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Facial features of cartoon characters and their perceived attributes

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The aim of this study is to investigate the relationship between skeletal antero-posterior profile of popular family cartoon characters and their perceived personal characteristics. The Internet Movie DataBase (IMDB) was used to identify popular animated family movies released since 2000. Cartoon characters were identified, and classified based on their gender (male/female), skeletal profile (Class I, II or III) and character assessment (protagonist/antagonist). Descriptive statistical analysis was carried out. Chi Square analysis was used to assess the differences (p-value) between gender and character assessment against the skeletal profile. Fifty popular animated family movies were identified. Within these 88 humanoid cartoon characters were identified made up of 32 male protagonists, 27 female protagonists, 22 male antagonists and 7 female antagonists. 40, 30, 21 were assessed as having a Class I, II and III skeletal profiles respectively. Statistically significant differences were observed in both FPFA and MPFP values for Class III characters (P = 0.009 and P = 0.006, respectively). However, no significant variations were noted when comparing the remaining groups. Female antagonists and male protagonists were most likely to be portrayed with a Class III skeletal pattern when compared to female protagonists and male antagonists respectively.

Abbreviations

FPFA	Female protagonist female antagonist
MPFP	Male protagonist female protagonist
IMDB	The Internet Movie DataBase
AOB	Anterior open bite
OHRQoL	Oral health-related quality of life

Physiognomy, is the art of "reading personality traits from faces,"[1]. Opening impressions of others are frequently based on physical appearance with a particular emphasis on facial features. Facial appearance has been shown to influence the perception of personal characteristics including personality, integrity, social and intellectual competence and mental health[2]. Indeed certain facial features, mainly attractiveness, have been associated with higher earnings[3], further career progression[4] and perceived political competence[5].

Physical attractiveness plays a key role for social interaction, influencing the perception of an individual's social skills. Perceptions of more intelligence and talkative attitude in ideal smile participants have been confirmed by several studies[6]. Furthermore, children with well-aligned teeth resulted in having significantly stronger characteristics of honesty, personal happiness, and intelligence with respect to those with crowding and proclined upper incisors[6]. Pithon et al. reported significantly better scores for ideal smiles regarding performance in sport, popularity, leadership, intelligence, and health, when compared with malaligned teeth[6]. Aesthetic impairment for patients and psychological impairment and functional problems have been reported in association with Class III and anterior open bite (AOB) malocclusions[7]. Valletta et al. reported that elderly did not place as much importance on the appearance of their own teeth as did younger people[8]. In the previous study, the authors also highlighted a significant correlation between bullying and malocclusion as well as a significant negative impact on oral health-related quality of life (OHRQoL) resulting from oral symptoms[9].

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Impressions of social traits, such as trustworthiness or dominance, are reliably perceived in faces, for example, a person may be considered to have other immature characteristics based on a "babyfaced" appearance[10]. Physical attributes used in moral judgments are facial features, with particular attention on the eyebrows or mouth[11].

Although most research focuses on the subjective assessment of adults, children have also been shown to make decisions about the moral identity of characters based purely on their physical features[11]. There is a clear association amongst both children and adults that unattractive characters are antagonists and attractive characters as protagonists[11]. The use of unattractive or disfigured faces as antagonists in movies. For examples, films makers use facial disfigurement as a "shortcut" to manifest evil motivations of characters[12]. A classic example is facial scarring. The children's film The Lion King features as a villainous character with a traumatic facial scar who is actually named "Scar."[12].

Worldwide, cartoons have been a part of cinema history since the first motion pictures were produced in the late 1800s[13]. Rai et al., showed that 63% (among 200 children surveyed) of 5–10 years of age watch cartoon programs with 24% spending more than 2 h watching cartoon programs a day. Similarly, a study conducted by Liebert and Sprafkin shows that T.V viewing rises from about 2 and half hours per day at the age of 5 to about 4 h per day at the age of 12[14]. Much of children's media involves animated characters, with many popular characters developed by Disney, Warner brothers', Fox and DreamWorks film studios[15]. Children media has also been criticized for associating beauty with goodness and even pair beauty with intellect more than in adult movies[16].

Artists frequently portray opposing facial features between villains and heroes which have historically been used to demonstrate contrasting morality between characters, and this could have an impact on how humans view someone with certain facial features as good or evil in everyday life[17]. They concluded that the standard "bad guy" profile has a longer more prominent nose, a jutting chin (a bigger soft-tissue angle) and a higher upper third of the face than the lower third (the opposite of the standard profile of the "good guys")[18]. In addition, other physical characteristics, especially those reflecting some kind of threat, for instance, animals with claws, open mouths, sharp teeth, or convex eyes, might be used in illustrations to induce moral identities[11]. However, to our knowledge, no study has explored the facial features of good and bad cartoon characters in relation to people's perception.

Based on this evidence, it could be hypothesized that facial features of children cartoons will influence the perception of an individual. This paper has four-fold objectives:

Identify popular humanoid cartoon characters from children's media.
Determine the antero-posterior skeletal pattern of these cartoon characters.
Determine the perceived personal characteristics of these characters.
Assess for evidence of correlation between skeletal patterns and perceived/ associated characteristics.

The null hypothesis of this study was that there is no relation between skeletal profile of children cartoon characters and their perceived attributes.

Materials and methods

To identify popular children's animated films or television programs, the Internet Movie Database (IMDB) was used. The top 50 animated family movies and TV programs as rated on IMDb and released since 2000 were selected. Films and TV programs before the year 2000 were excluded so that only contemporary cartoon design was evaluated. The list as recorded on 23th July 2021 was used and all animation studios included. From each film the main protagonist and antagonist characters were identified using Wiki Fandom[19] (Table 1). Non-humanoid characters were excluded. Origin of the characters selected from top 50 animated family movies are from country USA, Japan and Canada (Table 2).

To assess the antero-posterior skeletal pattern of the characters Ricketts Zero Meridian line was used. To assist the landmarks identification, soft tissue A point and soft tissue B point were marked on a representative image and assessed relative to Ricketts zero-meridian line dropped from soft tissue Nasion (N′) (Fig. 1; Table 3). The characters selected based on their antero-posterior skeletal patterns, observed through side profile screenshots from the films. Hereby we include an example of each category: male protagonist Alfredo Linguini from Disney/ Pixar's *Ratatouille* (Class II skeletal), male antagonist Lord Farquaad from DreamWorks' *Shrek* (Class III skeletal), female protagonist Princess Anna from Disney's *Frozen* (Class I skeletal), and female antagonist Yzma from Disney's *The Emperor's New Groove* (Class III skeletal).

The reliability of assessments by the primary and secondary examiners was evaluated. The primary examiner (WJ) conducted the initial examination and then re-tested a random sample of 20 subjects after a four-week interval. The intraclass correlation coefficient (ICC) for test–retest reliability was 1.0, indicating perfect agreement. Additionally, the inter-examiner correlation coefficient between the primary examiner (WJ) and the secondary examiner (AA) was 0.86, suggesting high reliability between the two examiners. The secondary examiner also evaluated the same random set of 20 subjects to ensure consistency across assessments.

Variables	Operational definition
Protagonist	The protagonist can be considered as a relatively simple agent: they have some goal that they wish to achieve and they make a plan that they hope will lead them to achieve it
Antagonist	Antagonist in the narrative is to act as the force of opposition to interfere and obstruct the protagonist in achieving their goals

Table 1. Variables and operational definition.

Studio (country)	Total number of studio
Walts Disney Animation Studio (USA)	31
Disney Pixar (USA)	19
DreamWorks Animation (USA)	11
Sony picture (USA)	6
Nickelodeon Animation Studios (USA)	6
Studio Ghibli (Japan)	4
Zagtoon Method Animation (Canada)	3
Illumination Entertainment (USA)	3
Cartoon Network (USA)	2
Lucasfilm Animation (USA)	2
Laika (USA)	2
Warner bros	1
Spine Master Entertainment	1

Table 2. Origin of characters (studio and country).
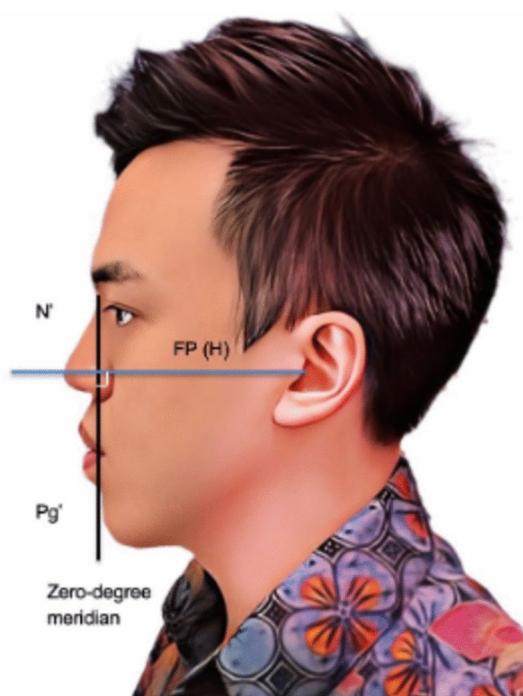
Fig. 1. Assessment of antero-posterior skeletal pattern.

Landmarks		Definition of parameters
N′	Soft tissue nasion	Most concave point at the bridge of the nose
A	Soft tissue A point	Most concave point between subnasale and the anterior point of the upper lip
Pg′	Pogonion	The most prominent point of the soft tissue chin
FP	Frankfurt plane	A line passing horizontally between the inferior margin of the orbit and the upper margin of the ear canal
Zero meridian line		A vertical plumb line from soft tissue nasion that is perpendicular to the Frankfort plane

Table 3. Landmarks for assessment of skeletal pattern.

	Protagonist	Antagonist
Gender		
Male (n = 56)	33	23
Female (n = 35)	27	8

Table 4. Split of gender and protagonist/antagonist.

Ethnicity	Male protagonist	Female protagonist	Male antagonist	Female antagonist
Asian (n = 14)	6	3	4	1
Caucasian (n = 52)	13	16	18	5
Africa-American (n = 5)	2	3	0	0
Hispanic (n = 17)	11	5	1	0
Unknown (n = 3)	1	0	0	2

Table 5. Ethnicity of characters.

Characters	Number of characters (n = 91)		
	Class I (n = 40)	Class II (n = 30)	Class III (n = 21)
Female protagonist (n = 27)	14 (51.9%)	13 (48.1%)	0 (0%)
Male protagonist (n = 33)	14(42.2%)	11 (33.3%)	8 (24.2%)
Female antagonist (n = 8)	4 (50%)	1 (12.5%)	3 (37.5%)
Male antagonist (n = 23)	8 (34.8%)	5 (21.7%)	10 (43.5%)

Table 6. P-value for all characters with Skeletal Pattern I, II and III.

Comparison	P value		
	Class III	Class II	Class I
Female protagonist–female antagonist (within sexes)	0.009**	0.108	1.000
Male protagonist–male antagonist (within sexes)	0.129	0.345	0.565
Male protagonist–female protagonist (within protagonists)	0.006**	0.244	0.466
Male antagonist–female antagonist (within antagonists)	1.000	1.000	0.676

Table 7. P-value in comparison of characters within sexes, protagonist and antagonist with Skeletal Pattern I, II and III.

Results

From the 50 movies, a total of 91 cartoon characters were identified, made up of 33 male protagonists, 27 female protagonists, 23 male antagonists and 8 female antagonists (Table 4). The ethnicity of cartoon characters was predominately Caucasian (n = 52, 57.1%). Asian (n = 14) and Hispanic (n = 17) were the next most frequent (Table 5).

There was an even distribution of Class I (n = 14, 42.2%), II (n = 11, 33.3%) and III (n = 8, 24.2%) amongst male protagonists. All female protagonists were assessed as Class I (n = 14, 51.9%) or II (n = 13, 48.1%). Most male antagonists were Class III (n = 10, 43.5%) or Class I (n = 8, 34.8%); with only 5 being Class II (21.7%). Of the female antagonists, half were Class I (n = 4, 50%), three were Class III (37.5%) and only one was Class II (12.5%) (Table 6).

Table 7 shows comparison of characters within sexes, protagonist and antagonist with Skeletal Pattern I, II and III. No significant difference in comparison of male antagonist and female antagonist for all Skeletal Pattern. No significant difference in comparison of male protagonist and female antagonist for all Skeletal Pattern. A significant difference in comparison of male protagonist and female protagonist in Skeletal Pattern III (P < 0.05), however no significant difference in Skeletal Pattern II and Skeletal Pattern I. A significant difference in comparison of female protagonist and female antagonist in Skeletal Pattern III (P < 0.05), no significant difference in Skeletal Pattern II and I.

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Statistical analysis

Categorical data were presented as percentage (%). The Chi Square analysis was used conducted on the overall results to see the differences (p-value) between the four groups (Male protagonist, Female protagonist, Male antagonist and Female antagonist). The p-value by subsequent chi-square analysis to ascertain relationship between two individual characters was used (Table 7). All the statistical analysis were performed using SPSS software version 27.0 A level of $p < 0.05$ is considered statistically significant.

Discussion

The present study appears to be the first to determine the relationship of antero-posterior skeletal profile of children cartoon characters and their perceived personal characteristics. Cartoon faces are widely utilized in daily life, serving as a crucial medium for both children to acquire emotional knowledge and for adults to express feelings and attitudes[20]. Prior research on virtual human (VH) realism highlights how various facial features such as eye size and shape can impact perceived trustworthiness, dominance, or eeriness[21,22]. For instance, large and symmetrical eyes are often associated with positive traits, while narrower or deep-set eyes can create a sense of suspicion or aggression[21]. However, our study's emphasis is on the anteroposterior position of the jaw, a feature directly related to skeletal classification (Class I, II, or III). This focus is chosen due to the specific role jaw alignment and prominence play in shaping overall facial profiles, which are frequently leveraged by animators to convey strength, attractiveness, or villainy, especially among adult and adolescent characters.

By examining characters within the simplified categories of "good" (protagonists) and "evil" (antagonists), we avoid the potential confusion that could arise from a complex classification of personality traits, which varies across psychological models and may complicate the interpretation of results. This binary distinction aligns with common storytelling conventions in animation, where characters are often visually crafted to convey clear moral alignments, allowing audiences to instantly recognise "heroic" or "villainous" attributes[23].

The majority of depicted characters were 18 years old or older, comprising 61 out of the total 91 characters. Notably, the male antagonist emerged as the most frequently portrayed character type, with 22 characters aged 18 and above, while only two adolescent characters shared this personality type. No characters fell within the preschool age range, and only 13 school-aged protagonists were represented across both genders. When comparing the skeletal patterns between female protagonists and antagonists, female protagonists were assessed as being either Class I or Class II, with a statistically significant P-value of 0.009 for Class III when compared within the female characters. This significant difference stemmed from the fact that 37.5% of female antagonists exhibited a Class III skeletal pattern, while none of the female protagonists demonstrated were Class III. Although there is no evidence supporting the notion that individuals with a Class III skeletal pattern are more inclined towards negative personality traits, there certainly appears to be predilection for female antagonists to be drawn with a Class III profile.

Within sexes male

In comparison between male protagonists and antagonists, there was no significant differences between Class I, II and III. Attractive and masculine males are reported in the literature to have a straight profile with a stronger mandibular profile or prominent chin[24], where prominent chins are usually associated with Class III skeletal patterns[25]. Despite evidence showing that individuals with class III malocclusion were perceived to be the most unaesthetic by orthodontists, there is perhaps the subtlety of the severity of the facial discrepancy in varying between what is deemed as aesthetics compared to unaesthetic[26]. As there is no definitive answer to whether Class III jaw skeletal pattern is a more desirable trait in males, as perceptions of attractiveness can vary among individuals and cultural contexts.

Within protagonists

In comparison between Class III male protagonists and female protagonists, there was a significant p-value of 0.006. There are no significant differences for class I and class II. This shows that animators avoid portraying female good characters with skeletal class III pattern; however, there are 8 protagonists that are skeletal class III male. As mentioned previously, there are a few studies supporting Class III in males to be attractive, which may be the reason why they are portrayed as protagonists[25]. In contrast, for females, class III skeletal pattern is generally considered unattractive due to its association with a masculine or harsh appearance, including a prominent chin and a more angular jawline[27].

This is based on perceived societal beauty standards, which prioritize more traditionally feminine facial features. Previous study shows that beautiful women have a shorter lower face and small chin[28]. Individuals with Class III skeletal patterns in females may be more likely to experience social difficulties and have lower self-esteem due to negative societal perceptions of their appearance. Surgical correction then improved self-esteem and diminished depressive symptoms. Conversely, Class III malocclusion in male patients showed no alteration in self-esteem and depression with surgical intervention whilst Female patients showed improved self-esteem and diminished depressive symptoms due to surgical intervention[29].

Within antagonists

The antagonists in males are mostly of Class III (43.5%), whereas in females, they predominantly belong to Class I (50.0%). However, there are no significant differences between female and male antagonists in all skeletal classes I, II, and III characters. In a slightly relevant study, it is shown that villains exhibit a significantly higher incidence of dermatologic findings than heroes (60% vs. 0%), including alopecia, periorbital hyperpigmentation, deep rhytides on the face, scars on the face, verruca vulgaris on the face, and rhinophyma[30]. Nevertheless, there is no scientific evidence supporting the notion that individuals with a Class III skeletal pattern are more likely

to manifest negative personality traits. Therefore, care must be taken regarding stereotypes that may form those with a Class III skeletal pattern will have negative personality traits.

Limitations

Internet movie database (IMDB) was used to identify films and programmes as it is considered to be the number one consumer site of movies. It contains information about programs, films and television including financial information, biographies, user rating, cast, reviews, crew, actors, directors, summaries etc. Ratings of films are determined by an average score provided by its 60 million registered users. Fandom, also known as Wikia before October, is an active collaborative platform that bridges expert knowledge with fan curiosity by allowing the use of both collective and individual practices through creation and distribution of original content for experts and beginners[19]. Wikia with its 120 million fans hosts 34 million pages of rich content with regard to different popular culture areas, such as games, movies, TV, comics, music, books, and lifestyle[19].

This study only included media produced from 2000 and excluded anything produced earlier. This will have excluded some earlier animation films that are still popular today; however, the aim of the study was to assess the portrayal of contemporary characters, and the turn of the century was considered a suitable cut off point. Furthermore, despite the unbiased selection of the top 50 animated films in IMDB in 2021, the majority of studios were based in the United States. The findings should be interpreted with caution, as this study is cross-sectional and limited to a sample of the top 50 films, which may not be representative of the broader population of animated media. Small sample sizes can reduce statistical power, potentially limiting the test's ability to detect significant associations and affecting the robustness of the results. Expanding the sample to include more films from studios in Asia or other regions could provide different cultural insights into the portrayal of characters' appearances and personalities.

The primary focus of this research is the skeletal jaw pattern and its influence on facial characteristics. The decision to limit the analysis to jaw positioning reflects a need to provide a detailed understanding of skeletal pattern implications without introducing potential confounding effects from features like eye size, nose shape, or skin texture. While these aspects are significant, they fall outside the scope of this study, which aims to reveal how jaw positioning alone correlates with character roles and societal perceptions of personality traits. By narrowing our focus, we provide a clear framework for understanding how skeletal profiles independently shape perceived character traits, potentially informing future studies that could examine the combined effects of skeletal and additional facial features.

Conclusion

Female antagonists and male protagonists were most likely to be portrayed with a Class III skeletal pattern compared to female protagonists and male antagonists, respectively. Impressionable children may subconsciously come to believe that individuals with a Class III profile in females and males are inaccurately associated with antagonistic or protagonistic traits, respectively.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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Author contributions

All authors participated in study design, data collection, read and approved the final version of the manuscript, and agree with the order of presentation of the authors. Those authors contributed equally to this work.

Declarations

Competing interests

The authors declare no competing interests.

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