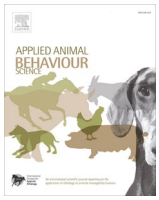
Applied Animal Behaviour Science 264 (2023) 105948

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim



The brachycephalic paradox: The relationship between attitudes, demography, personality, health awareness, and dog-human eye contact

Zsófia Bognár [a,b,*], Enikő Kubinyi [a,b,c]

[a] MTA-ELTE Lendület "Momentum" Companion Animal Research Group, Budapest 1117, Hungary
[b] Department of Ethology, ELTE Eötvös Loránd University, Budapest 1117, Hungary
[c] ELTE NAP Canine Brain Research Group, Hungary

ARTICLE INFO

Keywords:
Brachycephalic dogs
Eye contact
Health awareness
Attitude
Personality

ABSTRACT

Brachycephalic (flat-faced) dogs' popularity is rising worldwide despite the numerous health problems they often face. This is the brachycephalic paradox which led to a dog welfare crisis. To take meaningful steps in solving this crisis, we need to understand the appealing features of these dogs, and the characteristics of brachycephalic dog enthusiasts. We assumed that individuals who like these dogs have lower knowledge about the associated health problems, a unique personality profile, and highly value the tendency of these dogs to form eye contact with humans. We conducted an online survey with 1156 respondents. A Multinomial Log-linear Model was used to analyse respondents' attitudes towards brachycephalic dogs (positive, negative, or neutral), while a Binomial Generalized Linear Mixed-Effects Model was used to analyse their preference for eye contact with dogs. Some of the results were contrary to our expectations. People with a positive attitude towards brachycephalic dogs associated more health problems with brachycephalism and did not prefer photos of dogs making eye contact (looking into the camera) over those looking away. They were also found to be younger, more often women, have children, lower levels of education, a higher level of agreeableness, conscientiousness, and dog-directed emotional empathy. The results suggest that the tendency of brachycephalic dogs to form eye contact does not play a role in their popularity and that high emotional empathy and knowledge about health problems do not discourage people from liking these dogs. Our study can also serve as a basis for educational campaigns by demonstrating that factual knowledge about health problems alone is not enough to reverse the brachycephalic dog welfare crisis.

1. Introduction

The popularity of brachycephalic, or 'flat-faced' dogs is increasing globally (American Kennel Club, 2023; Teng et al., 2016; UK Kennel Club, 2023), despite their tendency to suffer from numerous serious health problems (Packer, Hendricks, and Burn, 2015; Packer, Hendricks, Tivers et al., 2015; Packer and O'Neill, 2021). Additionally, due to their health issues, they have a shorter lifespan (Packer and O'Neill, 2021; Teng et al., 2022). The French Bulldog, the most popular brachycephalic breed, has the shortest life expectancy of only 4–5 years (Teng et al., 2022).

Researchers are trying to explain this 'brachycephalic paradox', that is, how the popularity can constantly rise despite the obvious drawbacks, such as welfare problems, high veterinary costs, and short lifespan. The aim is to understand what features of flat-faced dogs contribute to their popularity and what motivates owners to choose such a breed. In the case of rabbits and cats, people with lower education levels and without veterinary expertise are more likely to prefer brachycephalic breeds (Farnworth et al., 2018; Harvey et al., 2019). Furthermore, for those who choose a brachycephalic dog breed, the appearance, behaviour, and personality are more significant factors than health or life expectancy (Beverland et al., 2008; Packer et al., 2017, 2020; Sandøe et al., 2017).

The potentially appealing appearance of the flat-faced breeds may be due to the "baby schema effect" (Lorenz, 1943). The shortening of the head creates a resemblance to baby faces, as brachycephalic dogs have large foreheads and big eyes (Paul et al., 2023). People are drawn to these infantile features, which elicit increased attention and a willingness to care for individuals with a "baby schema" (Hecht and Horowitz, 2015; Lorenz, 1943; Sternglanz et al., 1977).

* Correspondence to: Eötvös Loránd University, Pázmány Péter sétány 1/c, 1117 Budapest, Hungary.
E-mail address: zsofia.bognar@ttk.elte.hu (Z. Bognár).

https://doi.org/10.1016/j.applanim.2023.105948
Received 23 March 2023; Received in revised form 8 May 2023; Accepted 10 May 2023
Available online 12 May 2023

Brachycephalic dogs also possess potentially appealing behavioural traits. They pay increased attention to human faces and gestures. They tend to look longer at projected portrait photos, make eye contact with strangers more quickly, and follow pointing gestures more readily (Bognár et al., 2018, 2021; Gácsi et al., 2009). These behaviours may be due to the anatomical structure of the dogs' eyes, as their visual acuity is higher in the center of the visual field and lower at the periphery (McGreevy et al., 2004), enabling them to focus their attention better on their communication partner. Alternatively, people may be more likely to engage in mutual gaze with these dogs due to their baby-like facial features, providing flat-faced dogs with more opportunities to learn to pay attention to humans and form eye contact with them.

We assume that the ability to form eye contact with humans is a valued behavioural trait, and this propensity in brachycephalic dogs could contribute to their popularity. Frequent eye contact improves the effectiveness of communication and dog training (e.g. (Kaminski et al., 2012; Téglás et al., 2012)), strengthens the bond between the dog and owner (Nagasawa et al., 2009, 2015), and makes the dogs appear cuter and more appealing (Woo and Schaller, 2020).

Personality and empathy can influence whether people seek or avoid eye contact. Individuals with high scores in extraversion, conscientiousness, and openness tend to seek eye contact with their communication partners, while neurotic people tend to avoid mutual gaze (Jensen, 2016). In an eye-tracking study, higher emotional empathy (feeling the other person's emotions) was associated with longer looking times at the eye region of the actor when the stimulus was emotional (Cowan et al., 2014). People with higher cognitive empathy (being able to understand others' perspectives) had longer looking times at the eye region, regardless of whether the stimulus was emotional or neutral (Cowan et al., 2014).

Although many factors related to brachycephalism preference have been identified, there is a knowledge gap regarding people's personality traits and dogs' communicative behaviour. In this study, we aimed to examine [1] whether the factors affecting people's preference for brachycephalic animals found in the international literature hold true for a Hungarian population, [2] add personality and empathy as novel explanatory variables, [3] and investigate the relationship between sensitivity to dogs' eye contact, brachycephalism preference, personality, and empathy.

We hypothesized that the attitude towards brachycephalic dogs is associated with:

1) Knowledge about flat-face-related health problems. Those with knowledge about health problems like brachycephalic dogs less.
2) Level of education. Higher-educated people like brachycephalic dogs less.
3) Dog-related professional expertise. Those with dog-related professional expertise like brachycephalic dogs less.
4) Personality. No specific predictions.
5) Empathy. No specific predictions.

We also assumed that the preference for eye contact is associated with:

1) Personality. More extroverted, conscientious, and open people prefer dogs that establish eye contact.
2) Empathy. More empathetic people (both emotional and cognitive) prefer dogs that establish eye contact.
3) Attitude towards brachycephalism. Those who like flat-faced dogs prefer dogs that establish eye contact.

2. Methods

2.1. Questionnaire

The questionnaire consisted of six parts: 1) *demography*, 2) *attitude towards brachycephalic dogs*, 3) *knowledge of brachycephalic dogs' health problems*, 4) *human personality*, 5) *empathy towards dogs*, and 6) *photo evaluation*.

1) *Demography*. Respondents were asked about their A) age, B) sex, C) whether they have children, and D) their place of residence (where they spend most of their time per week).
2) *Attitude towards brachycephalic dogs*. The attitude was assessed indirectly to avoid influencing the responses. Instead of asking directly about their attitude, the extent to which brachycephalic dogs are present in the public consciousness and whether people have a positive or negative opinion of them was measured. We recorded A) whether the respondents have ever lived with a dog (what breed(s), or in the case of a mixed breed, what did it look like), B) their favourite breed(s) or appearance(s), C) if they disliked any breed(s) or appearance(s). We created three categories:
   i) *Like brachycephalic dogs*: respondents who lived together with a brachycephalic dog and/or mentioned brachycephalism, a brachycephalic breed, or a brachycephalic characteristic as an appearance feature they like in dogs.
   ii) *Dislike brachycephalic dogs*: respondents who mentioned brachycephalism, a brachycephalic breed or a brachycephalic characteristic as an appearance feature they dislike in dogs.
   iii) *Neutral towards brachycephalic dogs*: respondents who never lived with a brachycephalic dog or did not mention brachycephalism as a liked or disliked appearance in dogs.

   One percent of the respondents mentioned brachycephalism as both a liked and a disliked feature (see Table S1). Six respondents indicated different breeds of brachycephalic dogs as liked and disliked breeds, thus were categorized into the 'Like' group. Of the remaining six respondents, four stated a general dislike for brachycephalic dogs, and two mentioned their own dog's breed that they disliked. These six respondents were also assigned to the 'Like' group for the purposes of analysis. However, moving them to the 'Dislike' group has not influenced the results.
3) *Knowledge of brachycephalic dogs' health problems*. The respondents' knowledge was assessed in three ways:
   i) Directly: We assessed *the number of health problems* the respondents *associated with brachycephalism*. They filled out a quiz about dog health problems, associating seven problems (dystocia, allergic skin diseases, breathing difficulties, corneal ulceration, obesity, abnormal teeth, joint diseases) with three breeds (French Bulldog, Labrador Retriever, German Shepherd Dog). Respondents could assign one problem to multiple breeds. It was not necessary to assign every problem to at least one breed, or at least one problem to every breed to continue the survey. Then, we counted *the number of health problems* they associated with the French Bulldog breed.
   ii) Indirectly:
      a) *Level of education*: 1) not completed primary education, 2) primary education, 3) secondary education, 4) post-secondary non-tertiary education, 5) currently a Bachelor's or Master's student, 6) Bachelor's or Master's level, 7) currently a PhD student, 8) doctoral level. These categories were grouped later (Table 1).
      b) *Dog-related professional expertise*: 1) veterinary (veterinarian, assistant), 2) other dog-related professional expertise (dog trainer, beautician, shelter worker/volunteer, researcher, etc.), 3) no dog-related professional expertise.
4) *Human personality*: We used the 44-item Big Five Inventory (John et al., 1991) in Hungarian (Szirmák, 2007) to assess the respondents' personalities (Table S2).
5) *Empathy towards dogs*: We used a modified Interpersonal Reactivity Index (Norring et al., 2014), changing the word 'animal' to 'dog' and translating it into Hungarian (Table S3).

Table 1
The characteristics of the respondents.

Demography	
Age	18–75 years (mean ± SD: 38.9 ± 11.8)
Sex	men: N = 136 women: N = 1020
Parental status	childless: N = 710 parent: N = 446
Residence (spend most of the time here a week)	capital city: N = 498 big city: N = 243 small city: N = 210 village: N = 150 abroad (i.e. non-Hungarian residence): N = 55
Attitude towards brachycephalism	
Attitude towards brachycephalism	dislike: N = 229 neutral: N = 659 like: N = 268
Knowledge of brachycephalic dogs' health problems	
Number of health problems associated with brachycephalism (0–7)	0–7 health problems (mean ± SD: 5.2 ± 1.4)
Level of education	lower than university level of education: N = 327 higher education: N = 829
Dog-related professional expertise	no dog-related professional expertise: N = 862 has dog-related non-veterinary professional expertise: N = 265 has dog-related veterinary professional expertise: N = 29
Personality (Big Five)	
Extraversion (1–5) higher scores mean the respondent is more extrovert	1.5–5.0 scores (mean ± SD: 3.4 ± 0.7)
Agreeableness (1–5) higher scores mean the respondent is more agreeable	1.4–5.0 scores (mean ± SD: 3.6 ± 0.6)
Conscientiousness (1–5) higher scores mean the respondent is more conscientious	1.7–5.0 scores (mean ± SD: 3.7 ± 0.6)
Neuroticism (1–5) higher scores mean the respondent is more neurotic	1.0–5.0 scores (mean ± SD: 3.0 ± 0.7)
Openness (1–5) higher scores mean the respondent is more open to experience	1.6–5.0 scores (mean ± SD: 3.7 ± 0.6)
Empathy towards dogs (modified Interpersonal Reactivity Index)	
Dog-directed emotional empathy (1–5) higher scores mean the respondent is more empathetic emotionally towards dogs	3.6–5.0 scores (mean ± SD: 4.7 ± 0.3)
Dog-directed cognitive empathy (1–5) higher scores mean the respondent is more empathetic cognitively towards dogs	3.7–5.0 scores (mean ± SD: 4.3 ± 0.3)
Photo rating	
Preference for eye contact (choice)	eye contact: N = 9962 no difference: N = 12065 look away: N = 6873
How much did respondents like the dog in the photo? (0–5) 0: the respondent did not like the dog in the photo at all; 5: the respondent liked it very much	0–5 scores (mean ± SD: 3.8 ± 1.3)

6) *Photo rating*: We used portrait photos of 25 dogs (of different breeds, including mongrels). We took these photos when the dogs visited our department for other experiments. We presented two photos of each dog: one where the dog was looking into the camera (*eye contact*) and another where the dog was looking elsewhere (*look away*) with the face and eyes still visible (Fig. 1). The respondents were asked:
   i) which photo they liked more (they could choose that there is *no difference* between the photos), and
   ii) their overall liking for the dog in the photo (on a Likert scale from 0 to 5, with 0 meaning they did not like it at all and 5 meaning they liked it very much).

This latter was necessary because we assumed that individuals who either do not like or especially like a particular dog in the photo would not choose between the two photos, but rather indicate that there is no difference between them.

To an independent sample with 20 respondents, the photos were presented one by one in a random order to test how the people perceived the gaze direction of the dogs. Respondents were asked for each photo, "Does the dog look at you?" and were given the options "Yes" or "No". The proportion of their answers was used to calculate a 'difference score' for each photo pair, which describes the distinctiveness of the photos in terms of the direction of the dog's gaze. These scores are presented in Table S4, but they did not affect the respondents' choices, so they were not included in the final analysis.

2.2. Subjects

We advertised our questionnaire through Facebook in our Hungarian Family Dog Project group, which has more than 15,000 followers, and to increase the sample size of flat-faced dog enthusiasts, we also advertised in groups dedicated to different brachycephalic breeds, such as French Bulldogs, English Bulldogs, Cavalier King Charles Spaniels, etc. The characteristics of the 1156 respondents are summarized in Table 1.

2.3. Statistical analysis

We used R 4.1.1 software (R Core Team, 2022) for statistical analysis. We used Cumulative Link Mixed Model ("clmm" function of "ordinal" package (Christensen, 2019)) with the respondents' ID as a random factor to analyse whether respondents in the different attitude groups differ in the extent to which they liked the French Bulldog mix and the Boxer dog in the photos, thereby validating our groupings of the *attitude towards brachycephalism*. The variance explained by the respondents' ID was 2.09 ± 1.45, indicating that there is a non-negligible variability between individuals across all attitude groups.

A Multinomial Log-linear Model ("multinom" function of "nnet" package (Venables and Ripley, 2002)) was used to analyse the effect of demographic factors (age, sex, parental status, residence), knowledge of health problems (number of health problems associated with brachycephalism, level of education, dog-related professional expertise), personality (extraversion, agreeableness, conscientiousness, neuroticism, and openness) and dog-directed empathy (emotional and cognitive), on the *attitude towards brachycephalism*.

Three Binomial Generalized Linear Mixed-Effects Models with logit link ("glmer" function of "lme4" package (Bates et al., 2015)) were used to analyse the possible relationship between the *preference for eye contact*, i.e., photo choices (*eye contact*, *look away* or *no difference*) in pairs as binary scores and demographic factors (age, sex, parental status, residence), knowledge of health problems (number of health problems associated with brachycephalism, level of education, dog-related professional expertise), attitude towards brachycephalism, personality (extraversion, agreeableness, conscientiousness, neuroticism, and openness), dog-directed empathy (emotional and cognitive), and a score indicating how much the respondents liked the dog in the photo. The respondents' ID and pictures' ID were included as random factors.

A bottom-up, AIC-based model selection was used to find the most parsimonious models ("anova" function of "stats" package (R Core Team, 2022)). The inclusion criteria were a significant likelihood ratio test for each tested variable and at least two value differences between the compared models.

According to the model selection, the most parsimonious model of Multinomial Log-linear Model for *attitude towards brachycephalism* contained age, the number of health problems associated with brachycephalism, agreeableness, and dog-directed emotional empathy as covariates, and sex, parental status, residence, level of education, and dog-related professional expertise as factors.

For the Binomial Generalized Linear Mixed-Effects Model between

Fig. 1. Examples of photo pairs (eye contact and look away photos, presented randomly). All photo stimuli are presented in Table S4.

eye contact and *no difference*, the most parsimonious model contained age, extraversion and dog-directed cognitive empathy as covariates, attitude towards brachycephalism as a factor, and the score about how much respondents liked the dog in the photo as an ordered factor. The variance explained by the respondents' ID was 4.92 ± 2.22, and by the pictures' ID was 1.28 ± 1.13.

For the Binomial Generalized Linear Mixed-Effects Model between *look away* and *no difference*, the most parsimonious model only contained age as a covariate and the score about how much respondents liked the dog in the photo as an ordered factor. The variance explained by the respondents' ID was 4.32 ± 2.08, and by the pictures' ID was 1.05 ± 1.03.

For the Binomial Generalized Linear Mixed-Effects Model between *eye contact* and *look away*, the most parsimonious model only contained age as a covariate, and level of education and dog-related professional expertise as factors. The variance explained by the respondents' ID was 0.45 ± 0.67, and by the pictures' ID was 0.58 ± 0.76.

A Tukey post-hoc test was conducted for comparisons between the groups of the dog-related professional expertise and attitude towards brachycephalism factors and the ordered factor of the score about how much respondents liked the dog in the photo ("emmeans" function of "emmeans" package (Lenth, 2019)).

Odds ratios were calculated using the "OR.multinom" function of the "RVAideMemoire" package (Hervé, 2022) in the case of the Multinomial Log-linear Model. For the Generalized Linear Mixed-Effects Models, we used the "standardize_parameters" function of the "easystats" package (Lüdecke et al., 2022) to calculate odds ratios for continuous variables and the "confint" and "emmeans" function with "response" type ("emmeans" package (Lenth, 2019)) for categorical variables.

We used the variance inflation factor (VIF; "vif" function of the "car" package (Fox and Weisberg, 2019)) to assess the possibility of multicollinearity among the independent variables. However, VIF cannot be applied to Multinomial Log-linear Models, so we made Binomial Generalized Linear Models and ran the VIF analysis on those, which provided a close approximation of the potential multicollinearity.

3. Results

All the variance inflation factor (VIF) scores were within the range of 1.00–1.72, indicating that there was no multicollinearity among the independent variables. Detailed information regarding the model selection process and the VIF analyses can be found in Supplementary Tables S5–12.

3.1. Attitudes towards brachycephalism

The respondents who liked brachycephalism liked the photos of the French Bulldog mix and the Boxer more than those who either disliked (ß ± SE: 2.82 ± 0.20; Z = 14.34; $p < 0.001$) or were neutral to the brachycephalic breeds (ß ± SE: 1.30 ± 0.15; Z = 8.55; $p < 0.001$). Furthermore, those who disliked brachycephalism disliked the French Bulldog mix and the Boxer more than those who were neutral to brachycephalic breeds (ß ± SE: −1.52 ± 0.16; Z = 9.78; $p < 0.001$). This supports the grouping of the respondents based on their attitude towards brachycephalism. Regardless of their attitude, the respondents liked the Boxer more than the French Bulldog mix (ß ± SE: 1.80 ± 0.09; Z = 19.00; $p < 0.001$).

The attitudes of the respondents towards brachycephalism were found to be associated with 1) age ($p < 0.001$); 2) sex ($p < 0.001$); 3) parental status ($p = 0.057$); 4) place of residence ($p = 0.004$); 5) the number of health problems associated with brachycephalism ($p < 0.001$); 6) level of education ($p < 0.001$); 7) dog-related professional expertise ($p < 0.001$); 8) agreeableness ($p = 0.012$) 9) conscientiousness ($p = 0.050$), and 10) dog-directed emotional empathy ($p = 0.004$). Their attitudes were not found to be related to other personality traits such as extraversion, neuroticism, and openness or with dog-directed cognitive empathy.

Those who liked brachycephalism were younger compared to those who disliked it (ß ± SE: −0.02 ± 0.01; Z = −2.24; OR = 0.98 [0.96–1.00]; $p = 0.025$) or were neutral to it (ß ± SE: −0.04 ± 0.01; Z = −4.45; OR = 0.96 [0.95–0.98]; $p < 0.001$). Men were more likely to be neutral to brachycephalism compared to women, who were more likely to dislike it (ß ± SE: 0.79 ± 0.27; Z = 2.89; OR = 2.21 [1.29–3.78]; $p = 0.004$) or like it (ß ± SE: 0.79 ± 0.29; Z = 2.77; OR = 2.20 [1.26–3.85]; $p = 0.006$). Additionally, parents were more likely to like brachycephalism than to be neutral to it (ß ± SE: 0.44 ± 0.20; Z = 2.15; OR = 1.55 [1.04–2.30]; $p = 0.032$) compared to childless respondents.

Residents of the Hungarian capital city (Budapest) were less likely to like brachycephalism than to dislike it or to be neutral to it, compared to those living in a Hungarian big city (dislike: ß ± SE: −0.78 ± 0.26; Z = −2.96; OR = 0.46 [0.28–0.77]; $p = 0.003$; neutral: ß ± SE: −0.55 ± 0.21; Z = −2.70; OR = 0.58 [0.39–0.86]; $p = 0.007$), small city (dislike: ß ± SE: −0.60 ± 0.27; Z = −2.21; OR = 0.55 [0.32–0.93]; $p = 0.027$; neutral: ß ± SE: −0.55 ± 0.22; Z = −2.53; OR = 0.58 [0.38–0.88]; $p = 0.012$), village (dislike: ß ± SE: −0.77 ± 0.30; Z = −2.59; OR = 0.47 [0.26–0.83]; $p = 0.010$; neutral: ß ± SE: −0.91

± 0.25; Z = −3.73; OR = 0.40 [0.25–0.65]; p < 0.001) or outside of Hungary (dislike: ß ± SE: −0.89 ± 0.45; Z = −1.97; OR = 0.41 [0.17–0.99]; p = 0.048; neutral: ß ± SE: −0.86 ± 0.35; Z = −2.48; OR = 0.42 [0.21–0.83]; p = 0.013).

When analysing the association between residence and level of education, we found that those who live in the Hungarian capital city are more likely to have higher education compared to those who reside in a big Hungarian city (ß ± SE: 0.43 ± 0.17; Z = 2.49; OR = 1.54 [1.10–2.16]; p = 0.013) or small city (ß ± SE: 0.59 ± 0.18; Z = 3.32; OR = 1.81 [1.28–2.57]; p < 0.001), whereas capital city residents do not differ in their level of education from village residents or those living outside of Hungary. Despite this association, the variance inflation factor indicated no multicollinearity among the independent variables; therefore, this did not impact our results.

Those who liked brachycephalism associated more health problems with it compared to those who disliked it (ß ± SE: 0.32 ± 0.07; Z = 4.31; OR = 1.38 [1.19–1.60]; p < 0.001) or were neutral to it (ß ± SE: 0.38 ± 0.06; Z = 6.23; OR = 1.47 [1.30–1.66]; p = < 0.001; Fig. 2a). Among all respondents, 98.79% associated breathing difficulties with brachycephalic dogs, 89.79% associated dystocia, 82.61% associated abnormal teeth, 79.15% associated allergic skin diseases, 67.21% associated obesity, 60.55% associated corneal ulceration, and 41.26% associated joint diseases with them (see Supplementary Tables S19–20 for more details about respondents' answers to the quiz about health problems).

Compared to individuals with lower levels of education, those with higher levels of education were less likely to like brachycephalism than to dislike it (ß ± SE: −1.12 ± 0.23; Z = −4.92; OR = 0.33 [0.21–0.51]; p < 0.001) or to be neutral to it (ß ± SE: −0.48 ± 0.16; Z = −2.93; OR = 0.62 [0.45–0.85]; p = 0.003), and more likely to dislike brachycephalism than to be neutral to it (ß ± SE: 0.64 ± 0.20; Z = 3.13; OR = 1.89 [1.27–2.81]; p = 0.002; Fig. 2b).

Compared to individuals without dog-related professional expertise, those with it were less likely to like brachycephalism than to dislike it (non-veterinary experience: ß ± SE: −1.18 ± 0.24; Z = −4.93; OR = 0.31 [0.19–0.49]; p < 0.001; veterinary experience: ß ± SE: −1.36 ± 0.57; Z = −2.39; OR = 0.26 [0.08–0.78]; p = 0.017) or to be neutral to it (non-veterinary experience: ß ± SE: −0.78 ± 0.21; Z = −3.80; OR = 0.46 [0.31–0.69]; p < 0.001), and more likely to dislike brachycephalism than to be neutral to it (non-veterinary experience: ß ± SE: 0.39 ± 0.18; Z = 2.19; OR = 1.48 [1.04–2.11]; p = 0.029; veterinary experience: ß ± SE: 0.95 ± 0.44; Z = 2.19; OR = 2.59 [1.10–6.08]; p = 0.029; Fig. 2c).

People who disliked brachycephalism had a lower level of agreeableness compared to those who were neutral to it (ß ± SE: −0.40 ± 0.14; Z = −2.86; OR = 0.67 [0.51–0.88]; p = 0.004) or those who liked it (ß ± SE: −0.40 ± 0.17; Z = −2.39; OR = 0.67 [0.48–0.93]; p = 0.017; Fig. 3a).

Those who disliked brachycephalism also had a lower level of conscientiousness compared to those who were neutral to it (ß ± SE: −0.32 ± 0.13; Z = −2.42; OR = 0.73 [0.56–0.94]; p = 0.016; Fig. 3b).

In addition, they had a lower level of dog-directed emotional empathy compared to those who were neutral to it (ß ± SE: −0.86 ± 0.28; Z = −3.07; OR = 0.42 [0.25–0.73]; p = 0.002) or those who liked it (ß ± SE: −0.98 ± 0.35; Z = 2.81; OR = 0.37 [0.19–0.74]; p = 0.005; Fig. 3c).

For more detailed information about the results of the attitude towards brachycephalism, see Supplementary Tables S13–15).

3.2. Preference for eye contact

The preference for the *eye contact* photo over the choice of *no difference* between the photos was associated with: 1) age (p < 0.001); 2) extraversion (p = 0.048); 3) dog-directed cognitive empathy (p = 0.007); 4) the extent to which respondents like the dog in the photo (p < 0.001); and 5) attitude towards brachycephalism (p < 0.001). The preference for the *eye contact* photo over the *look away* photo was associated with: 1) level of education (p = 0.021) and 2) dog-related professional experience (p = 0.002). The preference for the *look away* photo over the choice of *no difference* between the photos was associated with 1) age (p = 0.009) and 2) the extent to which respondents liked the dog in the photo (p < 0.001).

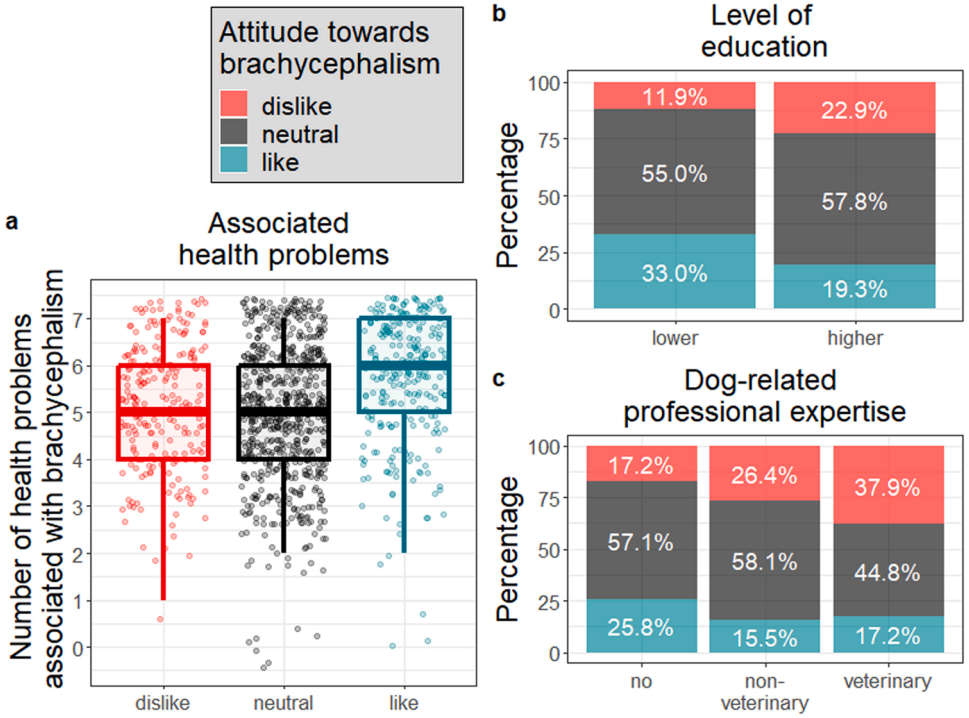


Fig. 2. The differences between the groups with different attitudes towards brachycephalism in terms of (a) the number of health problems associated with brachycephalism (0–7); (b) their level of education, and (c) their dog-related professional expertise.

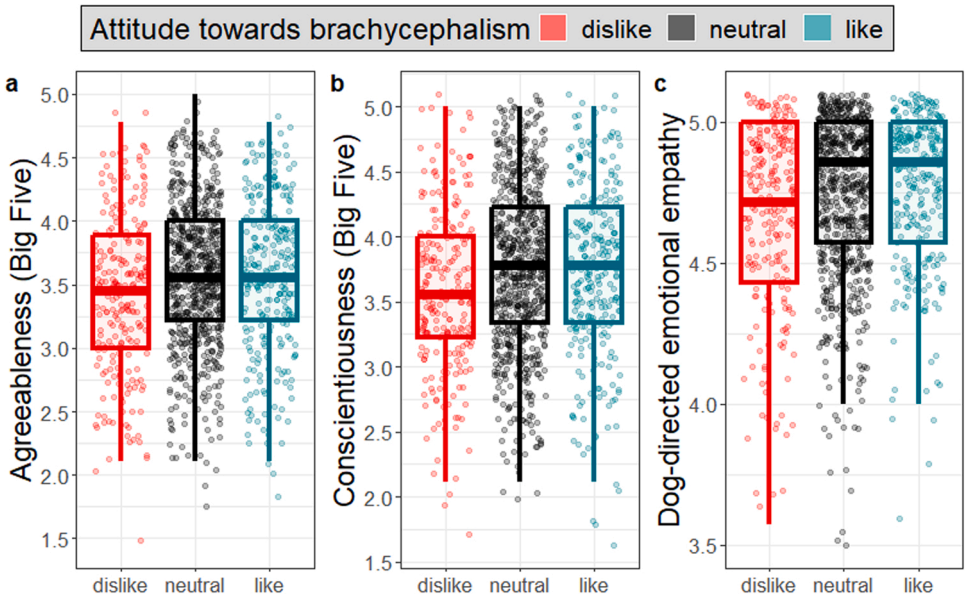


Fig. 3. The differences between the groups with different attitudes towards brachycephalism in terms of their level of (a) agreeableness, (b) conscientiousness and (c) dog-directed emotional empathy.

Older people are less likely to choose the *eye contact* photo or the *look away* photo than choosing *no difference* between the photos (eye contact: ß ± SE: −0.02 ± 0.01; Z = −4.12; OR = 0.57 [0.43–0.74]; p = < 0.001; look away: ß ± SE: −0.02 ± 0.01; Z = −2.63; OR = 0.71 [0.55–0.92]; p = 0.009).

Individuals with a higher level of education are more likely to choose the *eye contact* photo than the *look away* photo, compared to those with lower education levels (ß ± SE: 0.14 ± 0.06; Z = 2.32; OR = 1.16 [1.02–1.30]; p = 0.020).

Individuals with veterinary professional expertise are more likely to choose the *eye contact* photo than the *look away* photo, compared to those without dog-related professional expertise (ß ± SE: 0.53 ± 0.18; Z = 3.01; OR = 1.69 [1.12–2.56]; p = 0.007).

The more extroverted respondents were more likely to choose the *eye contact* photo than to choose *no difference* between the photos (ß ± SE: 0.18 ± 0.09; Z = 1.98; OR = 1.32 [1.00–1.72]; p = 0.047; Fig. 4a).

Respondents with a higher level of dog-directed cognitive empathy were more likely to choose the *eye contact* photo than to choose *no difference* between the photos (ß ± SE: 0.61 ± 0.22; Z = 2.75; OR = 1.46 [1.11–1.92]; p = 0.006; Fig. 4b).

Those who liked brachycephalism were less likely to choose the *eye contact* photo than to choose *no difference* between the photos, compared to those who were neutral to brachycephalism (ß ± SE: −0.60 ± 0.17; Z = −3.49; OR = 0.55 [0.37–0.82]; p = 0.001) or those who dislike it (ß ± SE: −0.74 ± 0.21; Z = −3.52; OR = 0.48 [0.29–0.78]; p = 0.001; Fig. 5). The photo pairs that were predominantly chosen by the groups

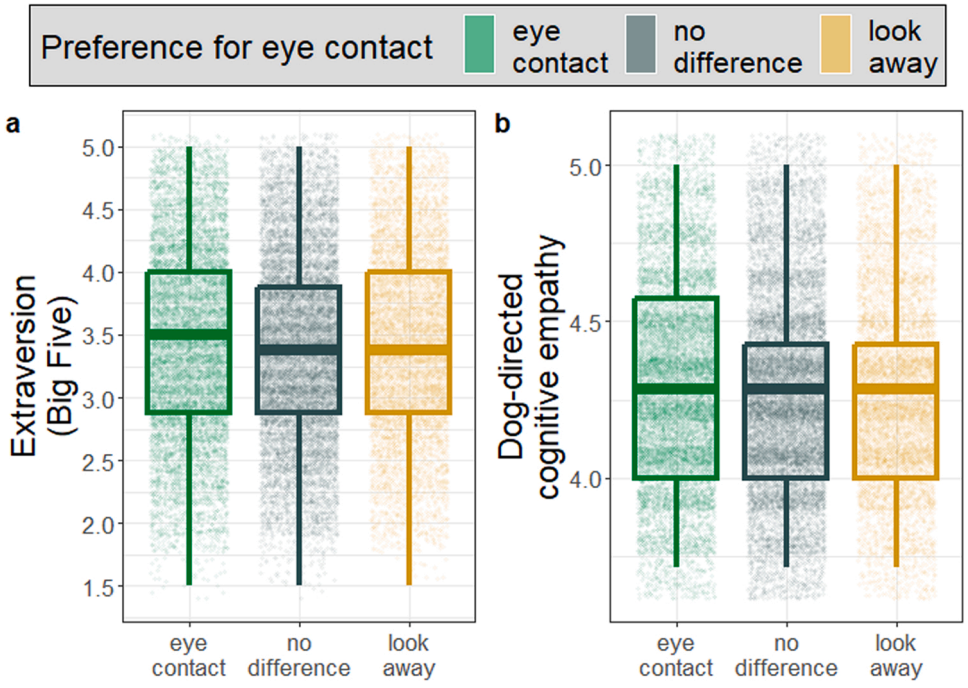


Fig. 4. Differences between eye contact preference groups in their level of (a) extraversion, and (b) dog-directed cognitive empathy.

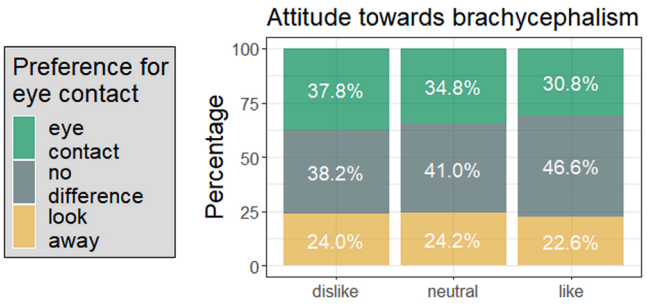


Fig. 5. Differences between eye contact preference groups in their attitude towards brachycephalism.

(dislike, neutral, like) are presented in Supplementary Table S4.

The extent to which respondents liked the dog in the photo affected their choice of photo. For instance, when respondents had a liking level of 0, they were less likely to choose either the *eye contact* photo or the *look away* photo than choose *no difference* between the photos, compared to respondents with a liking level of 4–5 (0 vs 4: *eye contact*: ß ± SE: −2.30 ± 0.16; Z = −14.57; OR = 0.10 [0.06–0.16]; p = < 0.001; *look away*: ß ± SE: −2.04 ± 0.16; Z = −12.71; OR = 0.13 [0.08–0.21]; p < 0.001; 0 vs 5: *eye contact*: ß ± SE: −1.94 ± 0.16; Z = −12.07; OR = 0.14 [0.09–0.23]; p = < 0.001; *look away*: ß ± SE: −1.71 ± 0.16; Z = −10.45; OR = 0.18 [0.11–0.29]; p < 0.001). On the other hand, when the liking level was 4, respondents were more likely to choose either the *eye contact* photo or the *look away* photo than choose *no difference* between the photos, compared to when the liking level was 5 (*eye contact* photo: ß ± SE: 0.36 ± 0.06; Z = 6.46; OR = 1.44 [1.22–1.69]; p < 0.001; *look away* photo: ß ± SE: 0.33 ± 0.06; Z = 5.48; OR = 1.39 [1.17–1.65]; p = < 0.001; see Supplementary Tables S16–18 for more details). The percentage of respondents in each group (dislike, neutral, like) who liked each dog in the photos is presented in Supplementary Table S4 and Figs. S1–3.

For more detailed information about the results of the preference for eye contact, see Supplementary Table S14-S16).

4. Discussion

We found that respondents' attitudes towards brachycephalic dogs were influenced by a variety of factors, including their demographic characteristics, knowledge of health problems, personality and sensitivity to dogs' eye contact. The main results are summarized in Fig. 6.

4.1. Attitudes towards brachycephalic dogs and respondents' demographic features

The attitude was found to be influenced by demographic features, with younger people and women being more likely to have a positive attitude compared to older people and men. This may be due to their increased sensitivity to the baby schema effect (Archer and Monton, 2011; Glocker et al., 2009; Lehmann et al., 2013). Furthermore, parents had a more positive attitude towards brachycephalism than those without children. This positive attitude may have been a result of the belief or perception that brachycephalic dogs are suitable for families with children (Packer et al., 2020). It is also possible that raising children makes individuals more sensitive to the baby schema features or that those who do not find infant-like features appealing do not become parents. Further investigation is needed to establish the causal relationship.

4.2. Attitudes towards brachycephalic dogs and respondents' knowledge of health problems

Our results showed that a higher level of education and dog-related professional expertise were linked to a negative attitude towards brachycephalism, which met our assumption. The connection between education level, veterinary expertise, and a negative attitude towards brachycephalism has already been reported in the case of cats and rabbits (Farnworth et al., 2018; Harvey et al., 2019). What is more, our results indicated that non-veterinarian dog-related professional expertise also plays a role in shaping people's attitudes. Specifically, those with expertise tend to have a negative attitude towards flat-faced dogs.

In addition to investigating the effect of formal education, we also

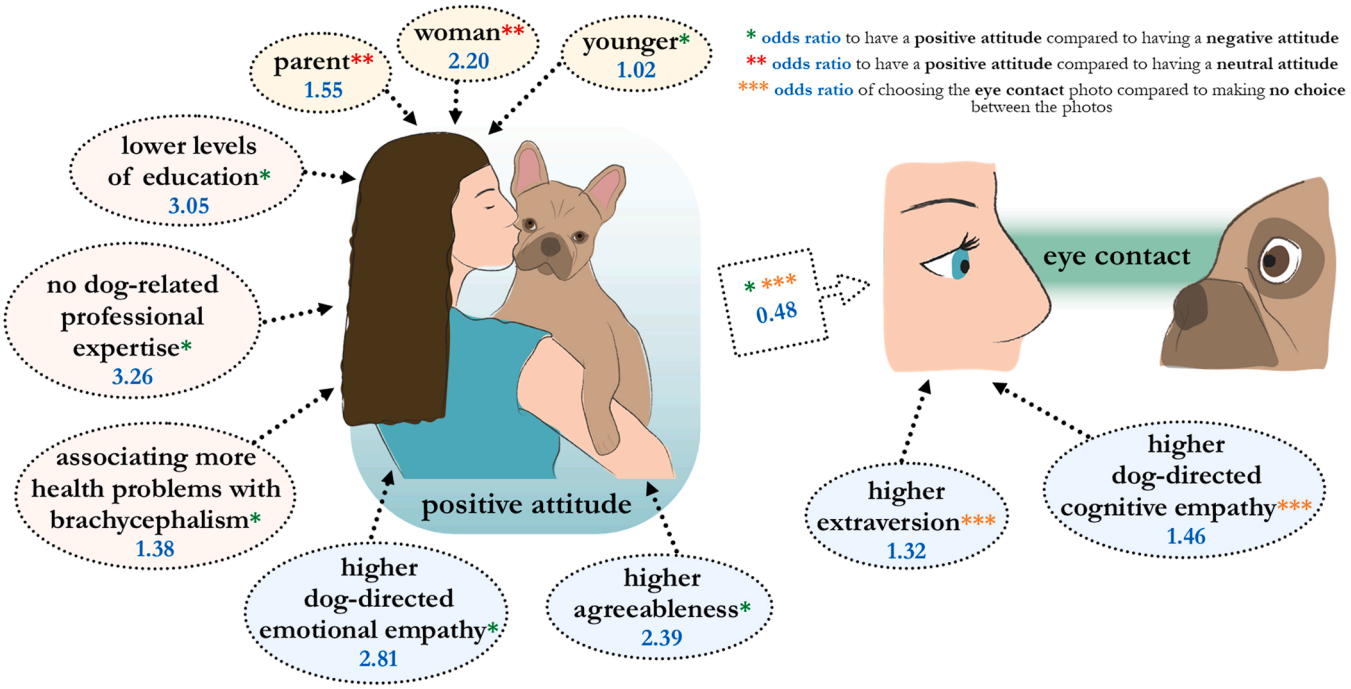


Fig. 6. Summary of the main features of respondents with a positive attitude towards brachycephalic dogs compared to those with a negative attitude. Yellow: demographic characteristics; red: knowledge; blue: personality; green: sensitivity to dogs' eye contact.

directly assessed respondents' knowledge of brachycephalic dogs' health problems. Surprisingly, we found that the respondents who had a positive attitude towards brachycephalic dogs were actually more aware of the health problems associated with these dogs compared to those who had a negative attitude or were neutral. Only a few respondents associated fewer than four health problems with brachycephalism. This suggests that brachycephalic animals' health issues are common knowledge, at least among dog enthusiasts in Hungary. Compared to this common knowledge, owners of brachycephalic breeds often rate their dogs as very healthy, even healthier than other dogs of their breed (Packer et al., 2019), despite these dogs being much more burdened with health problems compared to the average dog population (O'Neill et al., 2022). Our study suggests that knowledge of health problems is insufficient to shape people's attitudes towards brachycephalic dogs. Enthusiasts of these breeds are aware of the health issues, but they may not fully comprehend the extent of the suffering these dogs experience.

The owners' attitude towards the health problems associated with brachycephalism has been previously studied. It is common for brachycephalic dog owners to consider the health problems as normal features of the breed, even when the dogs exhibit clinical signs of disease (Packer et al., 2012). The normalization of these problems among veterinarians, owners, and breeders may prevent the improvement of the breed's well-being and reduce the likelihood of seeking veterinary intervention, even though the symptoms could often be reduced (Packer et al., 2012). This phenomenon also leads to the paradoxical result that despite the high incidence of health problems in certain dog breeds, the likelihood of reacquiring the same breed is not reduced (except in the case of French Bulldogs) (Sandøe et al., 2017). However, Packer et al. found the opposite to be true (Packer et al., 2020).

The presence of health problems in brachycephalic dogs does not negatively impact the quality of the owner-dog relationship. In fact, it can actually have a positive effect on the attachment between the owner and dog (Sandøe et al., 2017). Increased caregiving behaviour from the owner may contribute to the development of a strong attachment (Archer, 1997). Features of the "baby schema" can further stimulate and enhance caregiving behaviour towards brachycephalic dogs (Lorenz, 1943; Sternglanz et al., 1977). Owners of flat-faced dogs generally have a stronger bond with their pets (Packer et al., 2019; Sandøe et al., 2017), possibly due to the dogs' perceived need for care and their infant-like appearance. A close emotional connection to a certain dog breed increases the likelihood of breed loyalty, meaning that owners are more likely to acquire another dog of the same breed after the loss of their previous pet. In one study, 93% of owners of Pugs, French Bulldogs and English Bulldogs indicated that they would get another dog of the same breed (Packer et al., 2020). While in another research, only 57.3% of French Bulldogs' owners and 46.4% of Cavalier King Charles Spaniels' owners expressed willingness to reacquire the same breed in the future, compared to 39.6% of Cairn Terriers' owners and 38.5% of Chihuahuas' owners (Sandøe et al., 2017). In the future, it would be interesting to examine the reacquisition tendency of owners of different breeds, comparing owners of breeds with and without welfare issues.

Overall, health problems do not deter people from purchasing brachycephalic dogs but can actually be seen as appealing features of these dogs. Owners may view these dogs as helpless creatures that need to be saved due to their poor health status and view themselves as having an irreplaceable role in their dogs' lives, as they keep them alive and defend them (Beverland et al., 2008; Sandøe et al., 2017). In addition, purchasing expensive brachycephalic dogs can also be seen as a status symbol for owners who are extrinsically motivated and want recognition from others (Beverland et al., 2008). Brachycephalic dog owners appreciate the appearance of their dogs, even though a flat face is associated with a higher risk of health problems. They find the flat face of their dogs "cute", and avoid dogs with longer heads within the desired breed (Beverland et al., 2008). The results of studies indicate that brachycephalic dog owners have a higher level of attachment to their dogs (Beverland et al., 2008; Packer et al., 2017, 2020; Sandøe et al., 2017).

4.3. Attitudes towards brachycephalic dogs and respondents' personality

We also observed correlations between attitude and personality. Respondents who had a negative attitude towards brachycephalism were found to have lower levels of agreeableness, conscientiousness, and dog-directed emotional empathy. One possible explanation for this is that people who are agreeable try to avoid conflict (Tehrani and Yamini, 2020). They may believe that expressing dislike for a popular dog breed could lead to conflict, and, as a result, if they are not fans of brachycephalic dogs, they avoid taking a stance on the matter. Similarly, conflict management style is also associated with conscientiousness: individuals with higher conscientiousness try to find a compromise during conflict situations (Tehrani and Yamini, 2020). This could explain why respondents with higher levels of conscientiousness had a neutral attitude towards brachycephalic dogs rather than a negative one. Although we expected that people with high levels of empathy would feel the suffering of the dogs more and, as a result, not prefer brachycephalism, we found the opposite. A high score in dog-directed emotional empathy may indicate that the respondent loves all dogs so much that they would not say they dislike any particular breed. In line with this assumption, we received such responses (e.g. "I love every dog") when we asked respondents if they had any particular breed that they dislike.

The personalities of the respondents and their dog-directed empathy were also found to be related to their preference for eye contact. A higher level of extraversion and dog-directed cognitive empathy was associated with a higher likelihood of choosing the *eye contact* photo. Extroverted individuals tend to seek eye contact during conversations (Jensen, 2016), and our findings suggest that this trait of extroverts may extend to their interactions with dogs. Cognitive empathy refers to the ability to see the world from others' perspectives. People who tend to view things from a dog's perspective may be more sensitive to the signals and communication dogs use, particularly their eye contact, as they are better equipped to identify the animal's state of attention. One study has also shown that people with high levels of cognitive empathy pay more attention to eyes in eye-tracking experiments, regardless of the emotional state of the actor (Cowan et al., 2014). On the other hand, higher emotional empathy was found to be associated with longer looking times only when the stimulus was emotional (Cowan et al., 2014). In our study, we used neutral dog photos, which could explain why we did not observe a relationship between respondents' dog-directed emotional empathy scores and their preference for eye contact.

4.4. Attitudes towards brachycephalic dogs and respondents' sensitivity to dogs' eye contact

Contrary to our hypothesis, our results showed that respondents with a positive attitude towards brachycephalic dogs chose the *eye contact* photo less frequently and instead tended to choose the option indicating that there was *no difference* between the photos. This could be because they have high levels of dog-directed emotional empathy and love dogs so much that they cannot choose between two photos of the same dog. In line with this, those who rated the dog in the photo very highly (scores 4–5) were more likely to respond that there is *no difference* between the photos. Alternatively, they may be less sensitive to dogs' eye contact and less aware of the dogs' communicative signals, and thus potentially their suffering, which could explain why they perceive their dogs to be in good health (Packer et al., 2019). Further research is required to gain a deeper insight into the relationship between humans' attitudes towards brachycephalic dogs and their ability to understand and respond to eye contact from these dogs.

4.5. The need for educational campaigns

Previously, it was recommended that the public and potential buyers be educated about health issues to reduce the prevalence of inherited diseases in purebred dogs (Farrow et al., 2014). However, it appears that this approach has not led to a significant improvement in the welfare of brachycephalic dogs. Our findings indicate that knowledge of health problems does not have a significant impact on people's attitudes towards brachycephalism. As a result, it appears that providing factual education about the severe health issues faced by brachycephalic dogs will not discourage people from purchasing these types of dogs or reduce their popularity and will not result in an improvement in the health status of brachycephalic breeds.

Two crucial facts need to be emphasized in educational campaigns: (1) that the breed's health problems are not normal and are painful, and (2) that dog owners play a significant role as consumers in shaping the health of a breed. The health issues faced by brachycephalic dogs are not just normal features of the breed but are serious and painful medical conditions (Packer and O'Neill, 2021). Improving the well-being of these breeds requires a change in perception and an increase in demand for healthy individuals. While educational interventions may help to dispel the notion that health problems are normal for brachycephalic breeds among the general public, they may not have a significant impact on brachycephalic dog enthusiasts (Kenny et al., 2022). For this group, education should focus on the actions they can take to promote the health of brachycephalic breeds through their purchases. Many brachycephalic dog owners are unaware or unwilling to acknowledge that their purchasing decisions can contribute to their dog's health problems and worsen the overall health of the breed at a population level (Packer et al., 2020). It is crucial to educate owners about the role they play as consumers and how their choices can affect the health of the breed. If the buyers are not motivated to choose healthy individuals within a breed, "breed typical" health problems will persist, and breeders will have no incentive to breed healthy individuals. This perpetuates non-ethical breeding practices of the affected breeds. The health of the breed will only improve if people prefer to purchase healthy individuals and incentivize breeders to do the same.

Education about health issues should highlight not only the presence of diseases but also their implications for both the dog and its owner, the factors that increase the risk of these diseases (such as the flat facial structure), and the financial burden of potential treatments. Professionals need to be mindful that labelling health problems as "typical" or "normal" for certain breeds is harmful and can have a negative impact. Instead, labelling these breeds as "high-risk for suffering" may discourage people from purchasing brachycephalic dogs and help improve the well-being of these breeds.

Ethical statement

The United Ethical Review Committee for Research in Psychology (EPKEB) approved and accepted the experimental protocol (Ref. no.: 2022–81). All experiments were performed in accordance with relevant guidelines and regulations, and informed consent was obtained from all participants.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Supported by the ÚNKP-21-3 and ÚNKP-22-3 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund (ÚNKP-21-3-I-ELTE-595 and ÚNKP-22-3-II-ELTE-577); the Hungarian Academy of Sciences via a grant to the MTA-ELTE "Lendület" Momentum Companion Animal Research Group (PH1404/21), and the National Brain Programme 3.0 of the Hungarian Academy of Sciences (NAP2022-I-3/2022). We thank Tamás Faragó for his help in statistical analysis, Borbála Turcsán for her help in questionnaire development, and the respondents for their participation in our research.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Grammarly and ChatGPT for grammar correction. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Contributions

Each author declares substantial contributions through the following:

(1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content,

Conceptualization: ZB, EK.
Formal analysis: ZB.
Funding acquisition: ZB, EK.
Investigation: ZB.
Methodology: ZB, EK.
Project administration: ZB.
Supervision: EK.
Visualization: ZB.
Writing—original draft: ZB.
Writing—review and editing: ZB, EK.
Approval of the submitted version of the manuscript: ZB, EK.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.applanim.2023.105948.

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