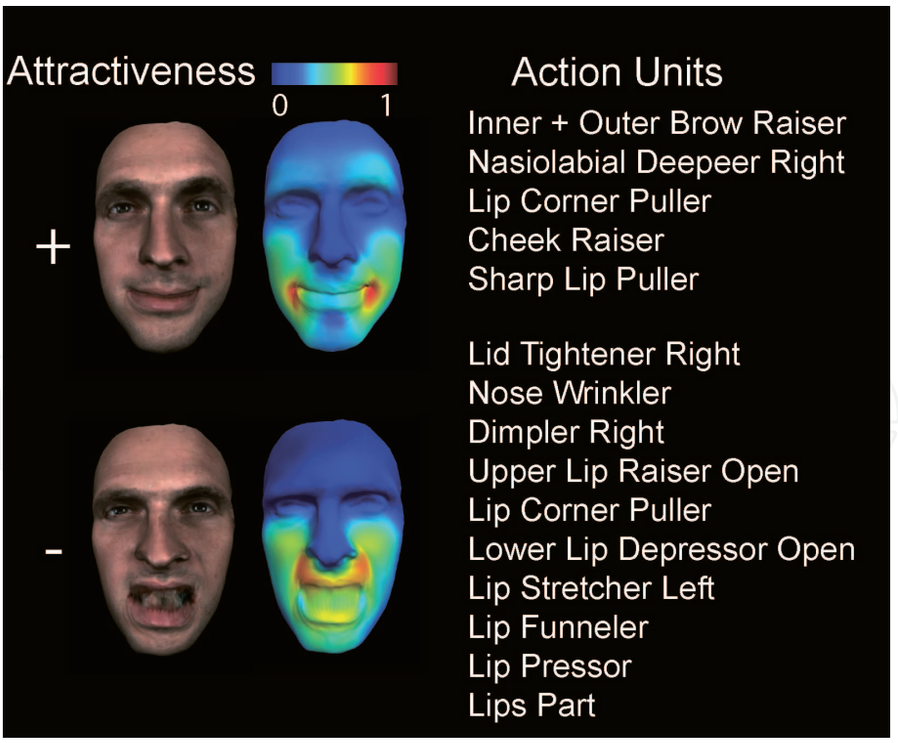


**Figure 1.**
*Social camouflage. The two rows depict the signals of attractiveness with strong (+) and weak (−) intensities. The texture maps at the left illustrate the appearance of attractiveness on a common face. The color-coded heat maps indicate the location of dynamic face regions of the attractiveness signal; red indicates the highest magnitude of vertex movement. The column on the right lists the action units present in the majority of the observers' individual models [5].*

observers across a wide range of viewing distances acting as a communication channel. Evaluating the social and reproductive capacity of others is paramount to negotiating the type of social interaction between individuals and, ultimately, to promoting the survival of the human species. However, social encounters begin at varying viewing distances, which can dramatically change the visual information and level of detail that is available for social judgments.

When a face moves closer to the receiver, its projection on the observing receiver's retina increases in size. As a result, the high spatial frequency information (HSF, representing fine details) projected initially on the retina progressively shifts toward lower spatial frequencies (LSFs, representing coarser scale and global information). Furthermore, new HSF details become progressively available on the retinal projection of the closer face for visual categorization in the receiver. When a face moves away from the receiver, it has the opposite effect: the retinal projection diminishes in size, the retina-based HSFs are no longer detected due to the finite resolution of the retina and the facial information initially represented in retina-based LSFs becomes retina-based HSFs. Combining different messages, transmitted by different spatial frequency bands, in one image is known as a *hybrid image* [32]. An illustrative example is shown in **Figure 2**, in which a hybrid image that combines the LSF of one face (a boy) with the HSF of another face (a girl). The available information of the image changes with viewing distance (or size) and as a result the face is perceived as a boy at a short distance (or in a large image size) and as a girl at a long distance (in a diminished size).

The critical impact of viewing distance, as a communication channel, raises the fundamental question of what specific facial signals communicate attractiveness and whether these signals change across viewing distance. Attractiveness diagnostic cues are found to covary with distance [33].

**Figure 2.**
*Diagnostic cues vary with distance. Left panel: a hybrid image consisting of the low spatial frequencies (LSFs) of a girl and the high spatial frequency (HSF) of a boy. From a short viewing distance, the image is perceived as the face of a boy. From a long viewing distance, the image is perceived as the face of a girl. Right panel: the LSF of the girl's image (upper image) and the HSF of the boy's image (lower image).*

**Figure 3** illustrates how observers use different information from faces (both structure and texture) to assess attractiveness from proximal and distal signals. The diagnostic cues, both structural and textural, are color coded as follows: distal diagnostic cues are in red, proximal diagnostic cues are in green, and cues that are diagnostic in both distal and proximal distances are in yellow. Across all receiver-transmitter gender conditions (e.g., females observing males and females observing females) consistently, the hair has been found to be the prominent distal diagnostic cue. This is not surprising, considering the relatively large projection of the hair on the retina at long viewing distances compared to other facial attributes. Interestingly, among female transmitters, short or pulled-back hair is perceived as a distal signal of unattractiveness. The latter result suggests that masculine attributes in women (i.e., short hair) may distally signal characteristics associated with masculinity. Among male signals, trimmed hair is perceived as a distal signal of unattractiveness. In proximal viewing distance there are more available cues and the influence of the hair as a determinant cue decreases. Among both female and male transmitters, the eye region structure is found as a proximal diagnostic cue (though to different extent across receiver-transmitter's gender conditions and social traits). Moreover, among male transmitters, the glabellar frown lines were found as a proximal cue.

Another interesting question is whether viewing distance induces a natural hierarchy across different social traits in which humans infer some of these traits at longer viewing distances with greater sensitivity than other traits. The communication channel induces a natural hierarchy of decoding success, with attractiveness being the trait inferred from the greatest viewing distances. When comparing four basic social traits (aggressiveness, attractiveness, dominance, and trustworthiness), attractiveness was found to be inferred from the longest viewing distance tested (96 m, [33]).

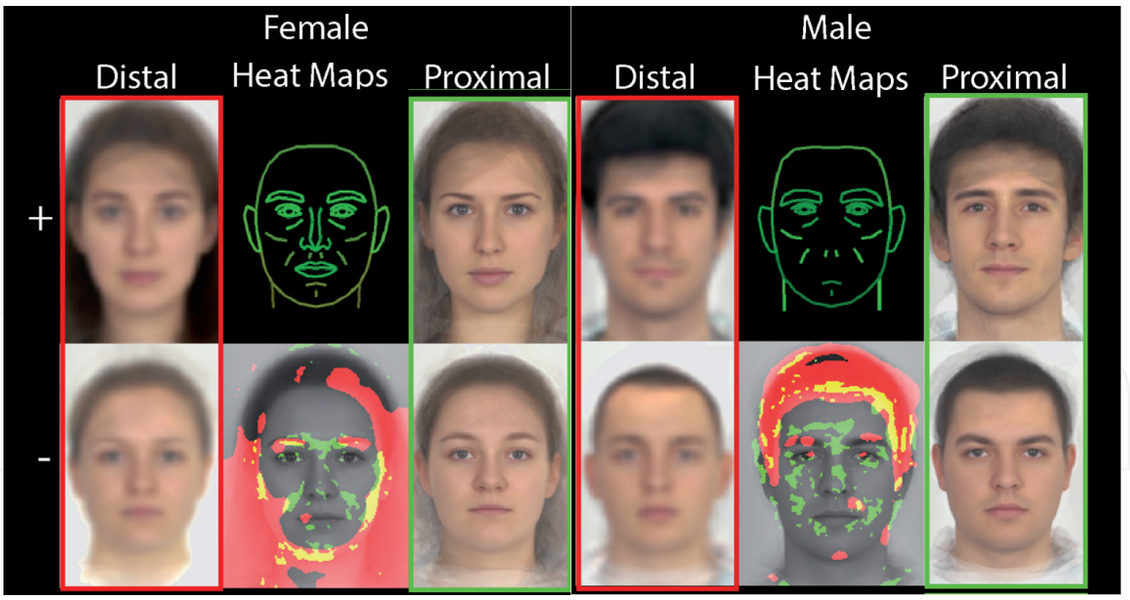


**Figure 3.**
*Attractiveness predictions and diagnostic cues. The results are organized by sex of stimuli (columns) and based on judgment of opposite sex observers. For each sex of stimuli, the leftmost (distal—48 m) and rightmost (proximal—1.5 m) columns show the model predictions for the two polarities of trait denoted by + and − (attractive and unattractive correspondently). The middle column of each sex of stimuli category shows the diagnostic structural (i.e., shape of the facial features) and textural cues using color codes: green (exclusively distal cues), red (exclusively proximal cues), and yellow (both distal and proximal cues) [33].*

## 4. Conclusions

The face is a communication tool that transmits a wide range of social signals. Inference of social traits from faces has evolved and diversified to serve, at least in part, as a rudimentary but instant communication tool to evaluate the benefits of cooperation or aversion during social interaction. Whether these signals are reliable or not, the facial signal decoding system in the receiver's brain has to deal with the major challenge of organizing the high-dimensional input from the retina and mapping it into a stable representation of a social category. Among the signals of some basic social traits, the signal of attractiveness is found to be outstanding in terms of interobserver agreement, reliability, and robustness to a variety of manipulations induced by the sender and the communication channel. Not only does the transmitter send complex social signals, in addition the communication channel induces large variability on the received signals. The limitations of the information that is caused by the camouflaging communication channel may challenge the receiver. An example for a potential scenario is that what is attractive from afar may be far from attractive at a short viewing distance and vice versa. The visual system is thus required to have a detailed set of diagnostic tools that varies with the availability of information and channel conditions. Interestingly, in a comparison among several social traits, attractiveness was found to be decoded from the longest distance, longer even the decoding distance of aggression.

The transmitter is not passive and by using specific facial movements they can camouflage the default neutral appearance of the face. Even if this is the case, the attractiveness of the face is found to be the most robust and hard to fake when compared with the other social traits that were studied [33].

Facial attractiveness is therefore a robust signal in social communication and the human brain seems to be adapted to detect it more effectively than any other social trait. There can be several possible reasons for the latter outcome. One possibility is

that attractiveness signals provide more reliable information about the transmitter. For example, while attractiveness is a reliable signal of potential successful reproduction and survival of descendants, signals of trustworthiness may reflect actual levels of trustworthiness to a lesser extent (if at all). Another possibility is that with the limited computational and attentional capacities of the human brain, the higher sensitivity to attractiveness signals reflects the gain and loss priorities. Such risk management policy may give priority to approaching an attractive transmitter while ignoring hazard cues of aggression.

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