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The influence of shape and colour cue classes on facial health perception

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ABSTRACT

Facial appearance signals information about an individual, and one trait in particular is vitally important for social interaction and mate choice decisions: physical health. Facial cues to health can be divided into two broad classes – facial shape, which is linked to previous health and is relatively fixed; and facial colouration, which changes over the short-term, reflecting current health. These cue classes in themselves give insight into the kinds of health condition valued by human observers when making social inferences. Here, using novel and generalizable methods, the influence of these cue classes on health perception and their link to a measure of general health are examined. Study One employs a Brunswik lens model approach, finding that observers utilise exclusively shape cues to judge health, and that of these shape cues, only averageness is related to a measure of self-reported general health. Study Two shows that when averageness and carotenoid colouration are varied together, both make separable contributions to perceived health, but that averageness explains a larger proportion of variance. Taken together, these results indicate that humans may have evolved to favour cues to previous condition when judging health, because they are more valid. However, the findings also suggest that the role of facial appearance in perceiving health is more complex than previously thought, with different cues potentially reflecting specific aspects of physiological health.

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1. Introduction

The belief that our faces convey information about our health is not a new one, existing across cultures and through history (Bridges, 2012). Recently, a growing body of literature investigating these associations has supported early ideas about the relationship between facial appearance and health. Humans can readily discriminate healthy and unhealthy looking faces (Jones, Kramer, & Ward, 2012), unconsciously associate positive attributes to healthy-looking faces (Grandfield, Thompson, & Turpin, 2005), and show strong agreement on which faces appear healthy or not (Jones, Porcheron, Sweda, Morizot, & Russell, 2016). An evolutionary approach to understanding these perceptions indicates that some facial traits may be honest cues to health, and that we evolved a sensitivity to these cues to find mates with good health (Rhodes, 2006; Scott, Clark, Boothroyd, & Penton-Voak, 2013; Thornhill & Gangestad, 2006). What are these facial traits that we use to make judgments about health, and are they accurate?

Early work on the link between health and facial appearance focused on aspects of facial shape as cues to health. Facial symmetry has long been considered to indicate good health and genetic stability (Møller & Swaddle, 1997), with symmetrically developing individuals being able to better resist environmental insults that cause deviations from perfect symmetry. In agreement with this, more symmetrical

individuals report better physical and mental health (Shackelford & Larsen, 1997; Thornhill & Gangestad, 2006). Concordantly, individuals are perceived as healthier with more symmetrical faces (Rhodes et al., 2001), suggesting an evolved ability to detect physical health from facial appearance alone. Sexual dimorphism in faces, or their femininity and masculinity, also seems linked to health. For example, the immunocompetence hypothesis suggests that more masculine-looking men, whose faces developed under the influence of greater amounts of immunosuppressing testosterone, should have better health (Thornhill & Gangestad, 2006). Women with higher facial femininity also seem to report better physical health, with fewer infections per year (Gray & Boothroyd, 2012), and have greater reproductive health (Law Smith et al., 2006). For both females and males, facial averageness (the closer an individual face is to the population average) is linked with both perceived health and actual health (Rhodes et al., 2001), and seems to share a relationship with actual genetic diversity, and thus greater disease resistance (Lie, Rhodes, & Simmons, 2008). Finally, facial adiposity, or the amount of weight carried in the face, is a good predictor of perceived health (Henderson, Holzleitner, Talamas, & Perrett, 2016). Given its relationship with body mass index, adiposity is also clearly related to actual health, with underweight and overweight individuals having poorer health outcomes (Coetzee, Perrett, & Stephen, 2009).

More recent research has examined the role facial colouration plays in health perception. Skin lightness, redness, and yellowness all seem to be preferred in faces when making judgments of health (Henderson et al., 2016; Stephen, Coetzee, Law Smith, & Perrett, 2009a; Stephen, Law

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Smith, Stirrat, & Perrett, 2009b). Carotenoid colouration, a specific combination of those colours, is strongly preferred (Lefevre & Perrett, 2015; Stephen, Coetzee, & Perrett, 2011; Tan, Graf, Mitra, & Stephen, 2017) and reflects the deposition of dietary carotenoids in the skin. This seems to be an honest cue to health, as carotenoids improve both immune function (Alexander, Newmark, & Miller, 1985) and reproductive health (Dowling & Simmons, 2009). Observers also rely on colouration in specific areas of faces when judging health. Darker skin under the eyes significantly lowers ratings of apparent health (Jones et al., 2016), as does the yellow-blue contrast around the lips (Russell et al., 2016; Stephen & McKeegan, 2010) and eyes (Russell, Sweda, Porcheron, & Mauger, 2014). These aspects of colouration also seem tied to actual health, in that sleep deprivation can cause dark circles and reddened sclera (Sundelin et al., 2013) and accelerate skin aging (Oyetakin-White et al., 2015), while poor circulation can affect lip colouration (Ponsonby, Dwyer, & Couper, 1997). Other cues to health from skin alone are related to texture homogeneity, with a smooth, even appearance seen as healthy and attractive (Matts, Fink, Grammer, & Burquest, 2007) and a cue to the absence of infectious disease (Samson, Fink, & Matts, 2010).

Physical health, then, seems manifest in the human face in the form of colouration and shape cues, and observers readily use these cues to infer health from facial appearance. These cues can be broadly separated into two 'classes', both of which seem related to distinct aspects of health. This segregation is apparent in the literature, but has not yet been widely argued for (Getty, 2002; Scott et al., 2013; Scott, Pound, Stephen, Clark, & Penton-Voak, 2010; Smith, Jones, DeBruine, & Little, 2009; Tybur & Gangestad, 2011). For example, consider that facial shape is almost entirely fixed and unchangeable by the individual after puberty (with the exception of adiposity, which takes concerted effort over time to produce a perceptual change; Re & Rule, 2016), and so is a 'class' of cues suited to reflecting long-term health and developmental stability. Indeed, the symmetry of older adults' faces reflects their childhood socioeconomic status – regardless of their health in later life, early life experiences seem to permanently shape the face (Hope et al., 2013), and this change can be seen from a young age (Özener & Fink, 2010). Averageness too is related to childhood and adolescent health (Rhodes et al., 2001; Zebrowitz & Rhodes, 2004), and twin studies suggest variance in facial averageness has a large environmental component (Lee et al., 2016). Conversely, colour cues from facial skin are a class of cues ideally suited to indicating current health, rather than previous condition. Colour cues can and do change along with health. For example, dietary increases in carotenoids alter skin colour to appear healthier (Stephen et al., 2011; Tan et al., 2017; Whitehead, Re, Xiao, Ozakinci, & Perrett, 2012), smoking cessation lightens skin (Cho et al., 2012), and acute infection causes facial skin to become paler and greener (Henderson et al., 2017). Even simply missing several hours of sleep causes colour changes in facial areas related to a healthy appearance (Axelsson et al., 2010; Jones et al., 2016; Sundelin et al., 2013), and reduces observers' desire to interact with individuals who look this way (Sundelin, Lekander, Sorjonen, & Axelsson, 2017).

While both shape and colour cues indicate health, they seem related to different aspects of it. Undoubtedly, both classes of cues are important and carry consequences for mate choice. Long term health, as indexed by shape, may cue indirect benefits to health such as disease resistance or developmental health (Lie et al., 2008), while colour may cue more direct benefits in the form of being free from disease and not currently infectious (Henderson et al., 2017; Sundelin et al., 2017). But which is more important? Evolutionary arguments have tended to focus on the former set of cues (Scheib, Gangestad, & Thornhill, 1999; Thornhill & Gangestad, 2006) because of their possible association with genetic quality, a fundamental tenet of reproductive success. However, recent mathematical models indicate that paying attention to cues to current condition can bestow fitness advantages, but there are diminishing returns to attending to cues to past health, particularly in species who have shorter lifespans and higher parasite loads (Adamo

& Spiteri, 2005, 2009). Is there evidence from human behavior that might indicate a reliance on one cue class over another?

The results of studies addressing this question have been equivocal. Observers seem to rely more strongly on colouration (current condition) than masculinity (past condition) when judging male attractiveness (Scott et al., 2013, 2010), and the intermediary shape cue of adiposity is a better predictor of health than masculinity (Rantala et al., 2013). However, skin yellowness seems to better predict perceived health than adiposity (Henderson et al., 2016). There are also interactions between cues to current and previous condition, with more feminine and masculine facial shapes being more attractive when those faces appear healthy (Smith et al., 2009). Colour cues also seem to be relied on more for perceiving health when shape adiposity is very low or high (Fisher, Hahn, DeBruine, & Jones, 2014). Recent work, using novel conjoint analysis techniques, has shown even more complex interactions between cue classes, with sexual dimorphism being preferred over colour for male faces, but symmetry and colour preferred for female faces (Mogilski & Welling, 2017). Conversely, more evidence suggests colour is not utilised when judging female health, with observers relying solely on femininity, which itself shows no relationship with actual health (Foo, Simmons, & Rhodes, 2017). The cues used by observers to make judgments of health are established, but a relationship with actual health and any interactions between cue classes are unclear.

The current studies aim to reveal what facial cues observers rely on when making judgements about female health, whether those cues are valid, and what interactions there are between cue classes. In Study One, a large set of female faces is measured for femininity, averageness, and symmetry, as well as skin luminance, redness, and yellowness. These cues are selected as they represent well-researched, distinct 'classes', indicating both long-term (shape factors) and current (colour factors) health. Participants also provided information on their general health condition and health over the previous four weeks using the 12-Item Short Form Health Survey (SF-12; Ware, Kosinski, & Keller, 1996), which provides an estimate of general and recent functioning in daily life that may be related to both long and short term health.

The relationships between perceived health, a measure of general health, and attributes of facial appearance are best understood using a Brunswik lens model (Brunswik, 1956), which is applied in Study One. This analytical approach has roots in early models of decision-making (Brunswik, 1955), stemming from the idea that humans operate in rich environments where things share variance. When making a decision about something, an individual can use cues (or 'lenses') correlated with the required decision to guide their judgment. The lens model thus describes two sets of relationships. The first are known as *cue utilisations*, which are the correlations between an observer's decision or judgment, and the lenses themselves. That is, an individual judgment of health from an observer may show a correlation with facial colouration and facial shape, one or the other, or none at all. Regardless, the model first highlights the kinds of cues that are used by an observer when making a judgment. The second set of described relationships is known as *cue validities*, or the correlations between the underlying variable and the cues themselves. These illustrate whether the cues themselves are good indicators of a directly unobservable trait – for example, does facial luminance share variance with a measure of health in daily living? In full, the model describes the cues observers utilise to make a decision, and whether the cues are valid or not. The lens model has had great influence in personality perception research (Gosling, Ko, Mannarelli, & Morris, 2002; Naumann, Vazire, Rentfrow, & Gosling, 2009; Vazire, Naumann, Rentfrow, & Gosling, 2008), but is not broadly used in evolutionary models of face perception, where it may be informative (but see Zebrowitz et al., 2014; Zebrowitz & Rhodes, 2004). Finally, Study Two examines and confirms the relative reliance on shape and colour cues based on the results of the lens model analysis, using facial manipulation techniques.

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