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The effects of owner and domestic cat (*Felis catus*) demographics on cat personality traits

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ABSTRACT

Personality has been researched in many companion animals and is described as differences in behavioural traits of individuals that often remain consistent over time. In domestic cats many factors have been discovered to influence personality, including breed, coat colour, gender, rearing experience, number of cats within a household, owner age, owner gender and owner personality. However, research is limited for certain factors, including owner demographics, so the aim was to demonstrate that a simple survey could be used to infer personality traits and identify domestic cat and owner demographical factors that influence certain traits. An online personality survey with 34 traits was sent out to cat owners in the UK, Europe and North America, containing cat and owner demographical questions. Housing type, total number of cats in household and owner animal preference all had significant effects on many of the personality trait scores. Unexpectedly, cat breed, owner age, neutering status and country of residence showed distinct clusters in the multifactor analysis individual model but did not have any significant effects on any of the personality traits, along with coat colour, owner gender and cat gender which were initially considered of importance to the study, contradicting some of the previous research. This study highlights the importance of considering demographical factors that influence personality traits, to predict cat personality based on these factors to cater for specific husbandry practices and to improve the chances of successful adoption for those within shelters.

1. Introduction

Although the term temperament is often used to avoid anthropomorphising non-human animal behaviour (Jones and Gosling, 2005), personality is becoming widely accepted (Gartner, 2015). Personality is described as differences in behavioural traits of individuals that often remain consistent over time (Powell and Gartner, 2011) and is found in many domestic companion animals, including cats, *Felis catus* (Bennett et al., 2017)), and dogs, *Canis lupus familiaris* (Svartberg and Forkman, 2002). Producing personality profiles can be beneficial for both the animal and the owner/handler as it can be used to predict illnesses, including feline immunodeficiency virus (Natoli et al., 2005), and can also improve the chances of successful adoptions (Dowling-Guyer et al., 2011; Weiss et al., 2015). Working animals that provide a service must undergo training and personality assessments before being accepted, including police (Slabbert and Odendaal, 1999), military (Sinn et al., 2010) and guide dogs (Goddard and Beilharz, 1984).

Cats are popular companion animals with over 10 million kept in the UK alone in 2010 (Murray et al., 2010), so it is not surprising there are over 43 studies on cat personality with almost half of those carried out within the last 5 years (Travnik et al., 2020). Litchfield et al. (2017) described five cat personality dimensions (dominance, neuroticism, impulsiveness, extraversion and agreeableness), classed as the 'Feline Five' and based on the human "Big Five" (Gosling and John, 1999). These dimensions are comprised of multiple personality traits (often adjectives describing a behaviour rated on a scale (McCrae and John, 1992)) that are arranged together by similar core elements (Gosling and John, 1999). Bennet et al. (2017,) identified six dimensions (dominance, playfulness, demandingness, amiability, gullibility and nervousness) but Arahori et al. (2016) recognized only four (friendliness, neuroticism, openness and roughness). Sometimes the dimensions can overlap and be interchanged, for example, agreeableness is similar to friendliness and dominance to roughness (Arahori et al., 2016; Litchfield et al., 2017).

Physical attributes can influence cat personality, including breed

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Table 1

Descriptions of 34 domestic cat personality traits rated from 1 to 12 by owner surveys based on traits used by Quintavalle Pastorino et al., in 2017 and 2019.

Personality traits	Description
Active	Cat moves around the house and outdoors e.g. running, walking or stalking.
Aggressive to familiar people	Cat is hostile and threatening towards familiar people (outside of the family) e.g. hisses, growls and attacks.
Aggressive to human family members	Cat is hostile and threatening towards human family members e.g. hisses, growls and attacks.
Aggressive to other animals	Cat is hostile and threatening towards animals of a different species e.g. hisses, growls and attacks.
Aggressive to other cats	Cat is hostile and threatening towards other cats e.g. hisses, growls and attacks.
Aggressive to owner	Cat is hostile and threatening towards owner e.g. hisses, growls and attacks.
Aggressive to unfamiliar people	Cat is hostile and threatening towards unfamiliar people e.g. hisses, growls and attacks.
Calm	Cat is not easily disturbed by changes in the environment.
Cooperative	Cat is compliant and willingly behaves when asked to do something.
Curious	Cat approaches and explores changes in the environment.
Dominant over other cats	Cat displays dominance over other cats e.g. seeking a higher status, bullying, not submissive, territorial and scent marking.
Eccentric	Cat shows stereotypical or unusual behaviours.
Excitable	Cat reacts strongly to changes in the environment.
Fearful of familiar people	Cat retreats and hides from familiar people (outside of the family).
Fearful of human family members	Cat retreats and hides from human family members.
Fearful of other animals	Cat retreats and hides from animals of a different species.
Fearful of other cats	Cat retreats and hides from other cats.
Fearful of owner	Cat retreats and hides from owner.
Fearful of unfamiliar people	Cat retreats and hides from unfamiliar people.
Friendly to familiar people	Cat seeks proximity to familiar people (outside of the family), approaching readily and in a friendly manner e.g. purrs, tail up, vocalizes and rubs on leg or objects.
Friendly to human family members	Cat seeks proximity to human family members, approaching readily and in a friendly manner e.g. purrs, tail up, vocalizes and rubs on leg or objects.
Friendly to other animals	Cat seeks proximity to animals of a different species, approaching readily and in a friendly manner e.g. purrs, tail up, vocalizes, head-rubs and body-rubs.
Friendly to other cats	Cat seeks proximity to other cats, approaching readily and in a friendly manner e.g. purrs, tail up, vocalizes, head-rubs and body-rubs.
Friendly to owner	Cat seeks proximity to owner, approaching readily and in a friendly manner e.g. purrs, tail up, vocalizes and rubs on leg or objects.
Friendly to unfamiliar people	Cat seeks proximity to unfamiliar people, approaching readily and in a friendly manner e.g. purrs, tail up, vocalizes and rubs on leg or objects.
Insecure	Cat scares easily so is jumpy or fearful in general.
Playful	Cat initiates and engages in playful behaviour, seemingly meaningless, non-aggressive behaviour, with objects and/or other cats or people.
Self-assured	Cat moves in a seemingly confident, well co-ordinated and relaxed manner.
Smart	Cat learns to associate certain events quickly and appears to remember things for a long time.
Solitary	Cat spends time alone, avoiding company.
Tense	Cat shows restraint in movement and posture.
Timid/shy	Cat is reluctant to approach other animals, novel objects or new situations.
Vocal: aggressive	Cat vocalizes in an aggressive manner e.g. hisses and growls.
Vocal: non-aggressive	Cat vocalizes in a non-aggressive manner e.g. meows, purrs and calls.

(Kaleta et al., 2016) and coat colour (Stelow et al., 2016). Higher vocal communication and shyness levels are found in pure breed cats compared to mixed breeds (Kaleta et al., 2016). Finka et al. (2019), also described pure breeds as being less aggressive, anxious/fearful and aloof/avoidant and more gregarious but some studies have reported no differences (Bennett et al., 2017). Coat colour is linked to personality with higher aggression levels in tortoiseshell, black-and-white and grey-and-white cats (Stelow et al., 2016), but also anthropogenic perceptions of tri-coloured cats being intolerant and aloof, orange cats being friendly and white cats being shy, aloof, calm and less active and bold (Delgado et al., 2012).

Biological factors have been found to influence personality, as higher levels of aggression are present towards novel people in female cats (Kaleta et al., 2016), but males have higher levels in the cat social dimension (Ha and Ha, 2017). Personality has been found to occur at an early age in kittens (Raihani et al., 2014), but there seems to be an age-related effect on dimensions (Arahori et al., 2016; Bennett et al., 2017). It is not just biological factors that can influence personality, but also environmental factors, as those socialised from a young age and with friendly fathers exhibit more friendly behaviour towards humans, along with lower stress levels during handling (McCune, 1995). As the number of cats increase within a household, gullibility decreases and amiability increases (Bennett et al., 2017), with the number of cats also influencing personality in a study by Ha and Ha (2017), as cats housed with others had higher levels in human aggressive and cat social dimensions.

Although anthrozoology (the study of animal and human interactions (York and Mancus, 2013)) is a vastly studied field (Gosling and Bonnenburg, 1998), the effect of cat owner demographics on cat personality is understudied (Evans et al., 2019). However, owner demographics, including age and gender, are known to influence personality in companion animals, with most studies on dogs (Kotrschal et al., 2009; Kubinyi et al., 2009). Owner personality is known to influence cat personality, as cats with neurotic owners are more anxious/fearful and aggressive than those with conscientious owners (Finka et al., 2019). Cat owner dominance has also been positively correlated to impulsive, extrovert and neurotic dimensions in cats, again suggesting that owner personality influences cat personality (Evans et al., 2019). However, there are a lack of studies focusing on particular owner demographical factors, apart from owner personality, that influence cat personality.

In this study we focus on both domestic cat and owner demographics influences or associations on cat personality because of the lack of studies focusing on owner demographics (apart from personality) and the lack of depth in those factors. Our aim is to demonstrate that a simple survey can be used to infer personality traits and identify cat and owner demographical factors that influence cat traits. The four specific hypotheses examined are that there are significant differences in personality trait scores among cat breeds, coat colours, cat gender and owner gender.

Table 2

Significant effects (p < 0.05) revealed from Kruskal-Wallis tests (owner animal preference and housing type) and Wilcoxon-rank tests (total number of cats) of domestic cat and owner demographics and 34 personality traits rated by owners. The p-values have been adjusted with the Benjamin-Hochberg False Discovery Rate step-up procedure, as a correction against the inflation of the Type I errors. (-) indicates no significant effects.

| Personality trait	Owner animal preference			Housing type			Total number of cats	
	X^2	df	p	X^2	df	p	W	p
Active	–	–	–	16.161	4	0.020 *	–	–
Aggressive to familiar people	–	–	–	–	–	–	8662.000	0.049 *
Aggressive to other animals	–	–	–	–	–	–	8465.000	0.023 *
Aggressive to other cats	–	–	–	15.892	4	0.020 *	–	–
Aggressive to owner	–	–	–	–	–	–	9034.500	0.023 *
Curious	13.480	2	0.034 *	–	–	–	–	–
Dominant over other cats	–	–	–	–	–	–	12569.000	0.049 *
Fearful of other animals	–	–	–	18.449	4	0.011 *	–	–
Fearful of other cats	–	–	–	32.525	4	0.000 *[1]	8689.000	0.049 *
Friendly to other cats	11.174	2	0.045 *	–	–	–	15804.000	0.000 *[1]
Friendly to owner	12.540	2	0.034 *	–	–	–	–	–
Smart	–	–	–	23.838	4	0.001 *	–	–
Solitary	–	–	–	–	–	–	9297.500	0.049 *

*Significant (p < 0.05), [1] p < 0.001.
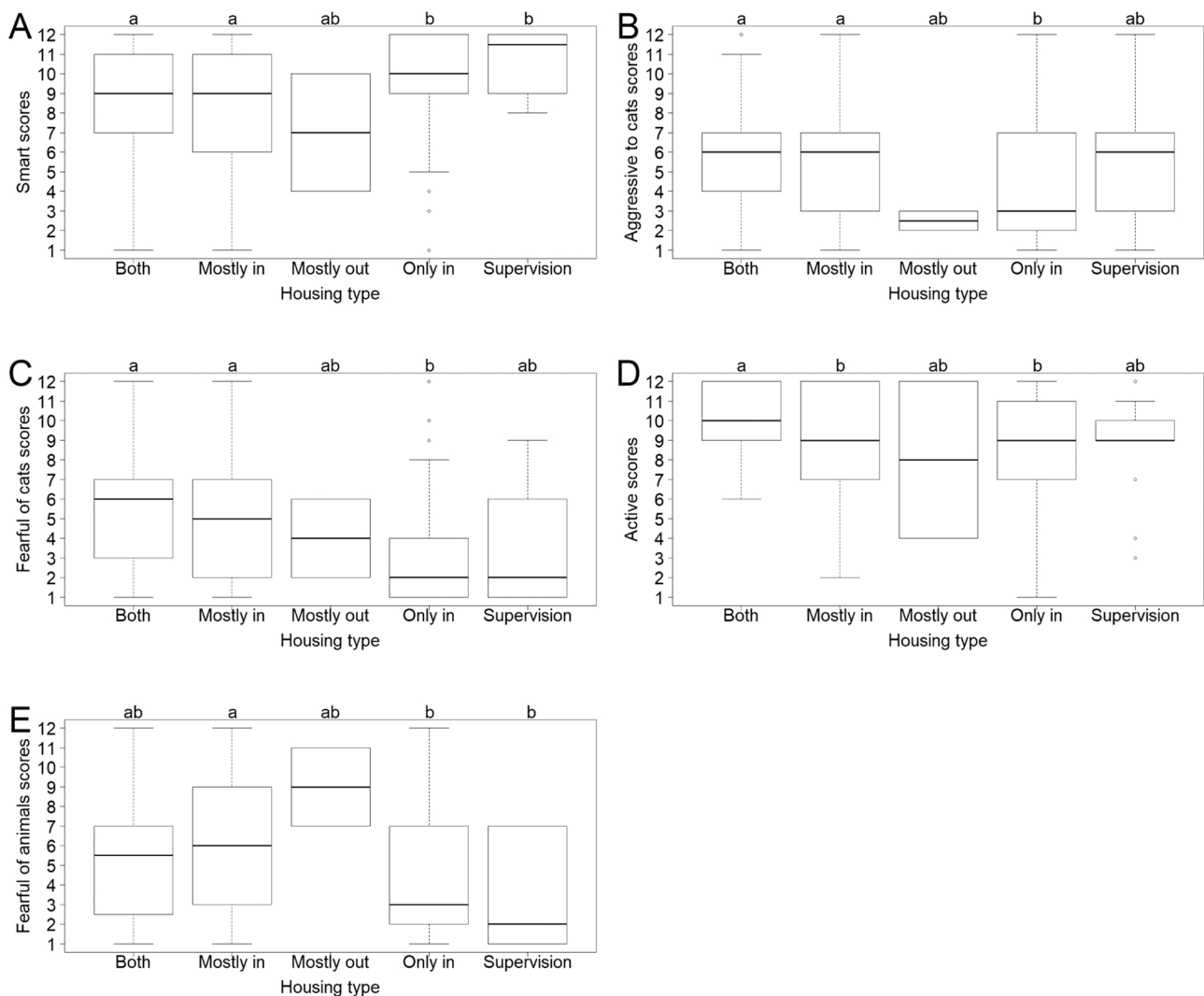
Fig. 1. Median, minimum (25%) quartiles and maximum (75%) quartiles of personality trait scores of domestic cats with different housing types rated by owners on a scale of 1 (never) to 12 (always). Significant differences from the Dwass-Steel-Critchlow-Fligner post hoc tests are indicated above the graph by different letters. Both refers to cats that were allowed indoors and outdoors equally and supervision refers to cats that were allowed outdoors only with supervision. (A) Median smart scores. (B) Median aggressive to other cats scores. (C) Median fearful of other cats scores. (D) Median active scores. (E) Median fearful of other animals scores.
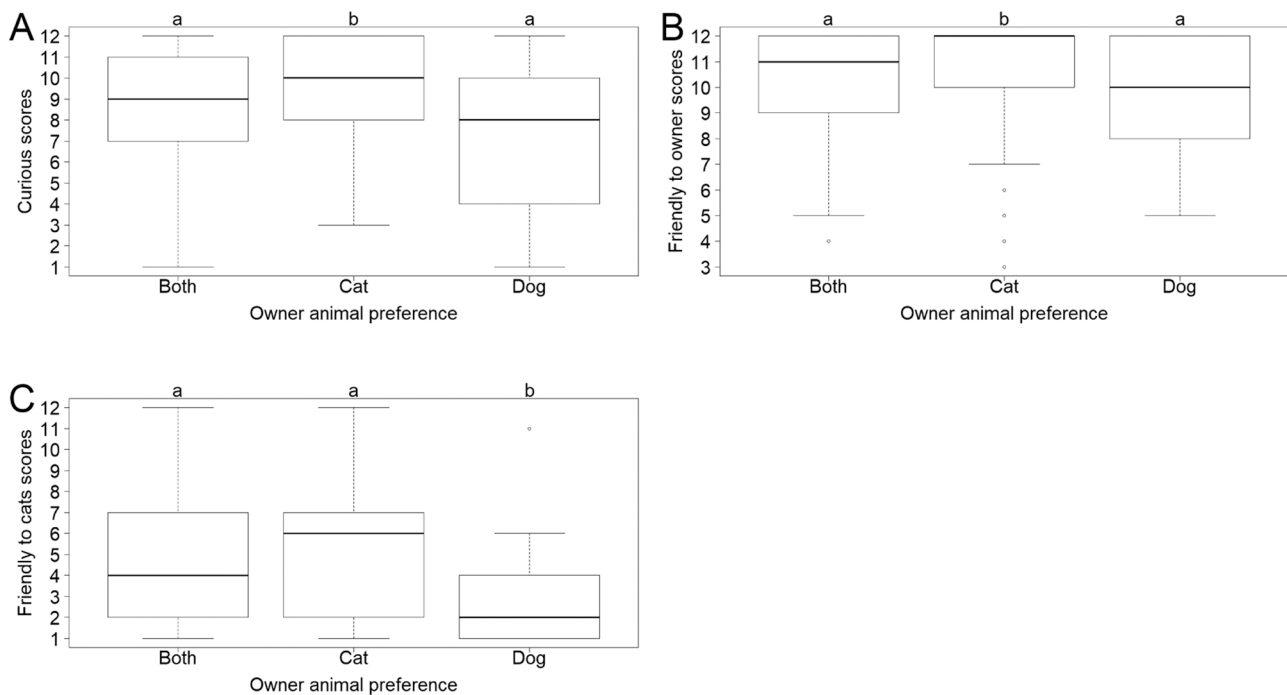
Fig. 2. Median, minimum (25%) quartiles and maximum (75%) quartiles of domestic cat personality trait scores on a scale of 1 (never) to 12 (always) with owners that have different animal preferences. Significant differences from the Dwass-Steel-Critchlow-Fligner post hoc tests are indicated above the graph by different letters. Both refers to owners that preferred both cats and dogs equally. (A) Median curious scores. (B) Median friendly to owner scores. (C) Median friendly to other cats scores.

2. Methods

2.1. Survey

An online cat personality survey with 34 traits (Table 1) on Survey Monkey (https://www.surveymonkey.co.uk/r/catsurvey), adapted from a survey used in a study by Quintavalle Pastorino et al., (2017, 2019), was sent to cat owners in the UK, Europe and North America from April to October 2019. The only survey produced was in English and was shared on Facebook in companion animal groups and an email was sent around Manchester Metropolitan University to staff and students in the School of Science and the Environment. The total amount of responses received was 393 surveys but only 312 were fully completed. Each participant could answer a separate survey for every cat that they owned. Survey questions were comprised of details about the cat, personality traits with description and owners' details, along with optional comments and photos. The rating method was used for the traits, all rated from 1 to 12, similar to other surveys used (Quintavalle Pastorino et al., 2017, 2019), with one specifying the trait was never observed and 12 specifying the trait was always observed. Validation of the survey along with similar surveys (Quintavelle Pastorino et al., 2017; 2019) has been carried out with participants from different countries, using a range of taxa with slight differences based on the species' behaviours with positive feedback of understanding of the questions and terms as intended.

2.2. Statistical analyses

Data analyses were carried out in R using RStudio (3.5.1) with data from all the surveys, including the incomplete surveys. Year of birth was converted into owners' age and the continuous variables (owners' age, number of people in the house, number of under 14-year olds in the house, years being a pet owner, total number of owned cats, years being a cat owner, years owned, cats' age and hours spent with the cat per day) were placed into categories in excel so clusters could be seen more easily in the multifactor analysis (MFA) individual models.

MFA models (MFA() function (FactoMineR package)) were executed (similar to those carried out by Quintavalle Pastorino et al., in 2019) using the edited data which consisted of eight personality dimensions (neurotic, dominant, extrovert, impulsive, agreeable, stable, antagonist and submissive) created from the positive and negative loadings of the personality traits on the 'Feline Five' (Litchfield et al., 2017) (**Appendix Table A1**). The analyses carried out were different to those in the study by Litchfield et al. (2017), so the 'Feline Five' (neuroticism, extraversion, dominance, impulsiveness and agreeableness) were split into dimensions that had traits with a positive loading and dimensions that had traits with a negative loading, for example, neuroticism was split into neurotic (containing the traits that had a positive loading on neuroticism) and stable (containing the traits that had a negative loading on neuroticism) (**Appendix Table A1**). However, some traits ('aggressive to other animals', 'vocal: aggressive', 'friendly to other animals' and 'vocal: non-aggressive') had to be removed, as they were not incorporated in the study by Litchfield et al. (2017), so only 30 personality traits were used. The 'Feline five' by Litchfield et al. (2017) has been validated from the cross-validation technique of two independent samples from different countries with high reliability. The 12 outlier data points visualised (fviz_mfa_ind() function (factoextra package)) in the plots were then removed and the MFA model was applied again to the data. The same process was carried out again, but with four personality dimensions (agonistic, extrovert, eccentric and affiliative) based on our
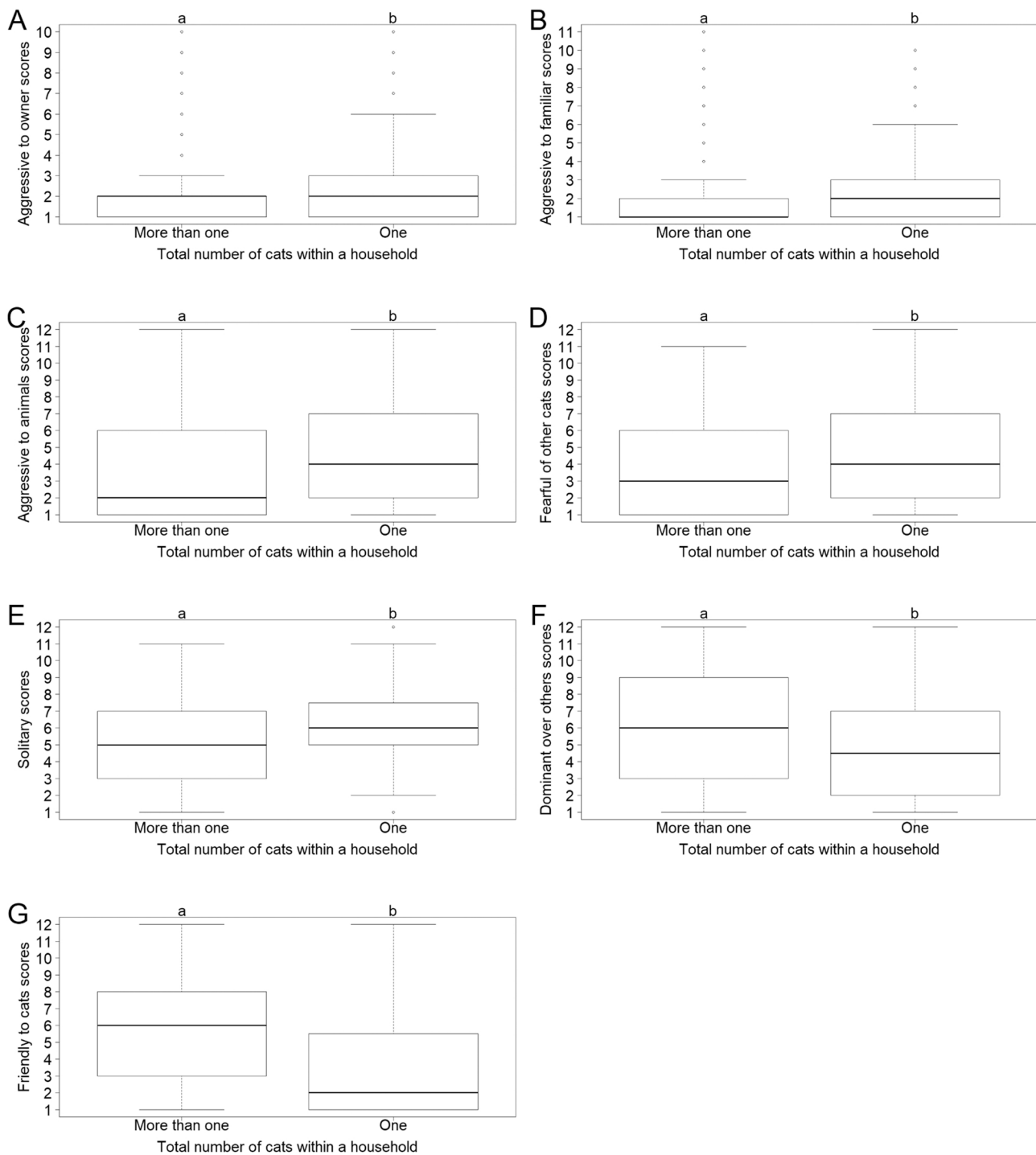
Fig. 3. Median, minimum (25%) quartiles and maximum (75%) quartiles of personality trait scores of domestic cats housed on their own or housed with other cats rated by owners on a scale of 1 (never) to 12 (always). Significant differences from the Wilcoxon-rank tests are indicated above the graph by different letters. (A) Median aggressive to owner scores. (B) Median aggressive to familiar people scores. (C) Median aggressive to other animals scores. (D) Median fearful of other cats scores. (E) Median solitary scores. (F) Median dominant to other cats scores. (G) Median friendly to other cats scores.

interpretations **(Appendix** Table A2**)** from a variety of studies, including Litchfield et al. (2017) and Kaleta et al. (2016), and contained all 34 personality traits.

Kruskall-wallis tests were executed with a significance level of p < 0.05 for the factors that contained three or more categories and clustering in the MFA models and were considered of importance (neutering

status, cat breed, housing type, owner age, owner country of residence and owner animal preference) or those that did not have clustering on the MFA models but were just considered of importance to the study (coat colour and owner gender). Kruskal-wallis tests (kruskal.test() function) were used to compare the chosen factors against the personality traits, succeeded by the Dwass-Steel-Critchlow-Fligner post hoc tests (dscfAllPairsTest() function (PMCMRplus package)) to identify where the significant differences (p < 0.05) were between the chosen factors. As so many Kruskal-wallis tests were performed the p-values were adjusted with the Benjamin-Hochberg False Discovery Rate step-up procedure (p.adjust() function), as a correction against the inflation of the Type I errors. Wilcoxon-rank tests (wilcox.test() function) were performed, with a significance level of p < 0.05, for the factors that contained only two categories and were considered of importance to the study (cat gender (male and female) and total number of cats (cats housed alone and cats housed with other cats)). Again, the p-values were adjusted with the Benjamin-Hochberg False Discovery Rate step-up procedure. Non-parametric tests (Kruskal-wallis and Wilcoxon-rank) were chosen as the data did not follow the parametric assumptions of homogeneous variances and normal distribution, obtained from the Bartlett's (bartlett.test()) and Shapiro-Wilk (shapiro.test()) tests (p < 0.05).

2.3. Ethical note

Ethical approval was granted by EthOS (Manchester Metropolitan University's online ethics application system) as it followed the Code of Ethics and Conduct of the British Psychological Society. To ensure safety of the data, it was not given to third parties and was electronically encrypted and stored on Survey Monkey.

3. Results

3.1. Owner demographics

Many cat owners participated in the survey, but there was a large bias towards females with 336 responses compared to 52 males and five preferring not to answer. Most owners were young aged between 20 and 39 (236) and the lowest responses were for the eldest age group, between 60 and 79 (19). Participants were from 16 different countries but most were from the UK (230), followed by the USA (126) and then all the other countries had nine or less responses. Therefore, most of the participants were British (224) or American (119), with 22 nationalities in total. Many participants had two people including themselves living within their household (155), but the number of people ranged from living by themselves to up to seven people including themselves within the household. Most of the cat owners had no under 14-year olds living in the household (344), but others had up to three. Years as a pet owner ranged from 1 to 50 years, with most owning a pet for 20 years (36) and a cat for one (27) and 20 years (27). The owners had a higher preference for cats (215) compared to dogs or both equally and most only owned cats as pets (229). Of those that owned other pets, 112 owned dogs, 37 owned rodents, 24 owned reptiles, 19 owned rabbits, 12 owned birds, eight owned invertebrates, five owned horses, four owned amphibians and four owned other pets including an African pygmy hedgehog, ferrets and a pig.

3.2. Domestic cat demographics

The number of responses for both cat genders were almost equal with

170 female cats and 176 male cats, with most individuals aged between 1 and 5 years old (171) and the least in the eldest category between 16 and 20 years old (18). There were 22 different cat breeds with most being mixed breed (moggie) cats (200), followed by unknown breeds (43) and then American shorthair cats (30). Only two cats were hairless which were the sphynx cats, but most cats had short hair (247) and multiple coat colours (283). Many had been adopted from an animal shelter or rescue group (129), were mother reared (162), had access to indoors only (144) and were housed with other cats (205), with up to 10 in one household. Most were on no medication (319), no special diets (318), had no behavioural problems (291) and were healthy with no illnesses or diseases (295), but most had undergone surgery (328), due to 327 individuals having been neutered.

3.3. Multifactor analysis of cat personality

Although there was overlap on the neutering status MFA individual model, most of the groups formed slight clusters (**Appendix** Fig. A1**A**). Again, there was overlap on the cat breed MFA individual model, particularly with unknown breeds and mixed breeds (moggies), but American shorthair and British shorthair seemed to form their own separate clusters (**Appendix** Fig. A1**B**). There was overlap but cats that were only indoors seemed to mainly be on the right side of the MFA individual model and cats that were indoors and outdoors equally along with those that were mostly indoors overlapped but were mainly on the left side of the model (**Appendix** Fig. A1**C**). Cats with owners aged 60–79 years old formed a cluster towards the top of the MFA individual model, although there was an overlap of cats with owners aged 40–59 years old in the middle of the model (**Appendix** Fig. A1**D**). There was a definite distinction between cats with American owners and those with British owners on either side of the MFA individual model, with other nationalities randomly spread and overlapped (**Appendix** Fig. A1**E**). Again, the country of residence MFA individual model had similar patterns to nationality with a definite distinction between USA and UK on either side of the model (**Appendix** Fig. A1**F**). Cats with owners that had owned a pet for 50–59 years formed a cluster on the MFA individual model and most of the other groups were overlapped, however, cats with owners that had owned a pet for 50–59 years were close to those with owners that had owned a pet for 30–39 and 40–49 years (**Appendix** Fig. A1**G**). A similar trend was therefore found in the years as a cat owner MFA individual model with cats with owners that had owned a cat for 50–59 years close to cats that had owners who owned a cat for 30–39 and 40–49 years (**Appendix** Fig. A1**H**). Most of the groups were overlapped on the owner animal preference MFA individual model, although cats with owners that preferred dogs were more clustered and towards the bottom of the model (**Appendix** Fig. A1**I**). None of the other MFA individual cluster models seemed to have distinct clusters relating to categories, so they were not included. All the MFA individual models had very similar patterns when the personality traits were categorised into the eight dimensions based on the 'Feline Five' (**Appendix** Table A1) although they were inverted, compared to when they were categorised using the four dimensions (**Appendix** Table A2), so the models using the eight dimensions based on the 'Feline Five' have not been included due to the close similarity in patterns and did not include all 34 personality traits used in this study.

Country of residence contributed the most to dimension one and explained the variability the most in the data when the personality traits were categorised into four dimensions. It was over the expected threshold for significance, along with nationality, indoors or outdoors (housing type), years being a pet owner, years as a cat owner, cat breed

and owner age. Years being a pet owner contributed the most to dimension two and was over the expected threshold for significance, along with years as a cat owner, owner age, cat breed, nationality, country of residence, indoors or outdoors (housing type), 'eccentric' and cat age. None of the quantitative variables exceeded the expected threshold for significance for dimension one although 'smart', categorised as extrovert, contributed the most. 'Eccentric', as a quantitative variable, contributed the most to dimension two and exceeded the expected threshold for significance.

3.4. Significant effects of demographics

Kruskal-Wallis tests revealed significant effects ($p < 0.05$) of housing type **(Appendix** Table A3**)** and owner animal preference **(Appendix** Table A4**)** on some of the personality traits and the Dwass-Steel-Critchlow-Fligner post hoc tests showed the significant differences ($p < 0.05$) between groups within these categories. Coat colour, neutering status **(Appendix** Table A3**)**, owner gender, country of residence **(Appendix** Table A4**)**, cat breed and owner age **(Appendix** Table A5**)** had no significant effects on any of the personality traits. Housing type had a significant effect on 'active' (Kruskal-Wallis test: x^2 (4) = 16.161, $p = 0.020$), 'aggressive to other cats' (Kruskal-Wallis test: x^2 (4) = 15.892, $p = 0.020$), 'fearful of other animals' (Kruskal-Wallis test: x^2 (4) = 18.449, $p = 0.011$), 'fearful of other cats' (Kruskal-Wallis test: x^2 (4) = 3.525, $p < 0.001$), 'smart' (Kruskal-Wallis test: x^2 (4) = 23.838, $p = 0.001$) scores (Table 2). Cats that were housed indoors only scored significantly more on the trait 'smart' than those that were housed mostly indoors and those housed indoors and outdoors equally **(Fig. 1A)** but were significantly less 'aggressive to other cats' **(Fig. 1B)** and 'fearful of other cats' **(Fig. 1C)**. Those that were allowed outdoors only with supervision had significantly higher scores in the 'smart' trait than those that were housed mostly indoors and those housed indoors and outdoors equally. 'Active' scores were significantly higher in cats that had access to both indoors and outdoors equally compared those that had mostly indoor access and only indoor access **(Fig. 1D)**, and 'fearful of other animals' scores were significantly higher in cats that had mostly indoor access compared to only indoor access and those allowed outdoors only with supervision **(Fig. 1E)**.

Owner animal preference had a significant effect on 'curious' (Kruskal-Wallis test: x^2 (2) = 13.480, $p = 0.034$), 'friendly to other cats' (Kruskal-Wallis test: x^2 (2) = 11.174, $p = 0.045$) and 'friendly to owner' (Kruskal-Wallis test: x^2 (2) = 12.540, $p = 0.034$) scores (Table 2). Cats with an owner that preferred cats were significantly more 'curious' (Fig. 2A) and 'friendly to owner' (Fig. 2B) than those with an owner that preferred dogs and those with an owner that preferred both dogs and cats equally. 'Friendly to other cats' scores were significantly lower in cats with owners that preferred dogs compared to cats or both equally (Fig. 2C).

Wilcoxon-rank tests revealed significant effects ($p < 0.05$) of total number of cats within a household on some of the personality traits (Table 2) but no significant effects of cat gender (Appendix Table A6). Cats housed alone were significantly more 'aggressive to owner' (Wilcoxon-rank test: w=9034.500, $p = 0.023$) (Fig. 3 A), 'aggressive to familiar people' (Wilcoxon-rank test: w=8662.000, $p = 0.049$) (Fig. 3B), 'aggressive to other animals' (Wilcoxon-rank test: w=8465.000, $p = 0.023$) (Fig. 3 C), 'fearful of other cats' (Wilcoxon-rank test: w=8689.000, $p = 0.049$) (Fig. 3D) and 'solitary' (Wilcoxon-rank test: w=9297.500, $p = 0.049$) (Fig. 3E) than those housed with other cats, but significantly less 'dominant over other cats' (Wilcoxon-rank test: w=12569.000, $p = 0.049$) (Fig. 3F) and 'friendly to other cats'

(Wilcoxon-rank test: w=15804.000, $p < 0.001$) (Fig. 3G).

4. Discussion

We propose our own four cat personality dimensions (extrovert, agonistic, affiliative and eccentric) as all the MFA individual models had very similar patterns when the personality traits were categorised into the eight dimensions based on the 'Feline Five' **(Appendix** Table A1**)**, compared to when they were categorised using the four dimensions **(Appendix** Table A2**)**. However, 'eccentric' as a quantitative variable forming it's own dimension, contributed the most to dimension two and exceeded the expected threshold for significance. Personality dimensions can vary between species and studies as Litchfield et al. (2017) suggested the 'Feline Five' in domestic cats differed from the human 'Big Five' (Gosling and John, 1999) and Gartner et al. (2014) found differences in personality dimensions across felid species. Further validation would be required for the four personality dimensions to be widely accepted and used within domestic cat personality studies.

Personality differences due to housing type have already been researched, although different categories were used by Menchetti et al. (2018), but similar categories with Labrador Retrievers (Lofgren et al., 2014). Cats housed both indoors and outdoors were significantly more 'active' than those housed mostly indoors and those housed only indoors, and cats housed only indoors were significantly less 'aggressive to other cats' than those housed mostly indoors and those housed both indoors and outdoors, with similar results in activity and aggressiveness found in dogs (Mirkó et al., 2012). Housing type had a significant effect on 'active', 'smart', 'aggressive to other cats', 'fearful of other cats' and 'fearful of other animals', with some similar effects found in dogs, but the literature for cats is limited, particularly as different categories are often used.

Total number of cats in a household had a significant effect on many traits, as cats housed alone were significantly more 'aggressive to owner', 'aggressive to familiar people', 'aggressive to other animals', 'solitary' and 'fearful of other cats', but significantly less 'dominant over other cats' and 'friendly to other cats' compared to cats housed with other cats. Ha and Ha (2017), found cats housed with other cats had higher levels of human-directed aggression, however the opposite effect was found in our study. Bennett et al. (2017), discovered that as the number of cats increased within the household so did amiability, which has been shown to represent some of the agreeableness scale, that contains a score from unfriendly to friendly (Zupančič et al., 2003). This reinforces the finding that in our study cats housed with other cats were significantly more 'friendly to other cats', also supported by Menchetti et al. (2018), as more cats present in a house improved sociability aspects.

It is surprising that rearing experience, neutering status, coat colour, cat gender, and cat breed did not have any significant effects on the personality traits. Rearing experience had no distinct clusters on the MFA individual model but has been discovered to influence personality traits in a range of species (McCune, 1995; Clarke and Snipes, 1998; Murray, 1998). Neutering status has been found to impact agonistic behaviours in cats (Finkler and Terkel, 2010; Finkler et al., 2011) but this is not always the case as discovered in both this study and one carried out by Menchetti et al. (2018). The effect of neutering on cat personality is understudied requiring further research (Gartner, 2015) as many papers are present for the impacts in dogs (Kubinyi et al., 2009; Starling et al., 2013). Coat colour has been reported to impact personality traits in companion animals (Lofgren et al., 2014; Stelow et al., 2016), although often due to people's perceptions of certain coat colours

having specific personality traits (Delgado et al., 2012). Cat gender is suggested to influence the sociability dimension (containing sociable, loving and playful) (Menchetti et al., 2018) but not affiliative traits (allogroom, amicable approach, allorub and social sniff) (Barry and Crowell-Davis, 1999), with no effects found in our study. No significant effects were found in cat breeds, although clusters were visible on the MFA individual model, which is reinforced by multiple studies comparing purebreds and mixed breeds (Bennett et al., 2017; Menchetti et al., 2018), but this is contradicted by other studies (Kaleta et al., 2016; Finka et al., 2019). Most of the literature focuses on comparing mixed breeds to pure breeds instead of the particular breed as in our study, apart from research by Wilhelmy et al. (2016), with many significant differences found across 12 breeds. Although a wider range of breeds were included in our study compared to Wilhelmy et al. (2016), the sample size for most was very low, as found in other cat surveys (Heidenberger, 1997), so improvements would be to increase the sample sizes and range of breeds.

Owner demographics (owner animal preference) had significant effects on 'curious', 'friendly to other cats' and 'friendly to owner' scores, although the literature is limited. Gosling et al. (2010) discovered personality differences between those that identified as a dog or cat person, which could explain some of the significant effects, as owner personality is already known to influence cat personality (Evans et al., 2019; Finka et al., 2019). No significant effects of owner gender, country of residence nor owner age were found on any of the personality traits, which is surprising as they are known to influence pet personality. Owner gender has previously been found to influence bold and calm traits (Kubinyi et al., 2009) and the sociable-active dimension in dog personality (Kotrschal et al., 2009). Other owner demographics such as the country of residence has been found to impact conscientiousness scores in dogs (Turcsán et al., 2012) and region of residence influencing personality in cats (Menchetti et al., 2018). Some clusters were found on the MFA individual model for owner age, but no significant effects were revealed, although Kubinyi et al. (2009) found it to influence calmness in dogs. It is hard to determine the reason owner demographics impact companion animal personality, whether it be due to their own perceptions (Walker et al., 2014), anthropomorphic projections (Paul et al., 2014) or that the companion animals resemble their owners in terms of personality (Turcsán et al., 2012). More research is required with owner personality traits identified through surveys and cat temperament tests carried out using the coding method to compare to the surveys and measure the reliability between the two methods, to suggest whether anthropomorphism was present.

Survey responses can easily become biased, as the sample population is not always representative of all the demographic groups classified in the target population (Choi and Pak, 2005; Schonlau et al., 2009). Age, gender and cultural biases were present in this study, with the least responses from the eldest category (60–79-year olds) probably due to internet access reducing with age (Schonlau et al., 2009), as often online surveys have less older subjects compared to paper surveys (Hill et al., 2007). Most responses were from female owners which seems to be a trend in similar studies, although the response bias was lower with 85% compared to Finka et al. (2019), with 92%. Majority of the cat owners were from the UK and USA, as these were the two main countries contacted, but all the other country of residencies each had nine or less subjects, probably the reason no effects of country of residence were found on any of the traits.

This research has practical implications in predicting cat personality from both cat and owner demographics and shows that a quick simple survey can be used to create personality profiles. Shelters could predict cat personality from these results or use the survey to create personality profiles to improve the chances of successful adoptions by compatible homes that can cater for their specific needs (Dowling-Guyer et al., 2011; Weiss et al., 2015) as using other factors, such as stress levels from faecal cortisol metabolites, to determine cat personality is not always successful (Fukimoto et al., 2020). Understanding the cat's personality can then help the owner provide the correct type of care and environmental enrichment for that individual, such as providing more hiding spaces for shy individuals (Amat et al., 2009), to avoid behavioural problems (Grigg and Kogan, 2019), otherwise it could be detrimental to welfare (Wielebnowski et al., 2002). As previously mentioned, personality profiles/assessments can be used to predict health (Natoli et al., 2005) and are used in police (Slabbert and Odendaal, 1999), military (Sinn et al., 2010) and guide dogs (Goddard and Beilharz, 1984) to determine that the most suited individuals are chosen. There are more applications for dogs compared to cats as cats are mainly companions instead of working animals. Perhaps personality profiles could be used to breed cats that have more desirable personalities for a stronger connection with owners and therefore improved welfare such as lower stress levels during vet visits and cattery stays etc. Also, personality matching during breeding can be beneficial for both the owners and the cats in terms of welfare to again reduce stress and potential injuries but also increase reproductive performance as seen in captive zoo animals (Martin-Wintle et al., 2017), therefore saving time and money for breeders as compatible pairs are chosen. This study provides a springboard on further animal personality research relating to health and welfare.

5. Conclusions

To conclude, a simple survey can be carried out to determine domestic cat personality traits. Significant effects of housing type, total number of cats in household and owner animal preference were present on some of these traits. Unexpectedly, cat breed, owner age, neutering status and country of residence showed distinct clusters in the multifactor analysis individual model but did not have any significant effects on any of the personality traits, along with coat colour, owner gender and cat gender, which were initially considered of importance to the study, contradicting some of the previous research. Further personality research should look at using this simple survey for creating personality profiles to be used for matching compatible shelter cats and owners and also compatible mates for breeding purposes, along with selectively breeding for desirable personality traits to improve cat-owner bonds to improve welfare, such as reducing stress during vet visits.

Declaration of Competing Interest

The authors report no declarations of interest.

Acknowledgements
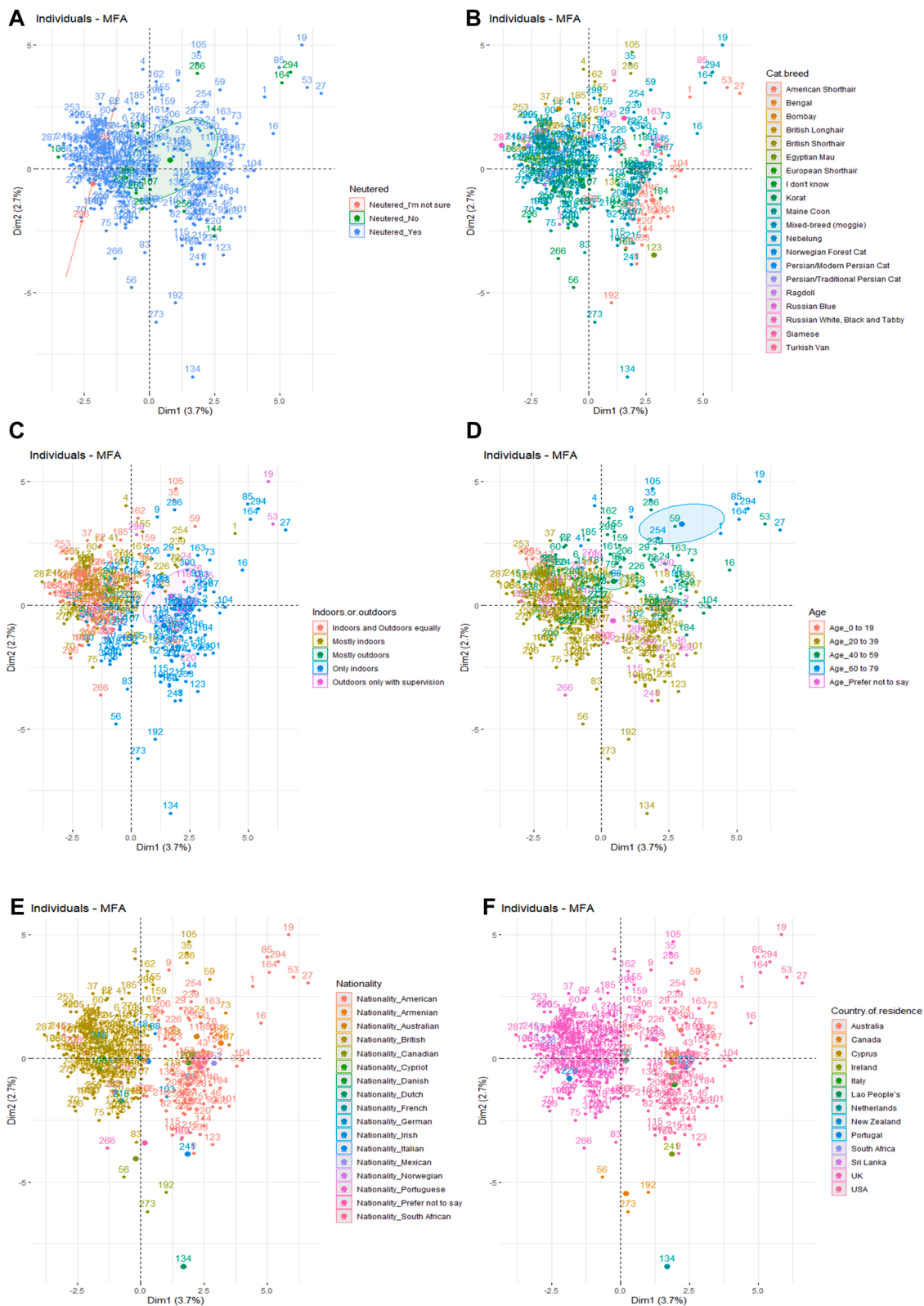
Appendix A

See Appendix Section here.

Fig. A1. MFA individual models of domestic cats. (A) Neutering status. (B) Cat breed. (C) Housing type. (D) Owner age. (E) Owner nationality. (F) Owner country of residence. (G) Years being a pet owner. (H) Years as a cat owner. (I) Owner animal preference.
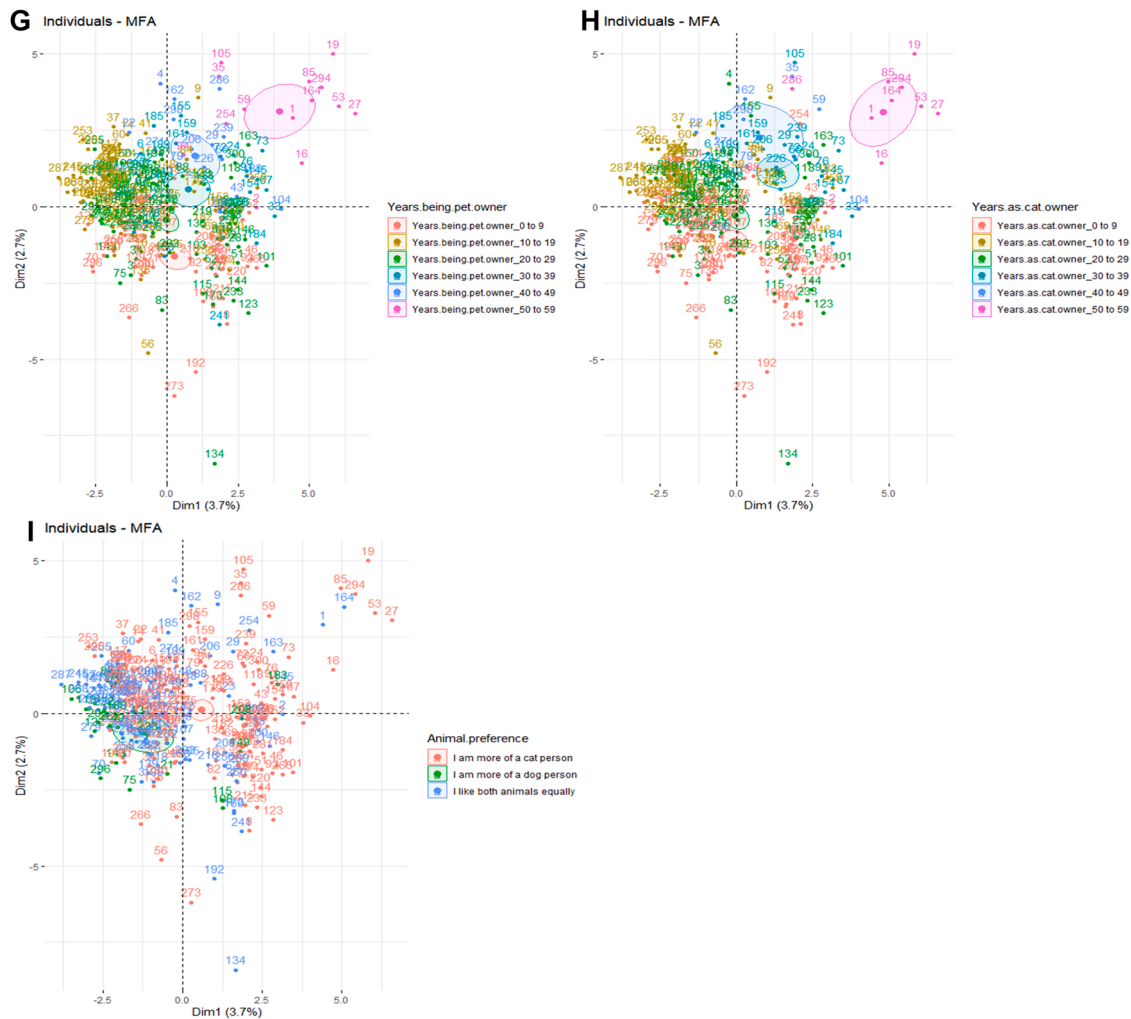
Fig. A1. (*continued*).

Table A1

Personality dimensions of domestic cats created from the positive and negative loadings of the personality traits on the 'Feline Five' used in survey based on Litchfield et al. (2017), containing only 30 personality traits from our study.

Personality dimensions	Feline Five dimensions	List of personality traits
Agreeable	Positive loading from agreeableness	Cooperative, friendly to you, friendly to human family members, friendly to familiar people, friendly to unfamiliar people and playful
Antagonist	Negative loading from agreeableness	Aggressive to you, aggressive to human family members, aggressive to familiar people, aggressive to unfamiliar people and solitary
Dominant	Positive loading from dominance	Aggressive to other cats and dominant over other cats
Extrovert	Positive loading from extraversion	Active, curious and smart
Impulsive	Positive loading from impulsiveness	Eccentric
Neurotic	Positive loading from neuroticism	Excitable, fearful of you, fearful of human family members, fearful of familiar people, fearful of unfamiliar people, fearful of other cats, fearful of other animals, insecure, tense and timid/shy
Stable	Negative loading from neuroticism	Calm and self-assured
Submissive	Negative loading from dominance	Friendly to other cats

Table A2

Personality dimensions of domestic cats created from personality traits used in survey based on own interpretations, containing all 34 personality traits.

Personality dimensions	List of personality traits
Agonistic	Aggressive to you, aggressive to human family members, aggressive to familiar people, aggressive to unfamiliar people, aggressive to other cats, aggressive to other animals, dominant over other cats, excitable, fearful of you, fearful of human family members, fearful of familiar people, fearful of unfamiliar people, fearful of other cats, fearful of other animals, insecure, solitary, tense, timid/shy and vocal: aggressive
Affiliative	Cooperate, friendly to you, friendly to human family members, friendly to familiar people, friendly to unfamiliar people, friendly to other cats, friendly to other animals, playful and vocal: non-aggressive
Eccentric	Eccentric
Extrovert	Active, calm, curious, self-assured and smart

Table A3

Kruskal-Wallis tests of domestic cat demographics (neutering status, coat colour and housing type) and 34 personality traits rated by owners. The p-values have been adjusted with the Benjamin-Hochberg False Discovery Rate step-up procedure, as a correction against the inflation of the Type I errors.

Personality trait	Neutering status			Coat colour			Housing type		
	X^2	df	p	X^2	df	p	X^2	df	p
Active	2.022	2	0.596	8.855	4	0.419	16.161	4	0.020 *
Aggressive to familiar people	0.236	2	0.966	2.994	4	0.613	4.716	4	0.636
Aggressive to human family members	0.441	2	0.966	3.073	4	0.613	6.253	4	0.590
Aggressive to other animals	2.891	2	0.512	6.772	4	0.564	4.285	4	0.644
Aggressive to other cats	7.323	2	0.281	3.577	4	0.613	15.892	4	0.020 *
Aggressive to owner	0.169	2	0.966	1.294	4	0.888	5.465	4	0.590
Aggressive to unfamiliar people	0.129	2	0.966	4.922	4	0.613	2.564	4	0.797
Calm	3.360	2	0.478	5.049	4	0.613	1.361	4	0.877
Cooperative	2.723	2	0.512	3.187	4	0.613	0.736	4	0.947
Curious	3.847	2	0.478	4.687	4	0.613	3.917	4	0.644
Dominant over other cats	6.818	2	0.281	3.501	4	0.613	6.847	4	0.590
Eccentric	1.423	2	0.642	3.407	4	0.613	5.541	4	0.590
Excitable	3.314	2	0.478	9.479	4	0.419	4.919	4	0.629
Fearful of familiar people	3.869	2	0.478	2.996	4	0.613	3.146	4	0.757
Fearful of human family members	3.245	2	0.478	5.262	4	0.613	1.633	4	0.860
Fearful of other animals	0.208	2	0.966	3.903	4	0.613	18.449	4	0.011 *
Fearful of other cats	2.275	2	0.596	5.851	4	0.613	32.525	4	0.000 *[1]
Fearful of owner	0.135	2	0.966	6.567	4	0.564	1.792	4	0.860
Fearful of unfamiliar people	1.712	2	0.633	4.056	4	0.613	2.651	4	0.797
Friendly to familiar people	5.760	2	0.381	3.784	4	0.613	1.601	4	0.860
Friendly to human family members	3.616	2	0.478	6.749	4	0.564	2.641	4	0.797
Friendly to other animals	2.000	2	0.596	9.643	4	0.419	2.081	4	0.860
Friendly to other cats	3.832	2	0.478	3.062	4	0.613	4.137	4	0.644
Friendly to owner	0.349	2	0.966	6.484	4	0.564	6.030	4	0.590
Friendly to unfamiliar people	3.321	2	0.478	8.541	4	0.419	5.130	4	0.621
Insecure	2.773	2	0.512	3.746	4	0.613	4.041	4	0.644
Playful	0.013	2	0.994	16.850	4	0.068	8.616	4	0.345
Self-assured	1.460	2	0.642	1.775	4	0.826	6.210	4	0.590
Smart	4.986	2	0.470	0.105	4	0.999	23.838	4	0.001 *
Solitary	1.524	2	0.642	11.616	4	0.340	1.715	4	0.860
Tense	1.698	2	0.633	4.692	4	0.613	3.723	4	0.658
Timid/shy	2.041	2	0.596	3.824	4	0.613	5.804	4	0.590
Vocal: aggressive	8.856	2	0.221	3.040	4	0.613	4.300	4	0.644
Vocal: non-aggressive	8.747	2	0.221	4.337	4	0.613	10.464	4	0.187

*Significant ($p < 0.05$), [1] $p < 0.001$.

Table A4

Kruskal-Wallis tests of owner demographics (owner gender, country of residence and owner animal preference) and 34 personality traits rated by owners. The p-values have been adjusted with the Benjamin-Hochberg False Discovery Rate step-up procedure, as a correction against the inflation of the Type I errors.

Personality trait	Owner gender			Country of residence			Owner animal preference		
	X^2	df	p	X^2	df	p	X^2	df	p
Active	5.967	2	0.469	12.405	12	0.647	2.637	2	0.536
Aggressive to familiar people	0.064	2	0.997	7.280	12	0.816	0.069	2	0.991
Aggressive to human family members	0.312	2	0.997	10.083	12	0.684	0.019	2	0.991
Aggressive to other animals	1.708	2	0.937	9.225	12	0.712	0.698	2	0.856
Aggressive to other cats	1.523	2	0.937	18.088	12	0.605	1.603	2	0.763
Aggressive to owner	0.104	2	0.997	9.586	12	0.739	1.134	2	0.808
Aggressive to unfamiliar people	0.671	2	0.997	14.558	12	0.605	1.042	2	0.808
Calm	5.350	2	0.469	16.971	12	0.605	1.783	2	0.734
Cooperative	6.120	2	0.469	11.171	12	0.684	7.831	2	0.112
Curious	2.676	2	0.912	11.719	12	0.664	13.480	2	0.034 *
Dominant over other cats	0.195	2	0.997	10.098	12	0.712	3.401	2	0.479
Eccentric	2.558	2	0.912	18.303	12	0.605	7.224	2	0.115
Excitable	4.170	2	0.641	12.341	12	0.647	9.632	2	0.068
Fearful of familiar people	1.403	2	0.937	7.084	12	0.816	0.491	2	0.918
Fearful of human family members	0.004	2	0.998	10.665	12	0.703	1.063	2	0.808
Fearful of other animals	0.174	2	0.997	17.629	12	0.605	1.988	2	0.699
Fearful of other cats	0.444	2	0.997	30.040	12	0.102	0.128	2	0.991
Fearful of owner	1.056	2	0.955	14.892	12	0.605	2.952	2	0.516
Fearful of unfamiliar people	4.055	2	0.641	7.891	12	0.793	0.790	2	0.856
Friendly to familiar people	0.629	2	0.997	14.637	12	0.605	1.049	2	0.808
Friendly to human family members	0.249	2	0.997	12.384	12	0.647	5.907	2	0.161
Friendly to other animals	2.006	2	0.937	13.675	12	0.644	7.587	2	0.112
Friendly to other cats	0.170	2	0.997	21.503	12	0.605	11.174	2	0.045 *
Friendly to owner	0.579	2	0.997	19.650	12	0.605	12.540	2	0.034 *
Friendly to unfamiliar people	2.286	2	0.912	12.552	12	0.647	1.463	2	0.779
Insecure	2.267	2	0.912	12.097	12	0.647	0.748	2	0.856
Playful	2.779	2	0.912	15.898	12	0.605	3.071	2	0.516

Table A4 (*continued*)

Personality trait	Owner gender			Country of residence			Owner animal preference		
	X^2	df	p	X^2	df	p	X^2	df	p
Self-assured	1.534	2	0.937	14.246	12	0.605	6.378	2	0.143
Smart	5.434	2	0.469	18.981	12	0.605	8.802	2	0.082
Solitary	1.512	2	0.937	15.922	12	0.605	5.626	2	0.170
Tense	0.083	2	0.997	6.829	12	0.869	0.165	2	0.991
Timid/shy	1.093	2	0.955	14.815	12	0.605	2.833	2	0.516
Vocal: aggressive	1.159	2	0.955	13.252	12	0.647	0.321	2	0.966
Vocal: non-aggressive	5.416	2	0.469	16.402	12	0.605	6.339	2	0.143

*Significant ($p < 0.05$).

Table A5
Kruskal-Wallis tests of cat and owner demographics (cat breed and owner age) and 34 personality traits rated by owners. The p-values have been adjusted with the Benjamin-Hochberg False Discovery Rate step-up procedure, as a correction against the inflation of the Type I errors.

Personality trait	Cat breed			Owner age		
	X^2	df	p	X^2	df	p
Active	21.108	19	0.667	6.393	4	0.614
Aggressive to familiar people	23.943	19	0.667	1.555	4	0.778
Aggressive to human family members	20.731	19	0.667	8.683	4	0.614
Aggressive to other animals	12.537	19	0.818	5.037	4	0.614
Aggressive to other cats	22.289	19	0.667	2.974	4	0.735
Aggressive to owner	25.592	19	0.667	3.622	4	0.639
Aggressive to unfamiliar people	18.302	19	0.683	5.650	4	0.614
Calm	21.226	19	0.667	3.746	4	0.639
Cooperative	14.119	19	0.800	3.751	4	0.639
Curious	19.299	19	0.667	5.462	4	0.614
Dominant over other cats	24.036	19	0.667	5.064	4	0.614
Eccentric	23.046	19	0.667	6.697	4	0.614
Excitable	19.918	19	0.667	2.083	4	0.778
Fearful of familiar people	17.839	19	0.667	0.404	4	0.982
Fearful of human family members	21.366	19	0.667	2.430	4	0.778
Fearful of other animals	19.340	19	0.667	1.780	4	0.800
Fearful of other cats	27.665	19	0.667	5.277	4	0.614
Fearful of owner	14.900	19	0.775	6.558	4	0.614
Fearful of unfamiliar people	22.578	19	0.667	8.888	4	0.614
Friendly to familiar people	19.101	19	0.667	6.475	4	0.614
Friendly to human family members	24.765	19	0.667	2.021	4	0.778
Friendly to other animals	15.140	19	0.775	3.550	4	0.639
Friendly to other cats	17.080	19	0.764	3.740	4	0.639
Friendly to owner	15.600	19	0.775	6.718	4	0.614
Friendly to unfamiliar people	20.193	19	0.667	5.646	4	0.614
Insecure	25.138	19	0.667	4.279	4	0.639
Playful	15.077	19	0.775	6.595	4	0.614
Self-assured	15.735	19	0.775	3.774	4	0.639
Smart	20.405	19	0.667	4.983	4	0.614
Solitary	21.824	19	0.667	3.663	4	0.639
Tense	20.075	19	0.667	6.153	4	0.614
Timid/shy	25.148	19	0.667	3.712	4	0.639
Vocal: aggressive	15.632	19	0.775	2.182	4	0.778
Vocal: non-aggressive	18.775	19	0.667	2.069	4	0.778

*Significant ($p < 0.05$).

Table A6
Wilcoxon-rank tests of domestic cat and owner demographics (cat gender and total number of cats) and 34 personality traits rated by owners. The p-values have been adjusted with the Benjamin-Hochberg False Discovery Rate step-up procedure, as a correction against the inflation of the Type I errors.

Personality trait	Cat gender		Total number of cats	
	w	p	W	p
Active	10488.000	0.655	11126.000	0.955
Aggressive to familiar people	10702.000	0.898	8662.000	0.049 *
Aggressive to human family members	11121.000	0.733	9124.500	0.119
Aggressive to other animals	11877.000	0.476	8465.000	0.023 *
Aggressive to other cats	11528.000	0.655	10238.000	0.648
Aggressive to owner	11880.000	0.655	9034.500	0.023 *
Aggressive to unfamiliar people	11347.000	0.655	9046.000	0.119
Calm	10406.000	0.655	11296.000	0.955
Cooperative	11221.000	0.983	11118.000	0.955
Curious	10426.000	0.655	11044.000	0.955
Dominant over other cats	10454.000	0.898	12569.000	0.049 *
Eccentric	11340.000	0.954	10298.000	0.492
Excitable	11453.000	0.898	10400.000	0.574
Fearful of familiar people	10930.000	0.858	9786.000	0.638
Fearful of human family members	10878.000	0.954	10112.000	0.638
Fearful of other animals	11803.000	0.612	9894.000	0.492
Fearful of other cats	12180.000	0.401	8689.000	0.049 *
Fearful of owner	10826.000	0.858	9898.000	0.176
Fearful of unfamiliar people	12416.000	0.401	11162.000	0.955
Friendly to familiar people	10550.000	0.655	10882.000	0.915
Friendly to human family members	10934.000	0.898	10813.000	0.851
Friendly to other animals	9685.500	0.655	11089.000	0.648
Friendly to other cats	9265.500	0.401	15804.000	0.000 *[1]
Friendly to owner	11459.000	0.898	11414.000	0.955
Friendly to unfamiliar people	9900.500	0.655	9694.500	0.442
Insecure	12370.000	0.548	9459.000	0.077
Playful	10472.000	0.655	11182.000	0.955
Self-assured	11298.000	0.963	12596.000	0.181
Smart	11462.000	0.898	11288.000	0.955
Solitary	11646.000	0.863	9297.500	0.049 *
Tense	11042.000	0.898	11696.000	0.807
Timid/shy	12646.000	0.401	10954.000	0.955
Vocal: aggressive	12964.000	0.401	10588.000	0.648
Vocal: non-aggressive	10074.000	0.544	10978.000	0.955

*Significant ($p < 0.05$), [1] $p < 0.001$.

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