# Does Altering the Lower Height of the Face Affect Our Perception of Personality?

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November 2023

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Master of Dental Sciences.

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**ABSTRACT**

Background: Although we are advised not to "judge a book by its cover", many of our opinions about others are based on their outward appearances. This is done via impression formation, which is the cognitive process by which individuals form judgments and evaluations of others based on available information, such as physical appearance, behavior, and social cues. Understanding "impression formation", based on facial morphology, has led to many theories and research in the field of psychology and more recently in orthodontics. More specifically, facial proportions have been shown to play an important role on judgements of appearance.

Objectives: The primary objective of this study was to investigate if changing the lower vertical height of the face on frontal photographs, could influence the perception of personality traits, such as intelligence, aggressiveness, friendliness, confidence as well as attractiveness. The secondary objective was to evaluate which image would be rated as most aggressive in each ethnicity and gender.

Methods: A questionnaire was created using standardized frontal facial photographs of middle-aged adults with average attractiveness, available through the Chicago Face Database v.3. One male and female of different origins: Caucasian, Asian, African American, Indian and Hispanic (total 10 photos) were chosen. Images were then edited via Photoshop 20. software to decrease or increase the LFH by increments of 3% (2 to 6mm), for each sample photo, giving 4 altered images in addition to the original. All 5 images of the same face were randomly presented in the questionnaire, asking the participant to pick any one photo, which would match best with a given personality trait (intelligence, aggressiveness, friendliness, confidence) and to select the most attractive face. This was done for all 10 sets of photos. All statistical analyses were conducted using SPSS (Version 29, SPSS Inc., Chicago, Illinois, USA) and R (2023.06.1).

Results: The survey was sent to 198 people and 133 of them fully completed it, giving a response rate of 67%. Most participants were female (62%), Caucasian (68%) between the ages of 20-30 years old (55%) and many had a background in dental medicine (41%). Using chi square tests (Bonferroni corrected) at $P < 0.05$, altering the LFH did affect the perception of personality and attractiveness. Furthermore, the log odds ratio analysis showed that the photographs with increased LFH of 6mm were chosen as the most aggressive for the African-American female sample photo, Caucasian female and male, Asian female and male, Hispanic female and Indian female and male.

Conclusion: In our chosen sample, LFH may influence the perception of personality and attractiveness. However, the relationship between LFH increase/decrease and impression formation appeared inconsistent across gender and ethnicity. Furthermore, differences were found in the way we judge aggressiveness with increased LFH, in various ethnicities. However, this needs to be confirmed on a larger sample size of laypersons, from diverse ethnicities and other photographic samples as no generalization can be made. This research is clinically important as there are ways to correct LFH through orthodontics or maxillofacial surgery. Future research should explore potential confounding factors and the interplay of multiple facial features to obtain a more comprehensive picture of how lower facial height may interact with other characteristics in influencing personality traits.

**RÉSUMÉ**

Introduction : Même si le proverbe dit : « Ne jugez pas un livre à sa couverture », nous fondons notre opinion des autres sur leur apparence extérieure. Cela se produit par la « formation des impressions », processus cognitif par lequel les individus portent des jugements et des évaluations sur autrui selon les informations dont ils disposent, notamment l'apparence physique, le comportement et les signaux sociaux. La compréhension de la « formation des impressions » basée sur la morphologie faciale a donné lieu à de nombreuses théories et recherches dans le domaine de la psychologie, et plus récemment en orthodontie. Ainsi, il a été démontré que les proportions du visage jouent un rôle important dans les jugements liés à l'apparence.
Objectifs : La présente recherche a pour but principal de découvrir si la modification des proportions verticales inférieures du visage sur des photographies de face pouvait influencer la perception des traits de personnalité comme l'intelligence, l'agressivité, la convivialité, la confiance ainsi que le degré d'attirance physique. L'objectif secondaire est d'évaluer quelle image serait jugée la plus agressive dans chaque groupe ethnique et chaque sexe.

Méthodes : Nous avons élaboré un questionnaire à l'aide de photographies standardisées prises de face représentant des visages d'adultes d'âge moyen ayant une attractivité moyenne, puisées dans la base de données du Chicago Face Database, version 3. Nous avons sélectionné 5 photos d'hommes et 5 autres de femmes d'origines différentes : caucasienne, asiatique, afro-américaine, indienne et hispanique (soit un total de 10 photos). Nous avons ensuite modifié les photos de l'échantillon à l'aide du logiciel Photoshop 20 pour réduire ou augmenter la HFI par incréments de 3 % (de 2 à 6 mm), obtenant ainsi 4 images modifiées en plus de l'originale. Nous avons présenté les 5 images du même visage de manière aléatoire dans le questionnaire, demandant au participant de choisir une photo qui correspondrait le mieux à un trait de personnalité donné

(intelligence, agressivité, convivialité, confiance) et de sélectionner le visage le plus attrayant. Cela a été fait pour les 10 ensembles de photos. Toutes les analyses statistiques ont été réalisées à l'aide de SPSS (Version 29, SPSS Inc., Chicago, Illinois, États-Unis) et de R (2023.06.1).

Résultats : Le questionnaire a été envoyé à 198 personnes et 133 d'entre elles l'ont rempli intégralement, soit un taux de réponse de 67 %. La plupart des participants étaient de sexe féminin (62 %), d'origine caucasienne (68 %), âgés de 20 à 30 ans (55 %) et nombreux étaient issus du domaine de la médecine dentaire (41 %). En utilisant le test chi carré (corrigé avec la méthode de Bonferroni) à $P < 0.05$, la modification de la HFI a effectivement eu un effet sur la perception de la personnalité et le degré d'attirance physique. De plus, l'analyse du rapport des cotes logarithmiques a montré que les photographies ayant fait l'objet d'une augmentation de la HFI de 6 mm ont été désignées comme étant les plus agressives pour les femmes afro-américaines, les femmes et les hommes caucasiennes, les femmes et les hommes asiatiques, les femmes hispaniques et les femmes et les hommes indiens.

Conclusion : Dans l'échantillon choisi, la HFI pourrait influencer la perception de la personnalité et de l'attractivité. Cependant, la relation entre l'augmentation ou la réduction de la HFI et la formation des impressions semblait incohérente en fonction du genre et de l'origine ethnique. De plus, avec une augmentation de la HFI, l'agressivité est jugée différemment dans diverses ethnies. Cette conclusion doit toutefois être confirmée sur un échantillon plus large de la population générale, provenant de diverses origines ethniques et avec plusieurs autres échantillons photographiques, aucune généralisation ne pouvant être établie. La présente recherche revêt une importance clinique puisqu'il existe des moyens de corriger la HFI par l'orthodontie ou la chirurgie maxillo-faciale. Les futures recherches devraient explorer les

facteurs de confusion potentiels et la combinaison de plusieurs caractéristiques faciales afin de mieux appréhender l’interaction de la HFI avec d'autres caractéristiques pour influencer les traits de personnalité.

**ACKNOWLEDGEMENTS**

I would like to thank my supervisor, Dr. Julia Cohen-Levy for allowing me to pursue an MSc in Dental Sciences under her direction. Dr. Cohen-Levy has provided an immense amount of knowledge and guidance that has helped me progress in this academic journey. She has been a great mentor and support throughout this process, and I could not thank her enough for the skills she has provided me with to complete my degree.

I would also like to thank Dr. Sreenath Madathil, assistant professor at McGill University and Shashank Kannan, Master's student at McGill University, who have given great insight for the statistical modelling and helped perform the data analysis for my research project.

I am appreciative for my thesis committee members, Dr. Marc Martel and Dr. Pascaline Kengne Talla, for providing valuable insight into the progression of the study, all of whom have provided me with advice and resources to be successful in my research. I would also like to thank the McGill Dental Clinic and Orthoperfection for allowing me to recruit participants at their respective sites.

Lastly, I am so grateful for my family and friends for their encouragement to pursue this MSc and their endless support throughout my academic journey.

## CONTRIBUTION OF AUTHORS

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MSc candidate. Vanessa conducted an extensive literature review, created the research instrument on LimeSurvey, selected sample photographs from the CFD, modified these photographs via Photoshop, recruited participants for the research study, administered the questionnaire, assisted with data analysis and writing of the thesis. She presented preliminary findings at McGill Research Day 2023 and to the MSc Thesis Committee.

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**LIST OF ABBREVIATIONS**

CFD= Chicago Face Database

fWHR= facial width to height ratio

LFH= lower facial height

OR= odds ratio

SD= standard deviation

SNMP= Sella-Nasion mandibular plane angle

## 1. INTRODUCTION

In the absence of any previous acquaintance and without any prior knowledge of an individual's personality or behavioural traits, people make subconscious and subjective judgments of one another[1]. Yet, these impressions are often not representative of people's actual traits and states, such as their tendency for sociability, responsibility, happiness, and aggression[2]. Nevertheless, facial appearance continues to be a decisive factor for social relationships[3] since the face plays a role in judgements of physical attractiveness, as it contains an overlapping array of morphological and facial expression-related features[4]. More specifically, the mouth and smile have been identified as key components[5, 6] when making first impressions of others. For example, a study by Walker et al. demonstrated that judgments of trustworthiness were influenced not only by the eyes but also by the mouth region[7]. It was found that participants rated individuals with a smiling expression as more trustworthy compared to those with a neutral or non-smiling expression[7]. Thus, the mouth region contributes valuable social cues and emotional expression.

This begs the question as to why we form such impressions. Understanding "impression formation," based on facial characteristics, has led to many theories and research in the field of psychology and more recently in orthodontics. A literature search found that most of these orthodontic studies, evaluating smile or facial proportions, only focused on attractiveness[1] and were conducted on Caucasian samples[8, 9].

The purpose of this research study was to perform an experimental study aimed at measuring how subjects rate the personality traits of an experimental sample of average faces, whose lower

facial proportions were altered. Lastly, the thesis conclusion summarizes the main findings of the study, the relevance, and future implications.

## 2. LITERATURE REVIEW

### 2.1 Impression formation

#### *2.1.1 The Importance of facial first impressions*

Humans naturally judge others based on their facial appearance, which can be formed within a few milliseconds[10]. These judgments are the product of impression formation, which is the process by which we form an overall initial impression of someone's character and abilities based on the available information[11]. The face is a primary source of information used to form initial judgments about others' personality traits, emotional states, and social characteristics. Research has shown that facial cues, such as facial expressions, attractiveness, and non-verbal behaviors, can significantly impact how individuals are perceived and evaluated[12, 13]. The ability to accurately decode facial expressions and traits from first impressions is essential for successful social functioning and establishing meaningful connections with others[14]. Therefore, it is crucial to understand how and why people judge others in this way as it has real life implications. For instance, legal decisions can even be influence by physical attractiveness as it was found that attractive criminal suspects were less likely to be convicted and were given less severe punishments than their unattractive counterparts[15].

However, it is important to note that these impressions can also be unfair[16, 17], which could have profound consequences. People begin forming impressions from faces at an early age, as young as 3 years old[18], and such impressions are even shared across cultures[19]. This suggests that they serve an evolutionary adaptive function. On the other hand, forming these consensual initial impressions can also be false. This paradox can be explained in part by the overgeneralization effect, which implies that first impressions can be influenced by facial features that typically reveal some personal characteristics, even if the individual being judged does not actually

possess these characteristics, but only physically resembles someone who does[19]. This leads to several overgeneralization effects which provide an explanation as to why we form these consensual first impression from faces.

*2.1.2 Baby-face overgeneralization*

Baby-face overgeneralization is characterized by the adaptive value of responding appropriately to babies, for example, giving protection or inhibiting aggression[20]. This produces a strong tendency to respond to facial qualities that depict babies which is overgeneralized to first impressions of people whose facial structure resembles that of a baby. This is characterized by larger eyes, higher eyebrows, smaller nose bridges, rounder and less angular faces, thicker lips, and a lower vertical placement of features, which creates a higher forehead and a shorter chin[21, 22]. Numerous studies have found that faces that have a more childlike appearance are associated with the perception of childlike traits such as an elevated level of warmth, low power, and low competence [20, 22]. This type of overgeneralization was seen in research by Zebrowitz & McDonald, which found that facial "baby facedness" has the power to influence financial awards in court decisions[23].

*2.1.3 Familiar-face overgeneralization*

Familiar-face overgeneralization refers to the tendency to perceive familiar faces as more attractive and trustworthy than unfamiliar faces, even when controlling for objective measures of physical attractiveness. Therefore, we respond to faces that look more familiar to us compared to unfamiliar looking strangers. In turn, this can cause own-race positivity bias since strangers from one's own racial group should appear more familiar than strangers from a different racial group, contributing to ingroup favoritism and negative outgroup stereotypes[24]. This is consistent with the mere-exposure effect, where people prefer faces they have seen before but also novel faces

that are similar to previously seen ones[25]. Additionally, strangers who appear more familiar are perceived as being more trustworthy than strangers who appear less familiar[24]. A study done by Kramer and Ward found that this effect was stronger for faces that appear more "baby faced"[26].

However, these effects of overgeneralization, when two strangers share a similar appearance, depend on the source of familiarity. For example, someone may be received favorably just because they resemble someone else who has been nice to the perceiver in the past. On the other hand, a person who resembles someone who has been rude to the perceiver will be avoided[27]. Furthermore, other indications that unfamiliarity with a face affects first impressions comes from a study done on White judges' responses to faces with more Afrocentric stereotypical features. The researchers found that people with such faces are thought to have more unfavourable qualities regardless of their actual race[28]. Consequently, members of a stereotyped group may be targeted to a greater extent than others, simply because they share more group-related physical features[28].

*2.1.4 Anomalous face overgeneralization*

This overgeneralization effect posits that people are seen more favourably across a wide range of criteria when they have more appealing faces. They are considered to be more extroverted, socially powerful, intelligent, and healthy[1, 29]. Additionally, preferential treatment of attractive people in a range of contexts, such as interpersonal interactions, professional settings, and the legal system, goes hand in hand with these attributed impressions[1]. According to this theory, the adaptive benefit of identifying people with illnesses or defective genes has equipped us to react to physical characteristics that could indicate low fitness. Then, when observing people whose appearances match those of the unfit, there is a tendency to overgeneralize responses. Since unattractive faces are more comparable to the faces of unhealthy people, which

are easier for us to identify, we therefore judge unattractive people more harshly than attractive ones[13]. Zebrowitz et al. found that even in normal, healthy people, unattractive faces give off impressions of less warmth, power, competence, and health than attractive faces[20].

*2.1.5 Emotional-face overgeneralization*

The emotional-face overgeneralization hypothesis speculates that people's facial expressions of emotion allow us to form assumptions about their emotional state as well as behavioural inclinations and personality features. For example, happiness communicates a person's positive affective state, but also a tendency to approach in a friendly and confident way. On the other hand, anger conveys a tendency to attack in a domineering, hostile and unfriendly manner[13]. Consistent with emotional-face overgeneralization, higher dominance and lower warmth are perceived not only in angry faces but also in neutral-expression faces that show more resemblance to angry expressions[30]. According to Zebrowitz et al., naturally lower eyebrows on a neutral-expression face are likely to make the person look angrier, while naturally higher eyebrows are likely to make the person look more surprised[31]. Additionally, naturally upturned corners of the mouth are likely to make the person look happier[31].

*2.1.6 Gender-emotion confound*

Even when separated from the rest of the face, features like the nose, the eyes, and the mouth all communicate information about gender[32]. Facial traits associated to facial dominance and maturity have also been linked to a significant portion of what separates male and female appearance[33]. For instance, men typically have traits that resemble a square jaw, thin lips, and heavy, low-set eyebrows, whereas women usually have rounded features such as full lips, and high eyebrows[34]. Therefore, people tend to think of men as being more authoritative and women as being more sociable[35]. Expressive faces also have the power to influence personality trait

interpretations. Various studies done by Marsh and colleagues found that people expressing anger were judged to have traits associated with maturity, such as independence, strength, dominance, masculinity and coldness, whereas people expressing fear were judged to have traits associated with babyishness, such as dependence, weakness, submissiveness, femininity and warmth[36]. This is consistent with research studies done by Becker et al., which suggest that decisions about the sex of a face and the emotional expressions of anger or happiness are not independent since participants were faster and more accurate at detecting angry expressions on male faces and at detecting happy expressions on female faces[37].

Throughout the literature it is evident that facial appearance plays a role in cultural stereotypes as women are typically perceived as having submissive or baby-faced facial characteristics, whilst men are typically perceived as having more dominating or mature features[31, 36]. These appearance cues also happen to closely resemble expressions of fear and aggression. Furthermore, a study was done using a computer that was able to systematically categorize neutral male and female faces into different emotion categories[31]. It was found that male faces were more often categorised as angry and female faces as surprised[31]. This is consistent with the stereotypic impression that women are less dominant than men. This is interesting since these effects were solely based on facial metric data and were consequently unaffected by any biases based on stereotypes or cultural learning. Therefore, the difficulty in separating gender and emotion perceptions from facial signals would imply that emotion overgeneralization may contribute to the formation of gender-related impressions.

*2.1.7 Emotion residue*

Emotion residue is defined as any observable temporary emotional tone remaining on a face once an individual has finished making an expression and has intentionally returned to a neutral

baseline[38]. This suggests that our face may never truly be a “blank slate” even if an individual tries to display a neutral facial tone since we are constantly expressing ourselves to one another via the face. Thus, it is important to understand how lingering emotional tone on our face can impact others’ impressions, even when we are not purposefully trying to show an emotion.

Researchers have examined the “neutral face” for decades, detailing when and why a specific set of facial features will be evaluated one way over another, the influence that sociodemographic factors such as age and sex/gender have on neutral face perception, and how these all interact to form consistent and stable impressions that observers appear to be able to draw from neutral faces[38]. Previous investigation has found that static physical features such as gender-related appearance and age-related changes in the face alter perceptions and impressions[31, 39]. Furthermore, initial perceptions based on supposedly "neutral" looks frequently hold true among diverse observers. This shows that, at some level, people have a similar sensitivity to socially significant stimuli from which they form similar conclusions.

According to Adams and colleagues, such conclusions are at least in part attributable to the interpretation of emotion resembling cues that are confounded with gender and age[39]. The mere resemblance of a face to an expression powerfully influences a wide array of trait impressions of others[4]. For example, lowering the eyebrows on a non-expressive face increases the perception of dominance and anger, whereas raising the eyebrows increases the perception of submissiveness and fear[34]. Additionally, shortening the distance between the eyes and mouth results in perceptions of anger, while lengthening the same distance results in sadness[40]. A study conducted by Albohn and Adams asked participants to discriminate between a neutral face that came before an expression (pre-expressive) or a neutral face that came after an expression (post-expressive)[38]. It was found that observers were able to correctly categorize these faces as

"coming after an expression" when residual emotion cues remained after an individual made an expression, at above chance levels[38]. Moreover, when asked to make personality judgements about these pre- and post-expressive faces (e.g., "how rude/smart does this individual appear?"), post-anger neutral faces were rated overall more negative than post-happy neutral faces, and post-happy neutral faces were rated more positive than post-anger neutral faces[38]. When considered as a whole, this body of work contends that, despite one's best efforts to present a subjectively "neutral" face, viewers are still able to pick out the minor emotional details that persist on the face even after an overt expression has been made.

**2.2 Cues to facial impressions**

Research has shown that attractive people are considered to be more intelligent and socially competent, to have a more positive personality, to have better social interactions, and to receive more favorable professional ratings[41-43]. This is because people make subconscious and subjective judgments of one another even in the absence of any previous acquaintance and without any prior knowledge of an individual's personality or behavioural traits [1, 44]. Humans naturally attribute personality, inner thoughts, and beliefs to others simply based on facial appearance in an effortless and non-reflective manner. Yet, these impressions are often not representative of people's actual traits and states, such as their tendency for sociability, responsibility, happiness, and aggression[2]. Nevertheless, facial appearance continues to be a decisive factor for social relationships[3] since the face is one of the key features in determining physical attractiveness, as it contains an overlapping array of morphological and facial expression-related features[4]. Facets of appearance such as facial maturity and attractiveness and cues related to gender, race, and age profoundly impact our impressions[4].

### *2.2.1 Facial gender*

Humans can judge a person's biological sex with 96% accuracy[45]. Male faces habitually have larger noses, jaws, and chins; smaller eyes, more prominent brows and less full cheeks, compared to females[32, 45]. When looking at facial texture, female faces typically have less facial hair[46] and show more contrast between (pale) skin and (dark) eyes[47] and have lips with redder hue[48]. Together, these cues are used by perceivers to categorise faces based on sex[49]. In part, these social impressions can be explained by female faces also looking more childlike; small chin and large eyes[50]. Furthermore, female faces objectively resemble happiness expressions[51, 52], whereas male faces resemble anger due to their larger jaws giving off impressions of dominance[53].

### *2.2.2 Facial race*

People can easily and quickly discriminate faces based on their apparent racial group[54]. Most face research has focused on three racial categories: Asian, Caucasian and African-American faces, even though our world is made up of many other racial groups. It was found that Asian faces look more baby-faced, with narrower eyes and decreased LFH and, even when neutrally posed, they seem to portray an expression of surprise[31, 55]. African-American faces typically have the darkest skin, relatively wide noses, and masculine features; while Caucasian faces typically have the light skin, more varied eye and hair colour, more convex faces with 'pointy' noses[31, 55].

Furthermore, research has shown that facial appearance is associated with certain social attributions. For example, faces perceived as African-American are often perceived as more athletic, masculine, and less reserved[24]. On the other hand, Asian faces are often perceived as more reserved, competent, and less aggressive[55]. Faces that are perceived as more Caucasian are

generally perceived somewhere in between[24, 31]. These social attributions appear to be influenced by the facial structural overlap with emotional expression and sexually dimorphic features, which may contribute to social biases and stereotypes[56].

*2.2.3 Facial age*

Perceived age is a good biomarker of 'biological age'[9] as perceivers rely on structural growth cues, such as changes in head shape and changes in skin texture, such as wrinkles and colour evenness[57]. In terms of social characteristics, research has found that older faces are often perceived as more trustworthy, warm, and sincere, while younger faces are associated with traits such as attractiveness, extroversion, and health[58, 59]. These findings are thought to be influenced by societal stereotypes and expectations associated with different age groups. For example, older individuals may be perceived as more trustworthy due to their perceived wisdom and life experience, while younger individuals may be viewed as more attractive and outgoing due to cultural ideals of youthfulness[59]. Moreover, research suggests that these age-based perceptions of personality traits may have real-world consequences, such as influencing hiring decisions and social interactions[58]. Overall, facial age is an important factor in how perceived personality traits in others and can have significant implications for social interactions and outcomes.

**2.3 Facial morphology and perception of personality**

The human face has been a source of great interest in recent years because of the extraordinarily well-developed ability of humans to process, recognize and extract information from other's faces[60]. It is a complex and multifaceted structure that conveys a wealth of information about the individual's identity, emotions, and social status. Facial features such as shape, size, symmetry, and color are known to affect our judgments of attractiveness, trustworthiness, competence, and other traits that are relevant to social interactions[17, 61]. In

particular, the lower third of the face, which includes the mouth, chin, and jawline, has been found to be a critical area for conveying dominance, aggression, and other personality traits[62]. One of the most crucial factors that influence the perception of the lower face is the vertical dimension or height of the mandible, which can vary widely among individuals due to genetic, environmental, and developmental factors[63]. Orthodontic treatment and orthognathic surgery are common methods of altering the lower facial height, and they can have significant effects on the overall facial harmony and balance, as well as on the perceived personality traits of the individual[64, 65].

*2.3.1 Facial width to height ratio*

In orthodontics, facial width to height ratio (fWHR) refers to the relationship between the bizygomatic width of the face (the horizontal distance between the two cheek bones) and the height of the face (menton to trichion -hairline)[66] (Figure 1). The proportionate fWHR for males is 1.35 and 1.3 for females[66].

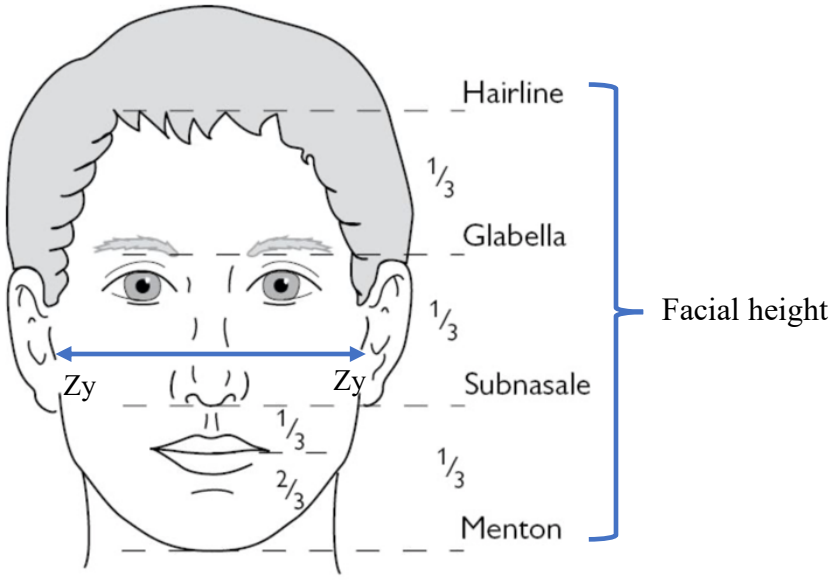


***Figure 1: Frontal view of the face showing facial height spanning from menton to trichion (hairline) and bizygomatic width (Photo extracted from: Dentistry P Orthognathic surgery[67])***

However, in psychology, fWHR is the result of dividing the facial width, breadth between cheek bones by the facial height, measured from the middle point of the upper lip to the middle of the eyebrow ridge[68] (Figure 2).

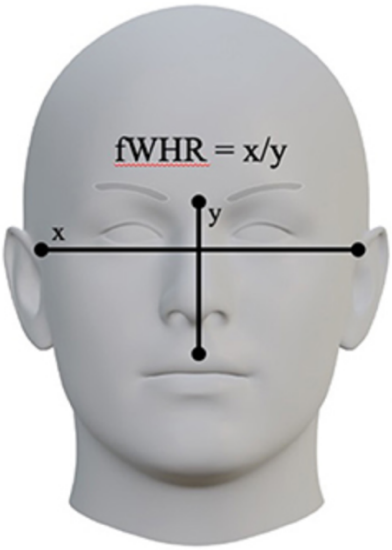


***Figure 2: fWHR: is the result of dividing the facial width (horizontal distance from cheek bones) by the facial height (upper lip to eyebrow ridge). (Photo extracted from: Sato et al.[69])***

On average men tend to have a slightly lower ratio than women, around 1.7 for men and women tend to have an average ratio of 1.8[70]. This ratio means that the width of the face is approximately 1.7 or 1.8 times the height of the face. However, it is important to note that there is a wide range of variation and facial proportions can be influenced by genetics, ethnicity and other individual characteristics. Orthodontic and surgical treatments have the capacity to alter the height of LFH but not the width of the face. This could affect the fWHR ratio as an increase in LFH will reduce the ratio.

Previous research has shown that fWHR was related to various social traits such as dominance, aggression, and trustworthiness. However, studies have revealed that the different

components of fWHR contribute differently to the perception of such traits. The width of the face has been found to be positively associated with perceptions of dominance and aggression. According to Carré & McCormick, a wider face has been shown to be a reliable predictor of aggressive behavior in male athletes[71], and individuals with wider faces are perceived as more dominant and aggressive by others[72, 73]. This could be due to puberty growth and the influence of testosterone, causing males to have larger facial width[74] which leads to them being perceived as more aggressive.

Furthermore, Short et al., designed a study investigating whether humans are sensitive to differences in fWHR when they are asked to judge the aggressiveness of faces with which they have little or no experience (other-race faces)[75]. The authors used a sample of adolescent males, with a roughly equal number of Caucasian and Asian participants. They first measured the participants' fWHR, then the participants' self-reported trait aggression and finally conducted a laboratory task that measured reactive aggression (i.e., aggressive behavior in response to provocation)[75]. It was found that a wider face was associated with higher levels of self-reported trait aggression and more reactive aggression in response to provocation, regardless of the race of the face[75]. This supports the findings found in the previous literature and may be due to the influence of testosterone exposure on facial structure and its link to personality traits related to aggression and dominance[75].

In contrast, the height of the upper face has been found to be related to perceptions of trustworthiness. A higher upper facial height is associated with a more trustworthy appearance, as these individuals are perceived as more honest and sincere[76]. This may be because a higher upper face height is associated with a less dominant appearance, which may be seen as less

threatening and more trustworthy by others. However, it is important to note that there seems to be a lack of research focusing on female fWHR. Nonetheless, these findings have important implications for our understanding of how facial features contribute to social perceptions, and how these perceptions can influence social interactions.

### *2.3.2 Lower Facial Height*

The concept of "facial harmony of thirds" is often discussed in the context of aesthetic and cosmetic analysis, particularly in fields like plastic surgery and dentistry[77]. It refers to the proportions of the face and how it can be divided into three equal horizontal sections, facial thirds (Figure 1). The idea behind facial harmony of thirds is that the ideal proportions between these three sections can vary from person to person, but they should generally be balanced and harmonious. When the thirds are in proportion, the face is often considered more aesthetically pleasing[77]. Factors such as symmetry, the size and shape of facial features, and the relative proportions of these thirds all play a role in facial aesthetics.

The mouth and smile, important aspects of the lower third portion of the face, have been identified as key components of facial attractiveness[5, 6]. Numerous studies have already explored the perception of facial attractiveness influenced by the lower portion of the face[78-80], especially the LFH, spanning from the *Sub-nasale* midpoint to *Menton*[66] (Figure 3).

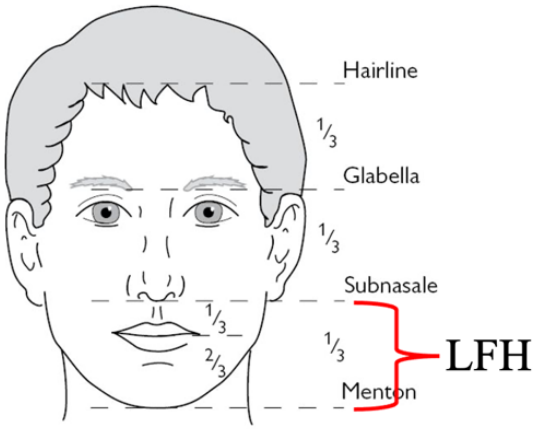


***Figure 3: Frontal view of the face showing division into thirds and further sub-division of lower third spanning from Subnasale to Menton. (Photo extracted from: Dentistry P Orthognathic surgery[67]).***

*2.3.3 Variation of LFH among ethnicities*

LFH varies among different ethnicities, and there are differences in average LFH measurements between different populations. Currently, there is limited research available on average LFH measurements for certain populations, such as Asian. However, there are some approximate LFH measurements reported in the literature for adults. According to Rabie and Wong, the mean lower facial height for Caucasians aged 22 to 25 years was reported to be 55 mm for males and 49 mm for females[81]. One study of African American adults aged 18 to 30 years reported a mean LFH of 60.12 mm[82]. Furthermore, a study done by Agrawal et al., reported a mean LFH of 57 mm for Indian adults aged 20-30 years[83]. Similarly, a study of Colombian adults aged 18 to 30 years also reported a mean LFH of 57 mm[84]. However, it is important to note that these values are based on averages and that individual variation is expected. Additionally, differences in measurement techniques and study populations can contribute to variations in reported values.

*2.3.4 Influence of LFH on attractiveness*

Previous research has evaluated the facial profile characteristics of attractive people[85] or rated facial photographs of subjects judged on their appearance[42, 78, 79, 86]. For instance, De Smit and Dermaut investigated the attractiveness of shadow profile silhouettes, which were edited to show varying LFH. These images were rated by dental students, and it was concluded that a reduced LFH was more acceptable than an increased lower facial proportion[87]. Similarly, research done by Michiels and Sather also found that profiles of Caucasian women with reduced vertical proportions were rated as more attractive than those with increased lower face vertical proportions, by a group of orthodontists and surgeons[8]. Similarly, in a study by Knight and Keith, increased LFH was found to be associated with less attractive faces for females, but no such trend existed for males[88]. Although, this study only utilized Caucasian subjects for the photographs and dental students as raters.

Additionally, a study done by Johnston and colleagues investigated the influence of changing lower face vertical proportion on the attractiveness ratings scored by university students. They rated the attractiveness of a series of male silhouettes with normal, reduced or increased lower face proportions. It was found that the profile images with a reduced lower face proportion were rated as significantly more attractive compared to the corresponding images with an increased LFH[89]. However, the study did not specify whether the raters had any idea about the gender of the silhouette used. Nevertheless, when it comes to comparing males and females, Varlik and colleagues found that there was a preference for increased LFH over decreased LFH in male silhouette images and the opposite was true for the female images[90].

*2.3.5 Occlusal influences on LFH*

Another important determinant of LFH is the occlusal vertical dimension (OVD). OVD describes the vertical relationship between the maxilla and the mandible during occlusion (Figure 4). In simple terms, it is the distance between two fixed points, such as the chin and the nose, when the teeth are in contact[91]. Therefore, tooth loss or wear will reduce OVD[91].

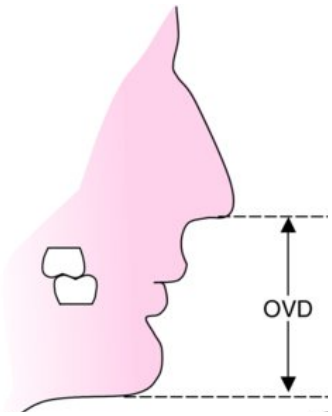


***Figure 4: Occlusal vertical dimension - distance between the chin and nose when the teeth are in contact (Photo extracted from: Turell [92]).***

When multiple posterior teeth are lost, the loss of OVD results in the collapse of the lower face. This makes the patient appear older as the lower face is vertically compressed, the cheeks and lips are slack, and the chin protrudes (Figure 5). This can also impair masticatory function and phonetics. Prosthetic treatments such as dentures aim to restore the OVD and re-establish the function and facial aesthetics the patient had before tooth loss[93].

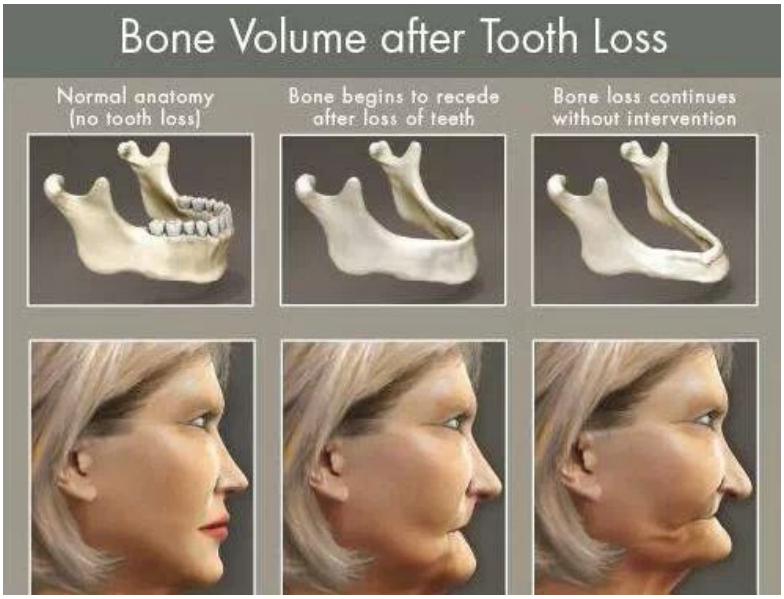


***Figure 5: Evolution of the effect of tooth loss on LFH appearance (Photo extracted from: Sassouni[94]).***

Complex restorative dental treatments in dentate patients can also involve changing the OVD. A study by Sun et al. evaluated the effects of varying the OVD in dentate participants on a number of parameters, including LFH and perceived facial aesthetics. Using digitally designed and 3D printed mandibular devices, the investigators incrementally increased the OVD in the study participants and measured the corresponding changes to LFH. Changes in facial aesthetics at different OVDs were evaluated by a group of prosthodontists, general dentists, and laypersons. The results showed that increasing OVD increases LFH, and that in people with no pre-existing loss of OVD, a vertical increase as small as 3 mm has been shown to be detected by both dentists and the public and perceived as less aesthetic[95]. In contrast, a 2002 study by Gross et al found that despite causing an objectively significant increase in LFH, OVD changes up to 6mm were not subjectively detected by participants evaluating changes in LFH[96].

*2.3.6 Skeletal influences on LFH*

Morphological changes of the skull that occur during growth and development also influence LFH. The mandibular growth pattern, which describes the degree of rotation of the mandible, affects the vertical relationships of the face[97]. LFH typically stops growing by the end of puberty, which is usually around the age of 18-21 years old for males and 16-18 years old for females[81]. Cephalometric measurements are often used to classify the pattern of mandibular growth. The growth patterns are typically described as hyperdivergent, normodivergent, and hypodivergent. The hyperdivergent pattern describes a backward rotation of the mandible and is typically associated with an increased LFH and a steeper mandibular plane, frequently associated with skeletal class II discrepancies. The hypodivergent pattern, which is a forward rotation of the mandible, exhibits opposite features to the hyperdivergent pattern, aggravating class III malocclusions[98].

The effects that mandibular growth has on the vertical height of the face has been thoroughly documented in the literature[91, 94, 99]. To investigate this relationship, a study by Rongo et al., used a combination of lateral cephalometric radiographs and 3D facial scans. Landmarks on the cephalometric images are used to study skeletal relationships (Figure 6). The Sella-Nasion mandibular plane angle (SNMP) was used to allocate participants to three groups: hyperdivergent (SNMP $\geq 42°$), normodivergent ($27° \leq$ SNMP $\leq 37°$), and hypodivergent (SNMP $\leq 22°$). Soft tissue analysis, including LFH was measured from the facial scans. Their results

showed that hyperdivergent participants had a significantly larger total facial height and LFH than the other groups[100].

Furthermore, the growth of the maxilla has an important effect on the LFH and the mandible. During growth and development, the maxilla undergoes vertical changes. If the maxilla experiences excessive vertical growth, it can lead to increased LFH[101]. Also, there is a reciprocal relationship between the upper and lower jaw, meaning that the growth of the maxilla can influence the growth of the mandible and alterations in one can affect the other. This shows that the natural growth patterns of the mandible and maxilla may have an influence on the variation in vertical facial dimension from person to person.

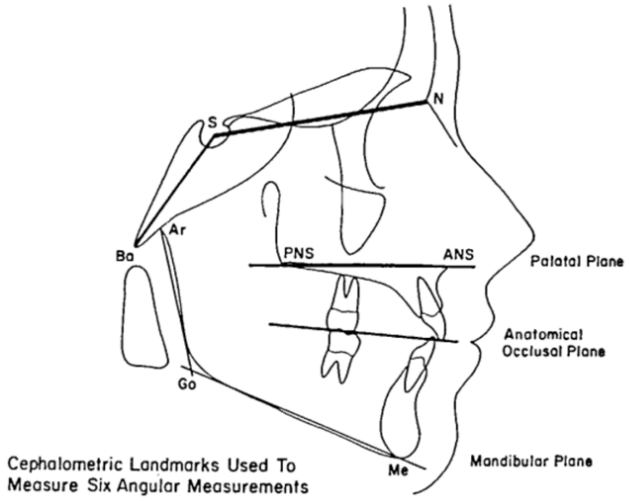


***Figure 6: Common skeletal landmarks used to measure angles on cephalometric images (Photo extracted from: Nanda[97]).***

## 3. RATIONALE

Previous literature has been heavily focused on perceptions of attractiveness which creates the need to explore if perception of personality also changes when altering the LFH. Most of the research used lateral photographs or profile silhouettes[87, 89, 90], whereas interactions between individuals are done from the front or from a 3/4 view. Furthermore, most of the published

studies described Caucasian populations[8, 88] while failing to explore various ethnicities. This contributes to the knowledge gap when exploring the relationship of perception of personality traits and LFH.

The LFH was chosen as the focus of this study as orthodontic diagnosis is performed in three dimensions, but the most emphasized part in the treatment plan is the esthetics of the facial profile, particularly, the lower third of the profile[102, 103]. Moreover, thanks to orthodontics and surgery the LFH can be altered.

Therefore, the primary aim of this study was to investigate if changing the lower facial height in frontal photographs can influence people's perception of personality traits, in various ethnicities (Caucasian, Asian, African American, Indian, and Hispanic) and between genders. Furthermore, aggressiveness has been previously explored throughout the literature; indeed, men with a high fWHR were described to be more aggressive[73, 104, 105]. To our knowledge, most of the studies published have looked at the width of the face, therefore we wanted to see if there would be an influence by the LFH, as orthodontic treatment and maxillofacial surgery can alter the length of the face. Therefore, the secondary outcome was to investigate which image, with increased or reduced LFH, would be rated as most aggressive for each gender and ethnicity.

## 4. STUDY AIMS AND OBJECTIVES

### 4.1 Research Question

Does Altering the Lower Height of the Face Affect Our Perception of Personality?

*4.2 Aims and objectives*

Since we know that the LFH can be influenced by growth and age, we chose photographs of middle-aged individuals as their growth is complete and can be offered a variety of treatment

options. We did not choose young individuals as they are still growing and their facial characteristics are still changing, we also did not choose older individuals as wrinkles may affect their neutral facial expressions. This was done to simplify the study and focus on only one specific age group.

### *4.2.1 Primary outcome*

Therefore, the primary aim of this study was to test the null hypothesis ($H_O$): the perception of intelligence, aggressiveness, confidence, friendliness and attractiveness will not be influenced by a change in the LFH. This means that the frequency of the selection of the images should be the same, statistically.

### *4.2.2 Secondary outcome*

The secondary outcome was to evaluate which image would be rated as most aggressive in each sample set. We decided to focus on the negative personality trait, aggressiveness, as the fWHR has already been documented as more aggressive in the literature. However, we cannot alter the width of the face but thanks to orthodontics and surgery we can alter the LFH.

## 5. METHODOLOGY

### *5.1 Study Design*

An experimental study was conducted, aimed at evaluating how subjects rate the personality traits of an experimental sample of photographs with average attractiveness whose lower facial proportions were altered.

*5.2 Study sample*

The raters included in this study: (1) were 18 years of age or older (2) freely consented to participate (3) read and understood French or English language.

*5.2.1 Evaluation of sample size*

Initially this research project was supposed to gather quantative data from a visual analogue scale (VAS), asking the participants to grade their perception of personality traits, however, this appeared to not be feasible when administering the pilot questionnaire. Based on research done by Varlik et al.[90], we estimated that a 10 point difference in the evaluation of attractiveness would be significant (based on the VAS from 0 to 100). We expected the average faces to have a mean of 60 (with a standard deviation of 20), and the altered imaged to be 50 (with a standard deviation of 20), with a risk alpha of 0.05 and power of 80%, we estimated a total number of 126 raters (epiR package 0.9-96 from BiostaTGV[106]) since e-mail response rates may only approximate 25% to 30% without follow-up e-mail and reinforcements[107]. If the response rate is estimated as being 20%, 650 participants would need to be invited to receive 130 responses. We believed that recruiting McGill's dental students/staff and patients will provide a good response rate as in person interaction and personalization has a significant impact on survey response rates[108]. Having a good response rate would reduce the non-response bias, increasing its validity and reliability.

*5.3 Ethical registration*

The research protocol was approved by the Research Ethics Office (International Review Board) of the Faculty of Medicine and Health Sciences at McGill University in April 2022, Quebec, Canada (IRB internal study number: A04-B35-228) (Appendix 10.1).

*5.4 Recruitment strategy*

For reasons of feasibility, cost, and safety in the context of a pandemic, raters (subjects responsible for evaluating the experimental photographs) were recruited among students or practitioners/staff members in the field of dental medicine, and among the general population (laypeople), more specifically from the waiting room of the dental medicine clinic of McGill University and Orthoperfection, a private orthodontic clinic. Raters were recruited from September 2022 to February 2023.

We would ideally offer this rating of photographs to the general population, to limit sampling bias. Unfortunately, major obstacles appear, such as nonresponse bias, the authorization to access email lists and low response rates.

*5.5 Data collection*

Participants completed the questionnaire online from their own tablet or computer, as they received a personal invitation by email. The questionnaire was also available for those without access to a computer, in the form of a paper booklet, printed in color and protected by plastic sheets, allowing for decontamination at each manipulation. The evaluations were reported by the researcher.

*5.6 Experimental materials: Photos*

This study utilized frontal face photographs taken from the Chicago Face Database (CFD version 3.0)[109] which provides photographs specifically intended for use in scientific research. It provides high- resolution, standardized photographs of male and female faces of varying ethnicities between the ages of 17-65. This age range was chosen because the LFH typically stops growing by the end of puberty, which is usually around the age of 18-21 years old for males and 16-18 years old for females[81]. These original photographs have been evaluated and subjectively rated by independent judges of the CFD, more specifically in terms of attractiveness. This allowed us to select an experimental photographic sample with average characteristics.

Photographs of a female and a male individual were chosen from each ethnicity: Caucasian, African American, Asian, Indian and Hispanic (Appendix 10.2). The photographs were chosen based on the following criteria: individuals needed to belong to a group of average attractiveness according to CFD database; to represent the Caucasian, African American, Asian and Hispanic ethnicities, individuals were chosen from a range of 2.46-4.00 (mean=3.23, SD=0.77). The photos selected to represent the Indian ethnicity were selected within an attractiveness range of 3.36- 4.52 (mean =3.94, SD =0.58, different database). Photos were taken with subject's faces at rest (closed mouth, neutral position), no apparent facial asymmetry, no lower vertical face disharmony, no labial incompetence or excessive dental protrusion, absence of facial hair (beard, moustache) or scars/skin imperfections.

*5.6.1 Manipulation of the photos to affect LFH*

For each real photo, four additional versions were edited to change the lower facial height, via a photographic editing software, Photoshop™ (CS6 version 21.01, Adobe Systems Inc., CA, USA). A study done by Alrbata and colleagues found that laypersons could detect a reduction in the LFH at 4% and an increase in LFH at 6%[77]. Their study utilized a participant with a total facial height of 70 mm and the photos were edited in increments of 2 mm. We used this study as a guiding measure to increase and decrease LFH in each of our chosen photographs. We first edited photos to follow a continuum, portraying two photos with decreased LFH, the control (unaltered) photo and two photos portraying an increased LFH (Figure 7). Therefore, five photos would be presented for each sample subject resulting in 50 distinct photographs generated in the experimental model.


***Figure 7: Continuum of altered LFH on African-American male sample***

Using Photoshop™, the lower third portion of the face was selected and either vertically displaced to increase or decrease it by 2-6 mm, and the clone stamp was used to fill in the missing parts of the image or create continuity of the skin contours (Figure 8).

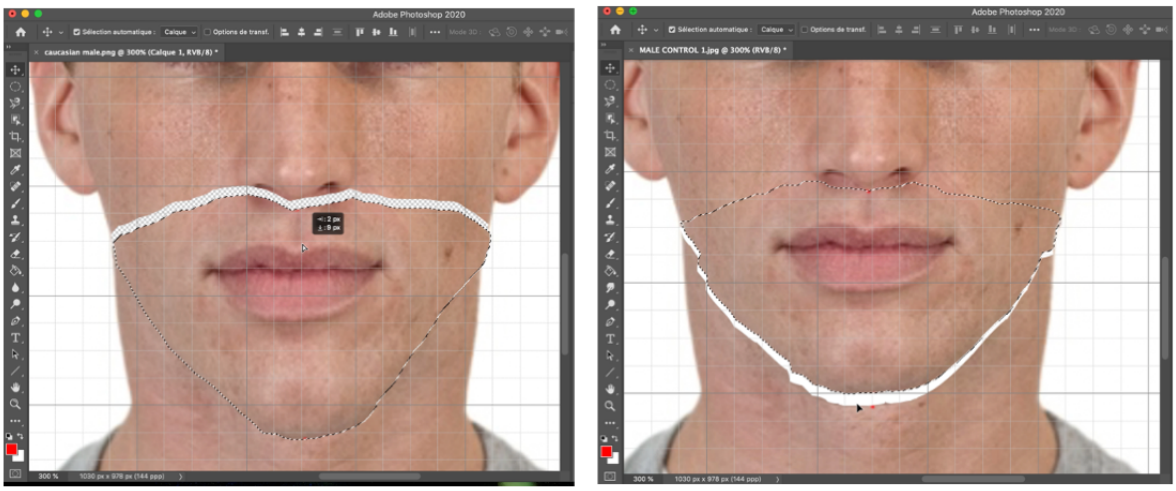

***Figure 8: Decreasing/increasing LFH on the male Caucasian via Photoshop***

Finally, the mouth was copied and pasted from the control image onto the edited ones in order to maintain the average ratio between the upper and lower lip lengths and not distort the lips. This was novel to our study as past research done by Alrbata et al.[77] did not take these lower facial landmarks into consideration causing increased or decreased height of the entire face, resulting in the stretching of soft tissues (enlarged and distorted lips) (Figure 9).


***Figure 9: Example of distorted photographs from Alrbata et al.[77] research (left) vs. edited photograph utilized in this study (right).***

*5.7 Study instrument*

The experimental questionnaire was given through McGill's LimeSurvey (v.3), a robust online survey tool, used to create surveys that can be published for public or private audiences, and particularly adapted to the questionnaire format that we created. It is hosted on a McGill server and maintained by IT Services. In the welcome page, raters were presented with a consent form and an explanation of the study (Appendix 10.3). Then, the next page gathered demographic data such as questions about their age, gender, ethnicity, education level, occupation, occupation domain and experience with orthodontics (Appendix 10.4).

The raters were then presented with the rating portion of the study, where they were shown all five photos of either a male or female from one of the five ethnicities through a randomization technique. They were then asked to pick one photo to match best with a given personality trait (for example: "Which of these subjects seems the friendliest?", "Which photo appears to be the most aggressive?" (Appendix 10.5)). Raters would repeat this for four personality characteristics (intelligence, aggressiveness, friendliness, confidence) and for attractiveness. These characteristics were chosen based on previous research done by Mugnier and colleagues, which explored the influence of orthognathic surgery on perception of personality traits in dysmorphic patients by laypersons[44]. In their review, they grouped together various research studies which used several questionnaires about personality and attractiveness. This included traits from four domains such as sociability, success, psychological adjustment and attractiveness. From this, we chose our four personality traits: intelligence, aggressiveness, friendliness, confidence and attractiveness.

*5.8 Primary variables influencing the outcome*

Age: participants from various age groups were included in this study (18-75+).

Ethnicity: participants from various ethnicities (Caucasian, Asian, Hispanic, Indian and African- American) were included in this study

Gender: females and males participated in this survey.

Occupation domain: participants were from various occupation domains, such as dentistry, which could influence how they rate the photographs.

*5.9 Data Analysis*

All statistical analyses were conducted using SPSS (Version 29, SPSS Inc., Chicago, Illinois, USA) and R (Version 1.0.153.)

*5.9.1 Descriptive analysis*

Descriptive analyses were conducted to describe the population sample characteristics. The variables included were the participants age, gender, ethnicity, education level, occupation, occupation domain and orthodontic experience. To address the projects first aim of exploring if altered LFH has an influence on how raters perceive personality traits and attractiveness chi square tests ($p=0.05$, Bonferroni corrected) and frequencies were used along with histograms describing the distributions. This specific analysis was conducted on SPSS.

*5.9.2 Odds ratio*

Odds-ratios with confidence intervals were used to analyze how certain choices were made by quantifying the strength and direction of associations between variables, more specifically how LFH effects the perception of aggressiveness in categories of gender and ethnicity.

## 6. RESULTS

### *6.1 Descriptive statistics*

#### *6.1.1 Participant characteristics*

The survey was sent to 198 people and 133 of them fully completed it, giving a response rate of 67%. Demographic details and participant characteristics are presented in Table 1. The raters comprised 82 females and 50 males. Many of the raters were between the ages of 20-30 years old (55%), had completed a bachelor's degree as their highest level of education (47%), were Caucasian (68.4%) and had a background in dental medicine (41%).

***Table 1: Baseline characteristics of participants***

| **Characteristic** | | **Frequency (n=133)** |
|---|---|---|
| **Age** | >20 years old | 2 (1.5%) |
| | 20-30 years old | 73 (54.9%) |
| | 31-40 years old | 21 (15.8%) |
| | 41-50 years old | 8 (6%) |
| | 51-60 years old | 15 (11.3%) |
| | 61-70 years old | 10 (7.5%) |
| | 71+ years old | 2 (1.5%) |
| | Prefer not to answer | 2 (1.5%) |
| **Gender** | Female | 82 (61.7%) |
| | Male | 50 (37.6%) |
| | Prefer not to answer | 1 (0.8%) |
| **Ethnicity** | Caucasian | 91 (68.4%) |
| | Afro-American | 1 (0.8%) |
| | Hispanic | 5 (3.8%) |
| | Asian | 14 (10.5%) |
| | Indian | 5 (3.8%) |
| | 2+ ethnicities | 2 (1.5%) |
| | Prefer not to answer | 15 (11.3%) |
| **Education Level** | High school | 7 (5.3%) |
| | Cegep DEC | 21 (15.85%) |
| | Bachelors degree | 63 (47.4%) |
| | Masters degree | 25 (18.8%) |
| | PH.D or higher | 8 (6%) |
| | Trade school | 6 (4.5%) |
| | Prefer not to answer | 3 (2.3%) |
| **Occupation** | Student | 60 (45.1%) |

| | | |
|---|---|---|
| | Employee | 45 (33.8%) |
| | Autonomous worker | 5 (3.8%) |
| | Business owner | 12 (9%) |
| | Retired | 8 (6%) |
| | Unemployed | 2 (1.5%) |
| | Prefer not to answer | 1 (0.8%) |
| **Occupation domain (N=130)** | Health & medicine | 12 (9%) |
| | Dental medicine | 55 (41.4%) |
| | Arts | 6 (4.5%) |
| | Business | 31 (23.3%) |
| | Communications | 2 (1.5%) |
| | Social services | 1 (0.8%) |
| | Education | 7 (5.3%) |
| | Science & technology | 6 (4.5%) |
| | Repair & maintenance | 2 (1.5%) |
| | Government | 1 (0.8%) |
| | Law | 5 (3.8%) |
| | Prefer not to answer | 2 (1.5%) |
| **Orthodontic experience** | Received treatment | 81 (60.9%) |
| | Did not receive treatment | 40 (30.1%) |
| | Consider receiving treatment | 8 (6%) |
| | Not interested | 3 (2.3%) |
| | Prefer not to answer | 1 (0.8%) |

*6.1.2 Effect of raters' variables influencing the outcome*

The variables of age, gender, ethnicity and occupation domain were not analyzed in the results because they added a lot of complexity since they could have introduced bias as most participants were between the age of 20-30 (55%), our sample size was too small for each ethnic group and the distribution between male (38%) and female (62%) was skewed. Furthermore, the participants with dental training were mostly dental students (from different grades) but also dental professionals, therefore some had more years of experience compared to others.

*6.2 Effect of varying LFH on personality traits and attractiveness*

For the primary outcome, a chi-square test of independence was performed to examine the relation between variations of the LFH and positive and negative personality traits and

attractiveness. The p-value was Bonferroni corrected, therefore, only p-values of <.001 were considered significant as they were multiplied by 50 (resulting in a p-value of .005), which is the number of times the test was run. Out of the 50 tests, only the 24 were found statistically significant (Table 2).

LFH influenced the choice for positive, negative or attractiveness personality traits in some of the photographs from our experiment (Table 2). For positive traits, such as intelligence, confidence and friendliness, the null hypothesis was rejected for female Asian and African-American as well as male Asian and Caucasian. LFH changes influenced the perception of aggressiveness in female African-American, Asian, Caucasian, Hispanic and Indian photos. LFH influence perception of attractiveness for female Asian, Indian African-American and Hispanic as well as Male Indian, Caucasian and Asian photos. These results indicate that LFH does influence the way we perceive these personality traits and attractiveness in our chosen sample of photographs.

*Aggressiveness judgements*

Aggressiveness perception was influenced by LFH as an increased LFH was perceived as more aggressive in the female African American, Asian, Caucasian and male Asian photos. A decrease in LFH was perceived as more aggressive for the female Hispanic and Indian photos.

*Intelligence judgements*

Intelligence perception was influenced by LFH as the unaltered and increased LFH were perceived as more intelligent in the female Asian while only an increased LFH was chosen for the male Asian. Normal and decreased LFH were preferred in the female African American.

*Confidence judgements*

Confidence perception was influenced by LFH as the unaltered and increased LFH were considered as more confident in the female Asian and male Caucasian, while the unaltered and decreased LFH were preferred in the female African American photo.

*Friendliness judgments*

Friendliness perception was influenced by LFH as the unaltered and increased LFH were considered more friendly in the female Asian and male Caucasian photos, while the normal and decreased LFH were chosen in the female Hispanic. A decreased LFH was preferred in the female African-American and male Asian photos.

*Attractiveness judgements*

Attractiveness perception was influenced by LFH as the unaltered and increased LFH were considered more attractive in the female Asian and Indian as well as Male Indian, Caucasian and Asian photos. Unaltered and decreased LFH were preferred in the female African American and Hispanic photos.

| | Variable | P-value* |
|---|---|---|
| 1 | The categories of female African American attractiveness do not occur with equal probabilities. | <.001 |
| 2 | The categories of female African American intelligence do not occur with equal probabilities. | <.001 |
| 3 | The categories of female African American aggressiveness do not occur with equal probabilities. | <.001 |
| 4 | The categories of female African American friendliness do not occur with equal probabilities. | <.001 |
| 5 | The categories of female African American confidence do not occur with equal probabilities. | <.001 |
| 6 | The categories of female Asian attractiveness do not occur with equal probabilities. | <.001 |
| 7 | The categories of female Asian intelligence do not occur with equal probabilities. | <.001 |
| 8 | The categories of female Asian aggressiveness do not occur with equal probabilities. | <.001 |
| 9 | The categories of female Asian friendliness do not occur with equal probabilities. | <.001 |
| 10 | The categories of female Asian confidence do not occur with equal probabilities. | <.001 |
| 11 | The categories of male Indian attractiveness do not occur with equal probabilities. | <.001 |
| 12 | The categories of female Hispanic attractiveness do not occur with equal probabilities. | <.001 |
| 13 | The categories of female Hispanic aggressiveness do not occur with equal probabilities. | <.001 |
| 14 | The categories of female Hispanic friendliness do not occur with equal probabilities. | <.001 |
| 15 | The categories of male Caucasian attractiveness do not occur with equal probabilities. | <.001 |
| 16 | The categories of male Caucasian friendliness do not occur with equal probabilities. | <.001 |
| 17 | The categories of male Caucasian confidence do not occur with equal probabilities. | <.001 |
| 18 | The categories of female Caucasian aggressiveness do not occur with equal probabilities. | <.001 |
| 19 | The categories of female Indian attractiveness do not occur with equal probabilities. | <.001 |
| 20 | The categories of female Indian aggressiveness do not occur with equal probabilities. | <.001 |
| 21 | The categories of male Asian attractiveness do not occur with equal probabilities. | <.001 |
| 22 | The categories of male Asian intelligence do not occur with equal probabilities. | <.001 |
| 23 | The categories of male Asian aggressiveness do not occur with equal probabilities. | <.001 |
| 24 | The categories of male Asian friendliness do not occur with equal probabilities. | <.001 |

*Since results were Bonferroni corrected only p values of <.001 were considered significant.

***Table 2: Chi square test results***

*6.3 Histogram of raters' choice based on personality traits and attractiveness, for all ethnicities and genders*

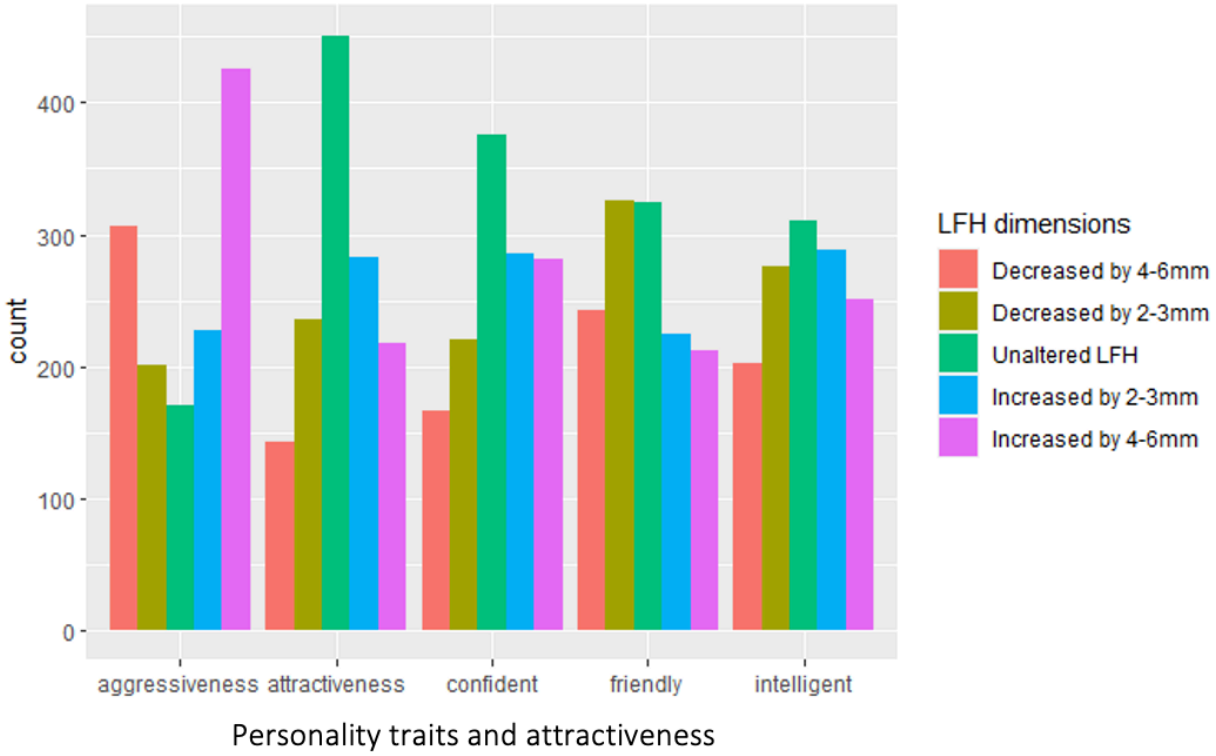


***Figure 10: Histogram of raters' choice based on personality traits and attractiveness for all ethnicities and genders***

Figure 10 illustrates the total count of participants selection as the "most" of each category: it shows which degree of altered LFH was chosen for each personality trait and attractiveness, all ethnicities and genders combined. It can be observed that the raters chose increased LFH as most aggressive while the unaltered LFH was chosen as most attractive, confident and intelligent. Additionally, raters seem to choose decreased LFH for most friendly.

*6.4 Raters choice based on gender of the photograph*

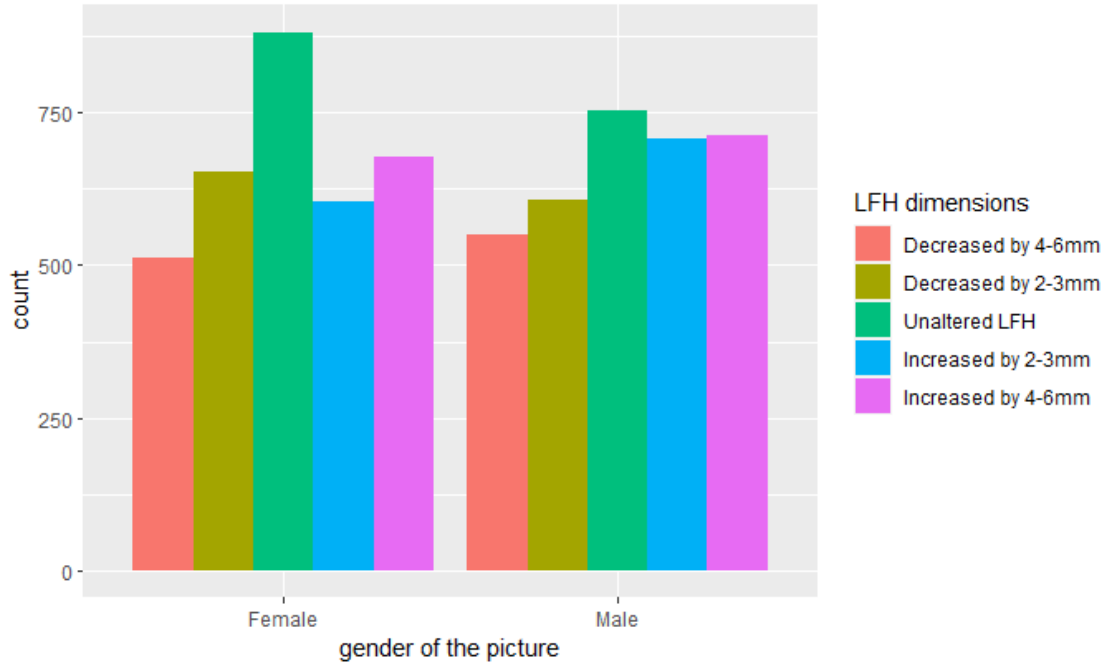


***Figure 11: Histogram of raters choice based on gender of the photograph***

Figure 11 illustrates the total count of participants selection for which degree of altered LFH was chosen for males and females, regardless of ethnicity. Visually, it seems that the distribution is centered around the unaltered LFH image for both male and female, this means the rater selected the image with average proportions most of the time. For females, there seems to be a strong preference for the unaltered LFH image and sharper decreases when choosing any of the altered LFH photos. For males, even though the distribution is centered towards the unaltered. However, it is important to note that this graph takes into account the negative and positive personality traits together.

*6.5 Raters choice based on ethnicity of the photograph*

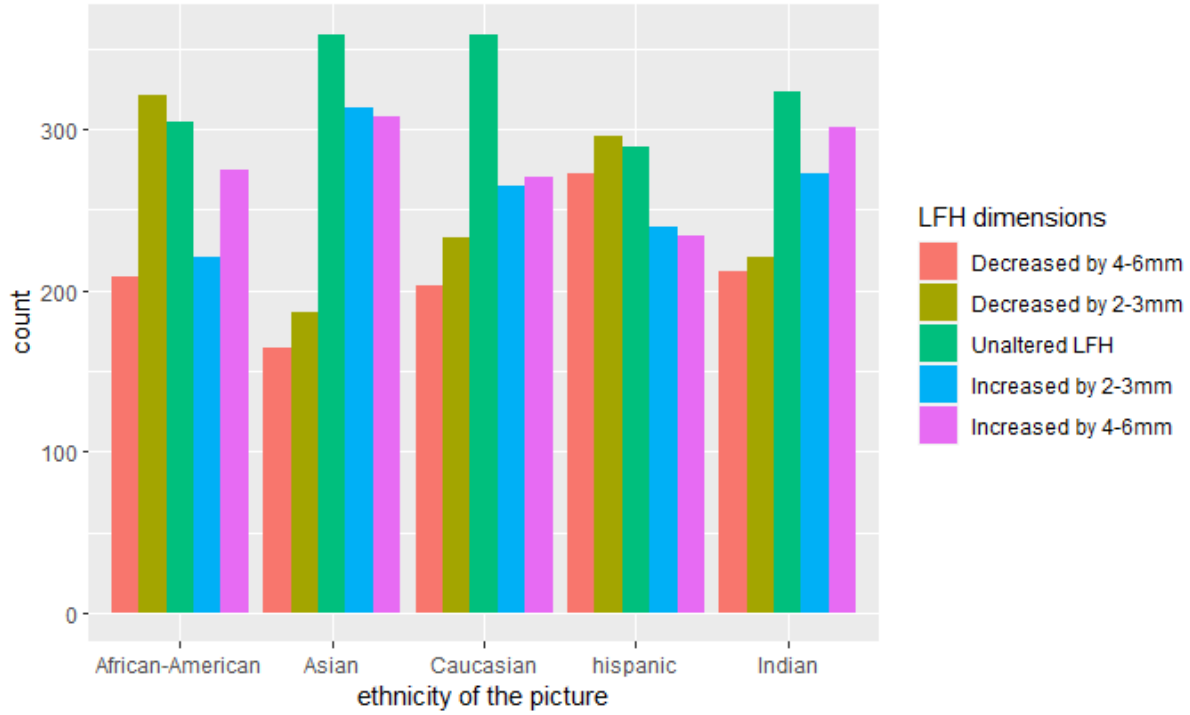


***Figure 12: Histogram of raters' choice based on ethnicity of the photograph***

Figure 12 represents which degree of altered or control LFH was chosen for each ethnicity in the sample photos (regardless of gender). We can see a trend to select the unaltered LFH for all ethnicities, except for the African-American and Hispanic, which tend to be more towards the decreased and unaltered LFH. However, it is important to note that this graph takes into account the negative and positive personality traits.

*6.6 Secondary outcome*

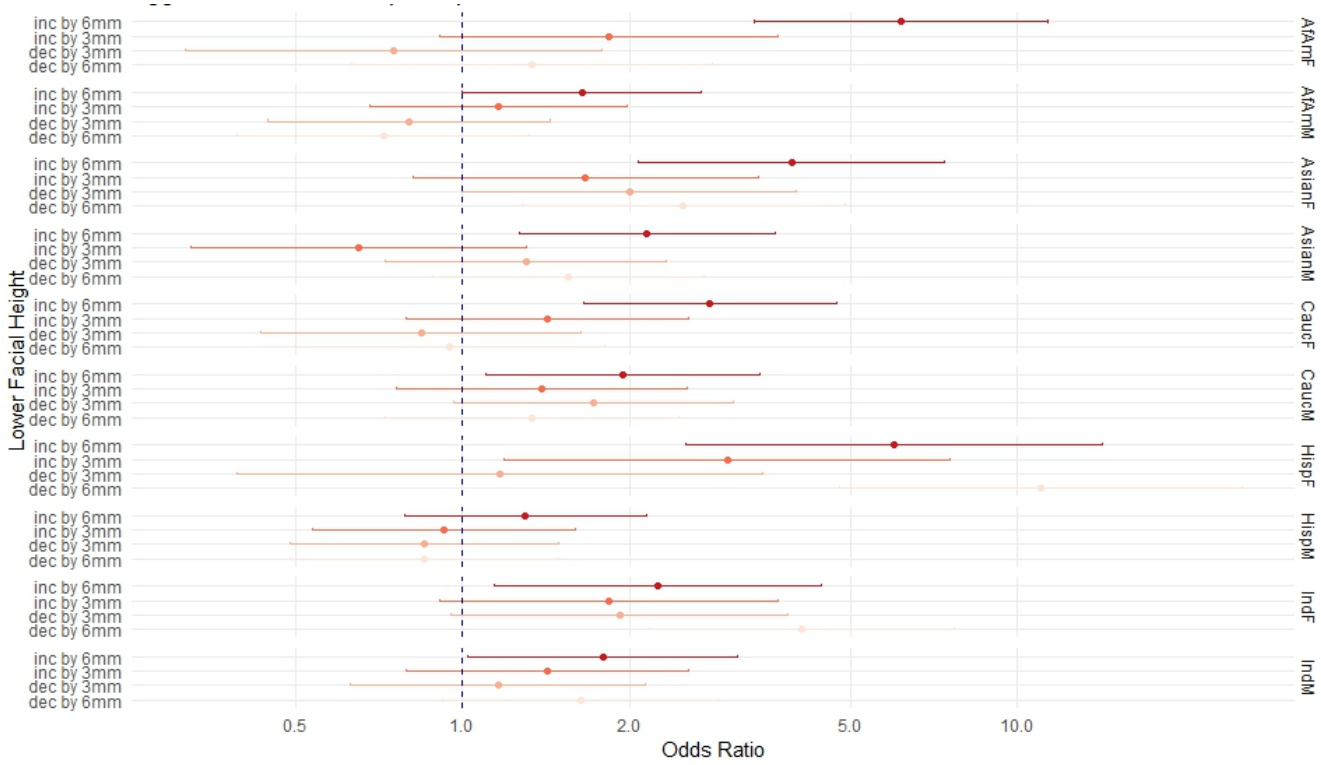


**Figure 13: Odds ratio of LFH aggressiveness**

An odds ratio analysis was performed on R to analyze which photograph was chosen as "most aggressive for all ethnicities and gender. Figure 13 indicates that the image of increased LFH by 6mm are more likely to be categorized as aggressive for: female African-American (odds ratio (OR)= 6.2 [3.4, 11.3]), Asian female (OR=3.9 [2, 7.4]) and male (OR=2.1 [1.3, 3.7]), Caucasian female (OR=2.8 [1.7, 4.7]) and male (OR= 2 [1.1, 3.4]), Hispanic female (OR=6 [2.5, 14.2]) and Indian female (OR= 2.3 [1.1, 4.4]) and male (OR= 1.8 [1.1, 3.1]) as their OR are greater than 1.0 and confidence intervals do not include 1.0.

## 7. DISCUSSION

The current study was designed to investigate how changing the lower vertical proportions of the face in frontal photographs can influence people's perception of personality traits and attractiveness, in various ethnicities and between genders. Secondly, we investigated which altered LFH image was chosen as most aggressive.

### *7.1 Summary of results*

Our results demonstrate that altering the LFH may affect the perception of personality. However, the relationship between LFH increase/decrease and impression formation appeared inconsistent across gender and ethnicity in our chosen sample.

Furthermore, the photographs with increased LFH of 6mm were chosen as the most aggressive for African-American female, Caucasian female and male, Asian female and male, Hispanic female and Indian female and male.

#### *7.1.1 Facial Width to Height Ratio*

Our results show that an increased LFH (6 mm) was perceived as more aggressive in the African-American female, Caucasian female and male, Asian female and male, Hispanic female and Indian female and male sample photos. More specifically, in our sample, we found differences in the way aggressiveness was perceived with increased LFH, in various ethnicities. For example, we found that the female African-American sample photo was 6.2 times more likely to be categorized as aggressive with an increased LFH (OR)= 6.2 [3.4, 11.3]). Additionally, the Hispanic female was 6 times more likely to be categorized as aggressive with an increased LFH (OR=6 [2.5, 14.2]).

Furthermore, the width of the face, which was unaltered could have played into the rater's perception. Indeed, facial width has been found to be positively associated with

perceptions of dominance and aggression. According to Carré & McCormick, a wider face has been shown to be a reliable predictor of aggressive behavior in male athletes[71], and individuals with wider faces are perceived as more dominant and aggressive by others[72]. However, a decrease in LFH was perceived as more aggressive for the female Hispanic and Indian photos in our sample. Past research done by Hehman and colleagues examining young adults' faces has revealed the impact of the fWHR on perceived traits, such that individuals with longer, thinner faces are perceived to be less aggressive, less physically powerful, and friendlier[110].

Additionally, confidence perception was influenced by LFH as the unaltered and increased LFH were considered as more confident in the female Asian and male Caucasian, while the unaltered and decreased LFH were preferred in the female African-American photo. Currently, there is some evidence to suggest that overall facial appearance can influence judgments of confidence and competence. Our results could be explained in part by a study by Todorov et al, which found that people's judgments of facial competence were influenced by variations in facial features such as the shape of the jawline and the distance between the eyebrows and the eyes[111]. Faces with a wider jawline and a greater distance between the eyebrows and eyes were perceived as more competent[111]. Other studies have suggested that judgments of confidence may also be influenced by facial features such as facial expressions, eye contact, and the presence of certain facial cues such as a strong jawline[33].

Furthermore, the photograph with unaltered LFH was chosen many times as the most attractive, confident, friendly, intelligent and aggressive. Baseline measurements of LFH and total facial height (TFH) were taken on our sample from the original unaltered photographs. The male Caucasian, Hispanic, Indian, African-American and the female Indian have LFH/TFH of 54-55% (Appendix 10.6). This could be explained by previous research done by Johnston and

colleagues, which investigated the influence of changing lower face vertical proportion on the attractiveness ratings scored by lay people[89]. They found that the profile with the Eastman normal value for LFH/TFH of 55% was considered by the lay judges to be the most attractive[89]. This could be related to Edler's proposal that 'averageness' in facial appearance was an important factor in attractiveness[112]. The current findings also support Sergl et al., who suggested that the perception of beauty was associated with regularity of facial features as conveyed by measurement values located close to the mean[113].

*7.1.2 Emotion residue*

Friendliness perception was influenced by LFH as the unaltered and increased LFH were considered more friendly in the female Asian and male Caucasian photos, while the normal and decreased LFH were chosen in the female Hispanic. Studies have suggested that judgments of approachability and friendliness may also be influenced by facial features such as facial expressions, symmetry, and the presence of certain facial cues such as a smile[33, 114].

Additionally, gender and race exhibit facial appearance cues that can be easily confused with emotional expressions. For example, a study by Zebrowtiz et al., demonstrated that neutral male faces triggered higher activation of angry expression nodes and lower activation of happy expression nodes compared to neutral female faces[31]. Furthermore, Caucasian faces tended to activate anger expression nodes more than African American or Korean faces, while African American faces activated happy and surprise nodes more than Caucasian faces[31]. These findings suggest that facial expressions of emotion not only convey a person's internal emotional state but also provide valuable cues for perceiving different interpersonal traits, which may influence the formation of trait inferences.

*7.1.3 Familiar face overgeneralization*

Familiar-face overgeneralization could have played a role in how participants from the same ethnicities as the photographs rated photographs from their own ethnicity. This could have caused own-race positivity bias since individuals tend to recognize and remember faces of their own racial or ethnic group more accurately than faces from other ethnic groups. This was seen in a study done by Tinio and colleagues, examining aesthetic judgments of faces, and how these effects are modulated by familiarization[115]. Their results showed that people are drawn to those with familiar characteristics, as familiarization to a specific face type resulted in structural generalization effects, providing higher aesthetic judgments to faces that were novel but had similar resemblances to those which they were familiarized[115]. Thus, this phenomenon has the potential to further contribute to ingroup favoritism and negative outgroup stereotypes[24].

*7.1.4 Dental training*

A large portion of the participant pool received dental training (41.4%) which may have impacted their choices. This profession requires perception and visual acuity which allows them to see minute changes, which allows them to properly judge positions, distances, and the size of objects[116]. Our photographs were edited by millimeters, which could have been unnoticed to the untrained eye of laypersons. Ultimately, dental training could have influenced certain participants to choose the photograph with the unaltered LFH as the others may have been more obviously edited and look more unnatural to them. Jung et al. conducted a study investigating the gender and dental education-specific differences in perception of facial attractiveness for varying ratio of lower face contour[117]. It was found that the facial image with an increased LFH were perceived to be much less attractive to the dentally educated respondents, which may suggest that the dental education might have some influence in sensitivity to vertical changes in lower

face[117]. Furthermore, research findings show that when rating photographs of altered LFH, orthodontists and oral maxillofacial surgeons were more critical in detecting reductions and increases in the LFH compared to laypersons[77].

*7.2 Methodological considerations*

*7.2.1 Study strengths*

One of the main strengths of this study is that it utilized high resolution, colored, photographs of real human faces, from various ethnicities. This added a realistic aspect to the study as previous research used drawings or silhouettes. Although this kind of image might distract the raters due to the presence of other face components, such protocol was found to add more realism to the representation of the facial esthetics and that these components were controlled in this study by maintaining the same features for all images manipulated.

*7.2.2 Limitations*

While this study offers valuable insights, it is important to acknowledge certain limitations. For one, our study did not have enough raters in each ethnicity group, therefore we had to group them as Caucasian and 'Non-Caucasian', which included all other ethnicities such as Hispanic, Indian, Asian and African-American. Furthermore, the chosen sample of photographs could have had a hyperdivergent pattern (associated with increased LFH) or a hypodivergent pattern (associated with decreased LFH)[98] that we were not aware of when initially picking the photographs from the CFD, as average attractiveness, middle age and lack of facial hair/imperfection were our main selection criteria. Furthermore, each sample photograph had different baseline measurements for the facial landmarks, such as upper facial height, LFH, total facial height which could cause major differences when altering the original photographs. For example, some original photos had smaller or greater LFH proportions to begin with and

when altered to decrease the LFH by 2-6mm this could cause the photograph to look strange, ultimately influencing the rater's choice when answering the survey.

Additionally, the perception of facial proportions, in a frontal view, can vary depending on the anteroposterior relationship between the maxilla and mandible, which can have an impact on the overall facial appearance. Therefore, the photographs should have undergone a preliminary assessment based on specific criteria. For instance, standardizing the photographs at baseline could have involved evaluating the facial thirds along with the upper and lower lip length ratio.

Although the photographs used in our study were of neutral facial expressions, there could have been traces of lingering emotional tone, also known as emotion residue. For example, the people in our selected sample of photographs could have been expressing an emotion right before their photo was taken, which could have an underlying effect on how the raters matched the pictures with a personality trait. This was also seen in a study by Knuston examining the impact of facial expressions of emotion on subjects' perceptions of interpersonal traits[118]. The results revealed that happy expressions were associated with higher ratings of dominance and affiliation and angry expressions were also linked to high dominance[118]. On the other hand, fearful and sad expressions were related to lower dominance ratings[118].

Moreover, when creating the initial protocol for this study, the secondary outcome we wanted to explore was if the raters' characteristics such as age, gender, ethnicity and education background could influence their rating of the photographs. However, this was not possible as our sample size was too small for each ethnic group and the distribution between male (38%) and female (62%) was not equal. Furthermore, the participants with dental training were mostly

students but also dental professionals, therefore some had more years of experience compared to others which may create a bias.

While the photographs in the questionnaire were randomized, the questions were not. This could have introduced the sequencing effect as all the questions were presented in the same order for each sample set of the photographs. This may cause respondents to unintentionally carry their choices from one question to the next, ultimately affecting their answers.

Additionally, most of the participants were between the ages of 20-30 (54.9%) this could cause the potential bias of age cohort effect as the results may be specific to that generation and may not be representative of other age groups or generations. Especially since young people are more concerned with the attractiveness of facial appearance[89]. This could also lead to limited generalizability as the participants primarily belong to a narrow age range, the results may not be applicable to the broader population. Generalizing the findings to other age groups or diverse populations becomes challenging, as the research might not capture the variability present in the larger population. Furthermore, for the statistical analysis it would be beneficial to separate the positive and negative personality traits so that we could compare the data separately.

*7.2.3 Future scope and implications*

Future research would require a larger sample from each ethnicity to investigate if different ethnicities rate the photographs differently. Additionally, the same protocol could be adapted for another specific age group, which could simplify the study by not having them all mixed together, ultimately decreasing the number of variables. With more participants implicated (at least 250) in the study, discrete choice modelling could be used to conduct the analysis since all the choices presented to the participants were mutually exclusive (altered

pictures of different ethnicities). This type of modeling is a research technique used to understand individual decision-making processes[119] and can explore if ethnicity or dental training of the rater had an influence on their choices. This modeling process involves using statistical techniques, such as multinomial logistic regression to analyze the collected data. These models estimate the choice probabilities based on the attributes of the alternatives and the preferences of the decision-makers[119].

Furthermore, it would be interesting to see how the use of videos instead of photographs could be incorporated into this kind of research. This could be beneficial as this mimic's real life daily encounters. This may affect how we perceive another person's personality traits and attractiveness. Also, future research should investigate the criteria which would explain how someone can benefit from an increase or decrease of LFH. This is clinically important as we may have a way to correct LFH through orthodontics or maxillofacial surgery.

## 8. CONCLUSION

This thesis sets out to explore if altering the LFH on frontal facing photographs would influence how people perceive personality and attractiveness. The results demonstrate that altering the LFH may affect perception of personality. However, the relationship between LFH increase/decrease and impression formation appeared inconsistent across gender and ethnicity in our chosen sample. Additionally, it was found that the photographs with increased LFH of 6mm were chosen as the most aggressive for African-American female, Caucasian female and male, Asian female and male, Hispanic female and Indian female and male.

Finally, the findings presented in this thesis underscore the importance of facial features in shaping our perceptions of others' personalities and the potential impact of facial height on social interactions. Recognizing these subtle yet significant connections has the potential to deepen our understanding of human behavior and may have implications in various domains, such as social psychology and even clinical practice. Moreover, future research should focus on using a larger sample size of laypersons with diverse ethnic backgrounds, and several other photographic samples, as no generalization can be made. Future research endeavors should explore potential confounding factors and the interplay of multiple facial features to obtain a more comprehensive picture of how LFH may interact with other characteristics in influencing personality traits.

Ultimately, this research project serves as a steppingstone for further investigations, encouraging researchers to delve deeper into the complex interplay between facial features and personality. This could lead to a more comprehensive understanding of the human psyche and the intricate ways in which physical appearance, more specifically the LFH, can influence our perceptions and social interactions.

## 9. REFERENCES


1. Langlois JH, Kalakanis L, Rubenstein AJ, et al. Maxims or myths of beauty? A meta-analytic and theoretical review. Psychol Bull 2000;126(3):390-423.
2. Said CP, Sebe N, Todorov A. Structural resemblance to emotional expressions predicts evaluation of emotionally neutral faces. Emotion 2009;9(2):260-4.
3. Pithon MM, Andrade D, Fernandes I, et al. Influence of malocclusion on social perceptions of adolescents at public and private schools. Eur Arch Paediatr Dent 2014;15(1):37-43.
4. Adams RB, Jr., Nelson AJ, Soto JA, Hess U, Kleck RE. Emotion in the neutral face: a mechanism for impression formation? Cogn Emot 2012;26(3):431-41.
5. Goldstein RE. Study of need for esthetics in dentistry. J Prosthet Dent 1969;21(6):589-98.
6. Kerns LL, Silveira AM, Kerns DG, Regennitter FJ. Esthetic preference of the frontal and profile views of the same smile. J Esthet Dent 1997;9(2):76-85.
7. Walker M, Vetter T. Portraits made to measure: manipulating social judgments about individuals with a statistical face model. J Vis 2009;9(11):12 1-13.
8. Michiels G, Sather AH. Determinants of facial attractiveness in a sample of white women. Int J Adult Orthodon Orthognath Surg 1994;9(2):95-103.
9. Gunn DA, Rexbye H, Griffiths CE, et al. Why some women look young for their age. PLoS One 2009;4(12):e8021.
10. Willis J, Todorov A. First impressions: making up your mind after a 100-ms exposure to a face. Psychol Sci 2006;17(7):592-8.
11. Asch SE. Forming impressions of personality. J Abnorm Psychol 1946;41:258-90.
12. Todorov A, Mandisodza AN, Goren A, Hall CC. Inferences of competence from faces predict election outcomes. Science 2005;308(5728):1623-6.
13. Zebrowitz LA, Montepare JM. Social Psychological Face Perception: Why Appearance Matters. Soc Personal Psychol Compass 2008;2(3):1497.
14. Hassin R, Trope Y. Facing faces: studies on the cognitive aspects of physiognomy. J Pers Soc Psychol 2000;78(5):837-52.
15. Yang Q, Zhu B, Zhang Q, et al. Effects of Male Defendants' Attractiveness and Trustworthiness on Simulated Judicial Decisions in Two Different Swindles. Front Psychol 2019;10:2160.
16. Rule NO, Krendl AC, Ivcevic Z, Ambady N. Accuracy and consensus in judgments of trustworthiness from faces: behavioral and neural correlates. J Pers Soc Psychol 2013;104(3):409-26.
17. Todorov A, Olivola CY, Dotsch R, Mende-Siedlecki P. Social attributions from faces: determinants, consequences, accuracy, and functional significance. Annu Rev Psychol 2015;66:519-45.
18. Cogsdill EJ, Todorov AT, Spelke ES, Banaji MR. Inferring character from faces: a developmental study. Psychol Sci 2014;25(5):1132-9.
19. Zebrowitz LA. First Impressions From Faces. Curr Dir Psychol Sci 2017;26(3):237-42.
20. Zebrowitz LA, Fellous JM, Mignault A, Andreoletti C. Trait impressions as overgeneralized responses to adaptively significant facial qualities: evidence from connectionist modeling. Pers Soc Psychol Rev 2003;7(3):194-215.

21. Berry DS, McArthur LZ. Perceiving character in faces: the impact of age-related craniofacial changes on social perception. Psychol Bull 1986;100(1):3-18.
22. Montepare JM, Zebrowitz-McArthur L. Children's perceptions of babyfaced adults. Percept Mot Skills 1989;69(2):467-72.
23. Zebrowitz LA, & McDonald, S. The impact of litigants' baby-facedness and attractiveness on adjudications in small claims courts. Law and Human Behavior 1991;15:603-23.
24. Zebrowitz LA, Bronstad, P. M., & Lee, H. K. The contribution of face familiarity to ingroup favoritism and stereotyping. Social Cognition 2007;25(2):306-08.
25. Zebrowitz LA, White B, Wieneke K. Mere Exposure and Racial Prejudice: Exposure to Other-Race Faces Increases Liking for Strangers of That Race. Soc Cogn 2008;26(3):259-75.
26. Kramer RS, Ward R. Internal facial features are signals of personality and health. Q J Exp Psychol (Hove) 2010;63(11):2273-87.
27. Lewicki P. Nonconscious biasing effects of single instances on subsequent judgments. Journal of Personality and Social Psychology 1985;48:563–74.
28. Blair IV, Judd CM, Sadler MS, Jenkins C. The role of Afrocentric features in person perception: judging by features and categories. J Pers Soc Psychol 2002;83(1):5-25.
29. Zebrowitz LA RG. Sensitivity to "Bad Genes" and the Anomalous Face Overgeneralization Effect: Cue Validity, Cue Utilization, and Accuracy in Judging Intelligence and Health. Journal of Nonverbal Behavior 2004;28:167-85.
30. Montepare JM DH. The ecological approach to person perception: Evolutionary roots and contemporary offshoots. Journal of Nonverbal Behavior 2003;27:237-54.
31. Zebrowitz LA, Kikuchi, M., & Fellous, J. M. Facial resemblance to emotions: Group differences, impression effects, and race stereotypes. ournal of Personality and Social Psychology 2010;98:175–89.
32. Brown E, Perrett DI. What gives a face its gender? Perception 1993;22(7):829-40.
33. Zebrowitz LA, Collins MA. Accurate social perception at zero acquaintance: the affordances of a Gibsonian approach. Pers Soc Psychol Rev 1997;1(3):204-23.
34. Keating CF, Mazur, A., & Segall, M. H. Facial gestures which influence the perception of
35. Hess U, Adams, R. B., Jr., & Kleck, R. E. Who may frown and who should smile? Dominance, affiliation, and the display of happiness and anger. Cognition and Emotion 2005;19
36. Marsh AA, Adams RB, Jr., Kleck RE. Why do fear and anger look the way they do? Form and social function in facial expressions. Pers Soc Psychol Bull 2005;31(1):73-86.
37. Becker DV, Kenrick, D.T., Neuberg, S.L., Blackwell, K.C., & Smith, D.M. The confounded nature of angry men and happy women. Journal of personality and social psychology 2007;92(2):179-90.
38. Albohn DN, & Adams, R. B. Emotion Residue in Neutral Faces: Implications for Impression Formation. Social Psychological and Personality Science 2021;12(4):479-86.
39. Adams RB, Jr., Garrido CO, Albohn DN, Hess U, Kleck RE. What Facial Appearance Reveals Over Time: When Perceived Expressions in Neutral Faces Reveal Stable Emotion Dispositions. Front Psychol 2016;7:986.
40. Neth D, Martinez AM. Emotion perception in emotionless face images suggests a norm-based representation. J Vis 2009;9(1):5 1-11.

41. Tung AW, Kiyak HA. Psychological influences on the timing of orthodontic treatment. Am J Orthod Dentofacial Orthop 1998;113(1):29-39.
42. Shaw WC. The influence of children's dentofacial appearance on their social attractiveness as judged by peers and lay adults. Am J Orthod 1981;79(4):399-415.
43. Shaw WC, Rees G, Dawe M, Charles CR. The influence of dentofacial appearance on the social attractiveness of young adults. Am J Orthod 1985;87(1):21-6.
44. Mugnier J, Ibrahim B, Bouletreau P, Sigaux N. The influence of orthognathic surgery on the perception of personality traits: A scoping review. Int J Oral Maxillofac Surg 2020;49(10):1294-302.
45. Bruce V, Burton, A. M., Hanna, E., Healey, P., Mason, O., Coombes, A., ... Linney, A. Sex discrimination: how do we tell the difference between male and female Perception 1993;22:131–52.
46. Burton AM, Bruce, V., & Dench, N. What's the difference between men and women? Evidence from facial measurement. Perception 1993;22:153–53.
47. Russell R. A sex difference in facial contrast and its exaggeration by cosmetics. Perception 2009;38(8):1211-9.
48. Stephen ID, McKeegan AM. Lip colour affects perceived sex typicality and attractiveness of human faces. Perception 2010;39(8):1104-10.
49. Dupuis-Roy N, Fortin I, Fiset D, Gosselin F. Uncovering gender discrimination cues in a realistic setting. J Vis 2009;9(2):10 1-8.
50. Friedman H, & Zebrowitz, L. A. The contribution of typical sex differences in facial maturity to sex role stereotypes. Personality and Social Psychology Bulletin 1992(18):430-38.
51. Adams Jr RB, Hess, U., & Kleck, R. E. The intersection of gender-related facial appearance and facial displays of emotion. Emotion Review 2015;7(1):5-13.
52. Hess U, Adams RB, Jr., Kleck RE. Facial appearance, gender, and emotion expression. Emotion 2004;4(4):378-88.
53. Keating CF, Mazur, A., & Segall, M. H. . A cross-cultural exploration of physiognomic traits of dominance and happiness. Ethology and Sociobiology 1981;2(1):41-48.
54. Montepare JM, & Opeyo, A. The relative salience of physiognomic cues in differentiating faces: A methodological tool. Journal of Nonverbal Behavior 2002(26(1)):43-59.
55. Strom MA, Zebrowitz LA, Zhang S, Bronstad PM, Lee HK. Skin and bones: the contribution of skin tone and facial structure to racial prototypicality ratings. PLoS One 2012;7(7):e41193.
56. Johnson KL, Freeman, J. B., & Pauker, K. Race is gendered: How covarying phenotypes and stereotypes bias sex categorization. Journal of Personality and Social PSychology 2012;102(1):116–31.
57. Mark LS, Pittenger, J. B., Hines, H., Carello, C., Shaw, R. E., & Todd, J. T. Wrinkling and head shape as coordinated sources of age-level information. Attention, Perception, & Psychophysics 1980;27(2):117–24.
58. Voelkle MC, Ebner, N. C., Lindenberger, U., & Riediger, M. Let me guess how old you are: Effects of age, gender, and facial expression on perceptions of age. Psychology and Aging 2015;30(4):828–34.

59. Zebrowitz LA, Hall, J. A., Lee, H. K., & Rhodes, G. Who said baby-faced men are weak? Facial cues to dominance and their influence on attribution of leadership capacity. Journal of Applied Psychology 2017;102(2):161–73.
60. Little AC, Jones BC, DeBruine LM. Facial attractiveness: evolutionary based research. Philos Trans R Soc Lond B Biol Sci 2011;366(1571):1638-59.
61. Etcoff NL, Stock S, Haley LE, Vickery SA, House DM. Cosmetics as a feature of the extended human phenotype: modulation of the perception of biologically important facial signals. PLoS One 2011;6(10):e25656.
62. Walker M, & Vetter, T. Changing the facial profile: Predicted impact on social perceptions. The Angle Orthodontist 2016;86(2):237-44.
63. Proffit WR, Jackson TH, Turvey TA. Changes in the pattern of patients receiving surgical-orthodontic treatment. Am J Orthod Dentofacial Orthop 2013;143(6):793-8.
64. Fish LC, Epker BN, Sullivan CR. Orthognathic surgery: the correction of dentofacial deformities. J Oral Maxillofac Surg 1993;51(1 Suppl 1):28-41.
65. Zhou W, Zhang, Q., & Chen, J. Facial Width-to-Height Ratio: A Meta-Analysis of Empirical Evidence. Personality and Social Psychology Review 2016;20(4):415–31.
66. Naini FB, Gill DS. Facial aesthetics: 2. Clinical assessment. Dent Update 2008;35(3):159-62, 64-6, 69-70.
67. Dentistry P Orthognathic surgery. 2015. "https://pocketdentistry.com/orthognathic-surgery/".
68. Marcinkowska UM. Facial Width-to-Height Ratio (FWHR). In: Shackelford TK, editor. Encyclopedia of Sexual Psychology and Behavior. Cham: Springer International Publishing; 2023. p. 1-3.
69. Sato S, Kinoshita K, Sekino K, et al. The Association Between Facial Width-to-Height Ratio (fWHR) and Sporting Performances: Evidence From Professional Basketball Players in Japan. Front Psychol 2021;12:714819.
70. Merlhiot G, Mondillon, L., Méot, A., Dutheil, F., & Mermillod, M. Facial width-to-height ratio underlies perceived dominance on facial emotional expressions. Personality and Individual Differences 2021;172.
71. Carre JM, McCormick CM. In your face: facial metrics predict aggressive behaviour in the laboratory and in varsity and professional hockey players. Proc Biol Sci 2008;275(1651):2651-6.
72. Zilioli S, Sell AN, Stirrat M, et al. Face of a fighter: Bizygomatic width as a cue of formidability. Aggress Behav 2015;41(4):322-30.
73. Geniole SN, Molnar DS, Carre JM, McCormick CM. The facial width-to-height ratio shares stronger links with judgments of aggression than with judgments of trustworthiness. J Exp Psychol Hum Percept Perform 2014;40(4):1526-41.
74. Penton-Voak IS CJ. High salivary testosterone is linked to masculine male facial appearance in humans. Evol Hum Behav 2004;25(229–241).
75. Short LA, Mondloch CJ, McCormick CM, et al. Detection of Propensity for Aggression based on Facial Structure Irrespective of Face Race. Evol Hum Behav 2012;33(2):121-29.
76. Oosterhof NN, Todorov A. The functional basis of face evaluation. Proc Natl Acad Sci U S A 2008;105(32):11087-92.

77. Alrbata RH, Alfaqih AK, Almhaidat MR, Al-Tarawneh AM. Thresholds of Abnormality Perception in Facial Esthetics among Laypersons and Dental Professionals: Frontal Esthetics. Int J Dent 2020;2020:8946063.
78. Albino JE, Lawrence SD, Tedesco LA. Psychological and social effects of orthodontic treatment. J Behav Med 1994;17(1):81-98.
79. Orsini MG, Huang GJ, Kiyak HA, et al. Methods to evaluate profile preferences for the anteroposterior position of the mandible. Am J Orthod Dentofacial Orthop 2006;130(3):283-91.
80. Phillips C, Griffin T, Bennett E. Perception of facial attractiveness by patients, peers, and professionals. Int J Adult Orthodon Orthognath Surg 1995;10(2):127-35.
81. Rabie AB, & Wong, R. W. Effects of age and sex on the lower face: A cross-sectional study of 22- to 25-year-olds. Journal of Orthodontics 2010;37(4):234-41.
82. Brown RH, Desai, K., Prasad, H., & Mars, M. Lower facial height of young African American adults. The Angle Orthodontist 2010;80(4):710-14.
83. Agrawal M, Lobo, S., Vyas, N., & Jadhav, A. . Lower facial height in Indian adults: A cephalometric study. Journal of Orthodontic Science 2012;1(1):11-16.
84. Bergersen EO, & Ogaard, B. Ethnic variations in the craniofacial skeleton and soft tissues: A cephalometric study of young Colombian adults. European Journal of Orthodontics 2014;36(5):501-08.
85. Zaidel DW, Cohen JA. The face, beauty, and symmetry: perceiving asymmetry in beautiful faces. Int J Neurosci 2005;115(8):1165-73.
86. Kenealy P, Frude N, Shaw W. An evaluation of the psychological and social effects of malocclusion: some implications for dental policy making. Soc Sci Med 1989;28(6):583-91.
87. De Smit A, Dermaut L. Soft-tissue profile preference. Am J Orthod 1984;86(1):67-73.
88. Knight H, Keith O. Ranking facial attractiveness. Eur J Orthod 2005;27(4):340-8.
89. Johnston DJ, Hunt O, Johnston CD, et al. The influence of lower face vertical proportion on facial attractiveness. Eur J Orthod 2005;27(4):349-54.
90. Varlik SK, Demirbas E, Orhan M. Influence of lower facial height changes on frontal facial attractiveness and perception of treatment need by lay people. Angle Orthod 2010;80(6):1159-64.
91. Sassouni V NS. Analysis of dentofacial vertical proportions. American Journal of Orthodontics. American Journal of Orthodontics 1964;1(50(11)):801-23.
92. Turrell AJ. Clinical assessment of vertical dimension. J Prosthet Dent 1972;28(3):238-46.
93. The glossary of prosthodontic terms. J Prosthet Dent 2005;94(1):10-92.
94. Sassouni V. A classification of skeletal facial types. Am J Orthod 1969;55(2):109-23.
95. Sun J, Lin YC, Lee JD, Lee SJ. Effect of increasing occlusal vertical dimension on lower facial form and perceived facial esthetics: A digital evaluation. J Prosthet Dent 2021;126(4):546-52.
96. Gross MD, Nissan J, Ormianer Z, Dvori S, Shifman A. The effect of increasing occlusal vertical dimension on face height. Int J Prosthodont 2002;15(4):353-7.
97. Nanda SK. Growth patterns in subjects with long and short faces. Am J Orthod Dentofacial Orthop 1990;98(3):247-58.
98. Karlsen AT. Association between facial height development and mandibular growth rotation in low and high MP-SN angle faces: a longitudinal study. Angle Orthod 1997;67(2):103-10.

99. Isaacson RJ, Zapfel RJ, Worms FW, Erdman AG. Effects of rotational jaw growth on the occlusion and profile. Am J Orthod 1977;72(3):276-86.
100. Rongo R, Antoun JS, Lim YX, et al. Three-dimensional evaluation of the relationship between jaw divergence and facial soft tissue dimensions. Angle Orthod 2014;84(5):788-94.
101. Schendel SA, Eisenfeld J, Bell WH, Epker BN, Mishelevich DJ. The long face syndrome: vertical maxillary excess. Am J Orthod 1976;70(4):398-408.
102. Bonetti GA, Alberti A, Sartini C, Parenti SI. Patients' self-perception of dentofacial attractiveness before and after exposure to facial photographs. Angle Orthod 2011;81(3):517-24.
103. Farkas LG, Hreczko TA, Kolar JC, Munro IR. Vertical and horizontal proportions of the face in young adult North American Caucasians: revision of neoclassical canons. Plast Reconstr Surg 1985;75(3):328-38.
104. Geniole S.N MCM. Facing our ancestors: judgements of aggression are consistent and related to the facial width-to-height ratio in men irrespective of beards. Evol Hum Behav 2015;36(4):279–85.
105. Haselhuhn MP, Ormiston ME, Wong EM. Men's facial width-to-height ratio predicts aggression: a meta-analysis. PLoS One 2015;10(4):e0122637.
106. BiostaTGV Calcul de nombre de sujets nécéssaires. Accessed November 18 2021.
107. Yun G.W. TCW Comparative response to a survey executed by post, e-mail, & web form. 2000. "http://jcmc.indiana.edu/vol6/issue1/yun.html ". Accessed September 2022.
108. Dillman DA. Why choice of survey mode makes a difference. Public Health Rep 2006;121(1):11-3.
109. Research TUoC-CfD Chicago Face Database. 2021. "https://www.chicagofaces.org".
110. Hehman E, Leitner JB, Freeman JB. The face-time continuum: lifespan changes in facial width-to-height ratio impact aging-associated perceptions. Pers Soc Psychol Bull 2014;40(12):1624-36.
111. Todorov A, Said CP, Engell AD, Oosterhof NN. Understanding evaluation of faces on social dimensions. Trends Cogn Sci 2008;12(12):455-60.
112. Edler RJ. Background considerations to facial aesthetics. J Orthod 2001;28(2):159-68.
113. Sergl HG, Zentner A, Krause G. An experimental study of the esthetic effect of facial profiles. J Orofac Orthop 1998;59(3):116-26.
114. Harrison V, Hole GJ. Evidence for a contact-based explanation of the own-age bias in face recognition. Psychon Bull Rev 2009;16(2):264-9.
115. Tinio PP, Gerger G, Leder H. Birds of a feather... Generalization of facial structures following massive familiarization. Acta Psychol (Amst) 2013;144(3):463-71.
116. Forgie AH, Gearie T, Pine, C.M. & Pitts, N.B. Visual standards in a sample of dentists working within Scotland. Primary Dental Care 2001;8(3):124-27.
117. Jung GH, Jung S, Park HJ, Oh HK, Kook MS. Factors Influencing Perception of Facial Attractiveness: Gender and Dental Education. J Craniofac Surg 2018;29(2):e170-e75.
118. Knutson B. Facial expressions of emotion influence interpersonal trait inferences. J Nonverbal Behav 1996;20:165-82.
119. Train K. Discrete choice methods with simulation: Cambridge University Press; 2009.

# 10. APPENDIX

## 10.1: IRB approval letter

McGill | Faculty of Medicine and Health Sciences | Faculté de médecine et des sciences de la santé

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March 10, 2022

Julia Cohen-Levy
Faculty of Dentistry
2001 McGill College Avenue – Suite 500
Montreal, Quebec H3A 1G1

**eRAP/Info-Ed File Number:** **22-04-028** **IRB Internal Study Number: A04-B35-22B**

**Study Title:** *Does Altering the Lower Vertical Height of the Face Affect Our Perception of Personality?*

**McGill Principal Investigator:** Julia Cohen-Levy

**McGill Student Investigator:** Vanessa Chetrit

Dear Dr. Cohen-Levy,

Thank you for submitting the above-referenced study for an ethics review, on behalf of your Master's student, Vanessa Chetrit.

As this study involves no more than minimal risk, and in accordance with Articles 2.9 and 6.12 of the 2nd Edition of the Canadian Tri-Council Policy Statement of Ethical Conduct for Research Involving Humans (TCPS 2 2018) and U.S. Title 45 CFR 46, Section 110 (b), paragraph (1), we are pleased to inform you that an expedited/delegated review was conducted and ethics approval for the study is provided 8-Apr-2022, valid until **07-Apr-2023**. The study proposal will be presented for corroborative approval at the next meeting of the Committee.

The following documents were reviewed and approved:

- Study protocol and questionnaire (March 9, 2022);
- Consent form (March 9, 2022)

The Faculty of Medicine and Health Sciences Institutional Review Board (IRB) is a registered University Research Ethics Board working under the published guidelines of the Tri-Council Policy Statement 2, in compliance with the Cadre de référence en recherche avec des participants humains (MSSS, 2020), and the Food and Drugs Act (17 June 2001); and acts in accordance with the U.S. Code of Federal Regulations that govern research on human subjects (**FWA 00004545**). The IRB working procedures are consistent with internationally accepted principles of good clinical practice.

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**The Principal Investigator is required to immediately notify the Institutional Review Board Office, via amendment or progress report, of:**

- Any significant changes to the research project and the reason for that change, including an indication of ethical implications (if any);
- Serious Adverse Effects experienced by participants and the action taken to address those effects;
- Any other unforeseen events or unanticipated developments that merit notification;
- The inability of the Principal Investigator to continue in her/his role, or any other change in research personnel involved in the project;
- A delay of more than 12 months in the commencement of the research project, and;
- Termination or closure of the research project.

***The Principal Investigator is required to submit an annual progress report (continuing review application) on the anniversary of the date of the initial approval (or see the date of expiration).***

The Faculty of Medicine and Health Sciences IRB may conduct an audit of the research project at any time.

If the research project involves multiple study sites, the Principal Investigator is required to report all IRB approvals and approved study documents to the appropriate Research Ethics Office (REO) or delegated authority for the participating study sites. Appropriate authorization from each study site must be obtained before the study recruitment and/or testing can begin at that site. Research funds linked to this research project may be withheld and/or the study data may be revoked if the Principal Investigator fails to comply with this requirement. A copy of the study site authorization should be submitted the IRB Office.

It is the Principal Investigator's responsibility to ensure that all researchers associated with this project are aware of the conditions of approval and which documents have been approved.

The McGill IRB wishes you and your colleagues every success in your research.

Sincerely,

Roberta M. Palmour

Roberta Palmour, PhD
Chair
Institutional Review Board

cc: Vanessa Chetrit
Sylvain Baillet, PhD, Associate Dean, Medicine Research
Svetlana Komarova, PhD, Associate Dean, Dentistry Research
A04-B35-22B (22-04-028)

**10.2: Photos chosen from the CFD**

**African-American**

**Caucasian**

**Asian**

**Hispanic**

**Indian**

**10.3: Survey consent form**

Dear participant,

You are invited to participate in a research study exploring how changes of the face effects our perception of personality. Please read this form carefully, take all the time you need, and feel free to ask any questions that you may have.

Your participation is completely voluntary, and you are able to withdraw at any time without consequence. There are no risks associated with this study.
If you decide to take part in this research, you will be asked to fill out an online questionnaire, which should only take about 10 minutes. **Please use a laptop or tablet to complete it.**

This research is solely for academic purposes, and your assistance in completing the following survey will be greatly appreciated. With the consent given by answering this survey, your participation and information will remain confidential, anonymous and only be used for the purpose of this research.
There is no guarantee that you will benefit directly from participating in this study. However, your participation will advance knowledge about perception of personality based on facial features.

By signing this form, I agree that:

- The study has been explained to me and I would like to participate
- All my questions have been answered to my satisfaction
- Possible harm and discomforts and possible benefits (if any) of this study have been explained to me
- I do not waive any of my rights by signing this consent
- I have been told that my personal information will be kept confidential

In addition, I understand that:

- I have the right not to participate and the right to stop at any time
- I have a choice of not answering specific questions
- I am free now, and in the future, to ask any questions about the study
- No information that would identify me will be released or printed without asking me first

Thank you very much for taking part in our study!

- o I accept

If you have any questions about the study, please contact:

Vanessa Chetrit
Email: vanessa.chetrit@mail.mcgill.ca
Dr. Julia Cohen-Levy
Email: Julia.cohen-levy@mcgill.ca

**10.4: Demographic survey**

**1. Quel âge avez-vous?/ What is your age?**

- <20 ans/ <20 years old
- 20-30 ans/ 20-30 years old
- 31-40 ans/ 31-40 years old
- 41-50 ans/ 41-50 years old
- 51-60 ans/ 51-60 years old
- 61-70 ans/ 61-70 years old
- 71+ ans/ 71+ years old
- Préfère ne pas répondre/ Prefer not to answer

**2. À quel sexe vous indentifiez-vous?/ What gender do you identify as?**

- Femme/ Female
- Homme/ Male
- Membre de la communauté LGBTQIA2S+/ Member of the LGBTQIA2S+ community
- Préfère ne pas répondre/ Prefer not to answer

**3. Veuillez préciser votre origine ethnique/ Please specify your ethnicity.**

- Caucasien/ Caucasian
- Afro-Américain/ African-American
- Hispanique/ Hispanic
- Asiatique/ Asian
- Issu des populations autochtones, premières nations/ First Nations
- From India/ Indien
- Deux ou plus/ Two or more
- Préfère ne pas répondre/ Prefer not to answer

**4. Quel est le diplôme ou le niveau d'études le plus élevé que vous ayez obtenu?/ What is the highest degree or level of education you have completed?**

- École primaire/ primary school
- École secondaire/ High School
- DEC Cégep/ Cegep DEC
- Diplôme universitaire/ Bachelors Degree
- Maîtrise/ Masters Degree
- Doctorat ou plus/ Ph.D or higher
- École professionnelle/ Trade School
- Préfère ne pas répondre/ Prefer not to answer

**5. Quel est votre situation professionnelle actuelle?/ What is your current occupation?**

- Étudiant/ Student
- Employé/ Employee
- Travailleur autonome/ Autonomous worker
- Propriétaire d'entreprise/ Business owner
- Retraité/ Retired
- Sans emploi/ Unemployed
- Préfère ne pas répondre/ Prefer not to answer

**6. Dans quel domaine est ou était votre métier ?/ What field is or was your occupation in?**

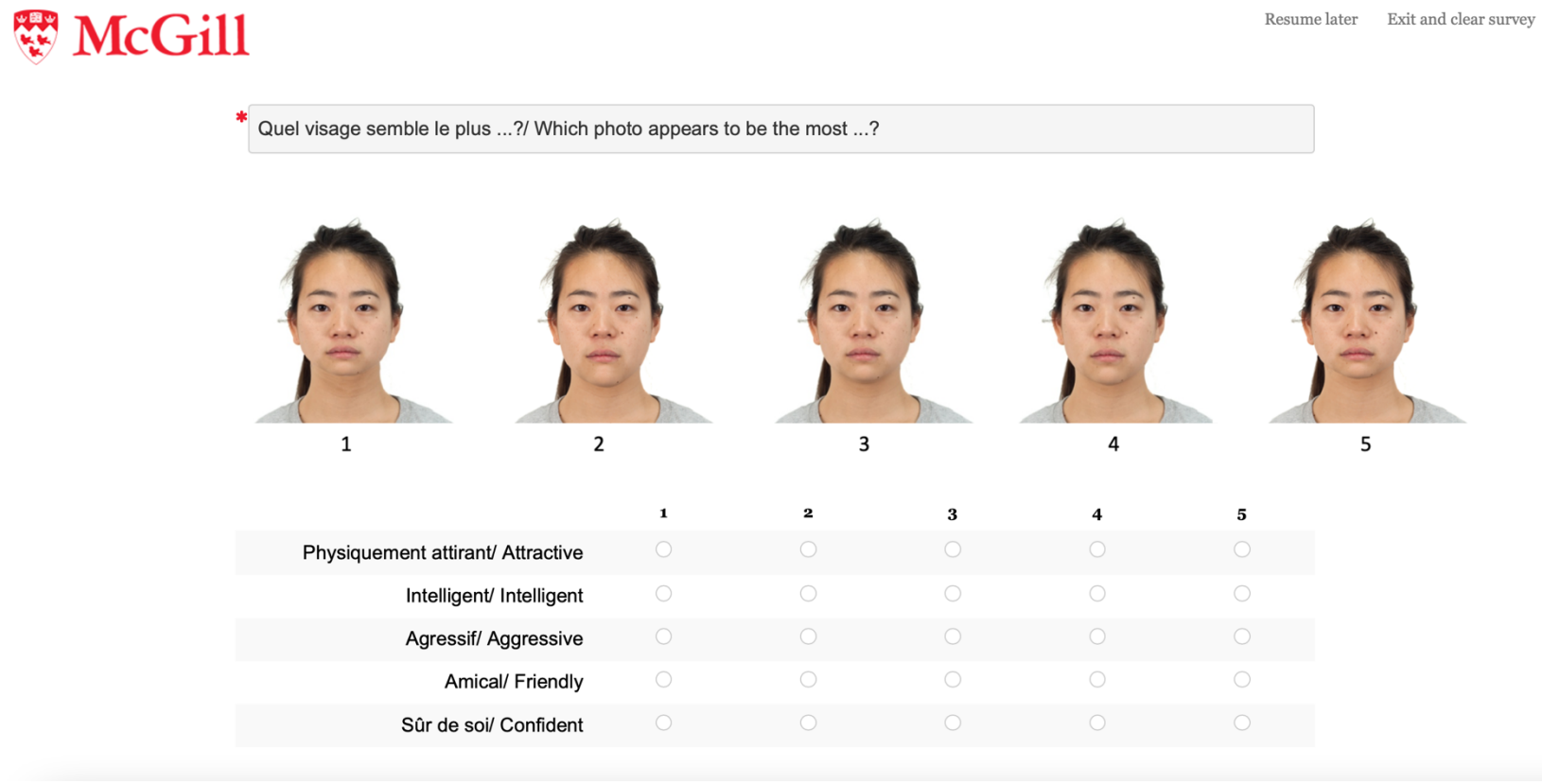
- Santé et médecine/ Health and medicine
- Médecine dentaire/ Dental Medicine
- Les Arts/ Arts
- Commerce/ Business
- Communication/ Communications
- Services sociaux/ Social services
- Éducation/ Education
- Sciences et technologies/ Science and technology

- Réparation et entretien/ Repair and maintenance
- Gouvernement/ Government
- Droit/ Law
- Préfère ne pas répondre/ Prefer not to answer

**7. Quelle est votre expérience personnelle avec l'orthodontie ?/ What is your personal experience with orthodontics?**

- Traitement reçu/ Received treatment
- N'a pas reçu de traitment/ Did not receive treatment
- J'envisage de recevoir un traitment/ I consider receiving treatment
- Pas intéressé/ Not interested
- Préfère ne pas répondre/ Prefer not to answer

## 10.5: Example of Female Asian sample set in the survey




## 10.6: Baseline measurements of LFH, TFH and LFH\TFH for unaltered photographs

1. Male Caucasian
LFH: 58 mm
TFH: 108 mm
LFH/TFH: 58/108= 54%

2. Female Caucasian
LFH:55mm
TFH: 108
LFH/TFH: 53/108= 49%

3. Female Asian
LFH:53mm
TFH:105mm
LFH/TFH:53/105=50%

4. Male Asian
LFH:57mm
TFH:108mm

LFH/TFH:57/108=53%

5. Female Hispanic
LFH: 57mm
TFH:109mm
LFH/TFH:57/109=52%

6. Male Hispanic
LFH: 65 mm
TFH:119 mm
LFH/TFH: 65/119= 55%

7. Female Indian
LFH: 64mm
TFH: 118 mm
LFH/TFH:64/118=54%

8. Male Indian
LFH:64 mm
TFH: 118 mm
LFH/TFH:64/118= 54%

9. Female African American
LFH:51 mm
TFH: 103 mm
LFH/TFH:51/103= 50%

10. Male African American
LFH:61 mm
TFH: 114 mm
LFH/TFH:61/114= 54%