Owner psychological characteristics predict dog behavioural traits

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Research Article

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Abstract

There is extensive literature on the human-dog bond, less however on the role of owner psychological characteristics within this bond, and less still on how these might mediate dog behaviour. Accordingly, the aim of this study was to explore the relationship between owner levels of depression, anxiety and self-esteem and dog behaviour. Multiple linear regression was conducted to determine the predictive power of the psychological variables on dog behaviour using self-report. Conceptual content analysis was performed on three open questions to assess owner beliefs regarding their psychological influence on their dogs’ behaviour. 497 responses were collected. Anxiety and depression positively predicted increased levels of dog attachment and attention-seeking ($p < 0.001$; $p = 0.006$), separation-related behaviour ($p = < 0.001$; $p = < 0.001$), stranger-directed aggression ($p = < 0.001$; $p = < 0.001$), stranger-directed fear ($p = < 0.001$; $p = < 0.001$), non-social fear ($p = < 0.001$; $p = 0.01$), dog-directed fear ($p = 0.01$; $p = 0.01$), touch sensitivity ($p = < 0.001$; $p = < 0.001$) and excitability ($p = 0.004$; $p = < 0.001$). Decreased self-esteem predicted dog non-social fear ($p = 0.01$). Fourteen themes were identified, including strong perceived bond, emotional dependency and anthropomorphism. Whilst only minimal within the vast interplay of factors impacted in canine ethology, owner psychological functioning plays a significant role in dog behaviour via numerous routes including interaction, emotion contagion and attachment. Understanding owner influence on dog behaviour can improve behaviour modification programmes, success of rehoming schemes, and improve wellbeing for both members of the human-dog dyad.

Introduction

Research suggests that there may be some association between owner psychological characteristics and dog behaviour, specifically aggression, fear, separation-related behaviour and trainability (O’Farrell 1995; Hunt et al. 2012; Kis et al. 2012; Dodman et al. 2018; Chopik and Weaver 2019; Sundman et al. 2019; Gobbo and Zupan 2020). It is likely that personality types encompassing high levels of anxiety might affect dog behaviour (O’Farrell 1995; Dodman et al. 2018; Gobbo and Zupan 2020) but there is little research on the influence of specific psychological characteristics on the human-dog bond and dog behaviour. The most prevalent behavioural disorders in both humans and dogs are underpinned by fear and anxiety-related conditions (Overall et al. 2006; Tiira et al. 2016; WHO 2017), and anxiety and depression are highly prevalent in the UK: 3 in 100 people experience depression in any given week, and 6 in 100 experience generalised anxiety (McManus et al. 2016). Self-esteem is often a factor in developing such conditions, being closely linked with mental health and fundamental for mental wellbeing (Macdonald 1994). Understanding owner psychological influence on dog behaviour could improve behavioural modification and provide better outcomes for dogs with behavioural problems that otherwise may end up in rescue kennels or even euthanised (Patronek et al. 1996; Powdrill-Wells et al. 2021; Luna-Cortes 2022), as well as emphasise the importance of incorporating owners in treatment plans, and guiding rescue centres in determining suitable prospective owners.

Domestication is the process of adaptation to humans and the captive environment (Price 1984), resulting in bonding between humans and animals. For example, tamed foxes possess greater oxytocin
concentrations than non-tame controls (Belyaev 1979). The human-animal bond is a ‘mutually beneficial and dynamic relationship’ (American Veterinary Medical Association 1998); indeed, human attachment theory (Bowlby 1969) is applicable to human-animal relationships (Zilcha-Mano et al. 2011). Interactions with pets can have significant benefits for both physical and mental health (McCune et al. 2014), and the bond shared between animal and human impacts heavily upon an animal’s behaviour and cognition (Payne et al. 2015). Physiological effects include reduced heart rate in horses when stroked (Lynch et al. 1974) and mutual increased oxytocin in positive human-animal interactions (Odendaal and Meintjes 2003), although the directionality of this correlation is unclear; oxytocin level could be innate, thus unaffected by human interaction. Such a correlation may help to explain why, during the COVID lockdowns, between 10–15% of all owners reported that their animal appeared to be more energetic and playful, and 20–30% indicated their animal seemed more relaxed, likely owing to the amount owners spent with their pets (Shoesmith et al. 2021). Such emotional involvement suggests owner psychological characteristics could have an impact on our companion animals’ behaviour.

As early as 12,000 years ago at the Natufian site of Ein Mallaha, Israel, a puppy skeleton was found buried with a human, evidencing the longevity and endurance of the human-dog bond (Davis and Valla 1978). Domestication of the dog followed the commensal pathway, and generations of shared living sites and co-operative hunting technique during the Mesolithic period solidified a powerful companionship (Clutton-Brock 1995; Horard-Herbin et al. 2014). We consider our pet dogs as our family and friends (Beck and Katcher 1996), and such a bond has enabled, and is maintained by, dogs’ ability to comprehend elements of human communication, particularly visual cognitive ability, including gazing (Hare and Tomasello 2005), and head-nodding and head-turning (Soproni et al. 2001).

The human-dog bond has remarkable positive effects on both members of the dyad. Dogs considered as “social partners” and “meaningful companions” by their owners have reduced cortisol concentrations (Schöberl et al. 2012), and human interaction reduces cortisol and stress behaviours of shelter dogs (Shiverdecker et al. 2013), although these results may be confounded by the intensely stressful shelter environment hastening positive reactions of the dogs. Interacting with our dogs has emotional implications: the social cue of a dog’s gaze stimulates oxytocin release in humans, creating a feeling of emotional connectedness (Nagasawa et al. 2009). This instigates perception of a stronger bond, and anthropomorphism, the attribution of human characteristics, motivations, intentions, or emotions to animals (Epley et al. 2007), often occurs. Indeed, owners attribute a range of basic and complex emotion to their companion animals, and the attribution of such human emotion correlates with higher scores on the Pet Bonding Scale (Martens et al. 2016) however this study relied on owner beliefs, and did not consider behavioural outcomes.

A significant factor in strength of the human-dog bond is attachment; research has demonstrated how the human-dog bond is analogous to human attachment (Topàl et al. 1998), the theory of which attests that an infant’s secure attachment to a caregiver is a primary and fundamental need (Bowlby 1969). Dog behaviour appears to be affected by attachment style to owners, for example securely-attached dogs showing greater proximity-seeking towards owners (Riggio et al. 2020). However, owner factors, including
attachment style, as well as other psychological variables, most likely have a greater influence than canine factors in strength of the human-dog bond (Meyer and Forkman 2014). An anxious or avoidant attachment with a pet renders pet owners with reduced expectations, more likely to view the bond in a negative light and unlikely to inspire and encourage positive behaviour (Zilcha-Mano et al. 2011). Confident owners inspire dogs to regard them as a secure base, eliciting increased proximity-seeking and greeting behaviour, whilst dogs of non-confident owners do not regard the owner as a secure base, displaying increased exploratory behaviour both in the presence of owner and stranger after separation (Siniscalchi et al. 2013). The authors theorise that the attachments dog owners develop as infants with caregivers are projected onto the dog-owner relationship, however this requires empirical investigation, and the 9 Attachment Profile test used is infrequently cited in literature and not extensively validated.

Whilst research into attachment and dog behaviour is widespread, there exists less on other psychological variables. Personality, an important variable for relationship satisfaction in human couples (Malouff et al. 2010), has been explored in relation to dog behaviour, although personality inventories can be critiqued for oversimplifying such a vast construct. Dodman et al. (2018) report a modest association between low scores on the ‘Big Five’ personality dimensions of agreeableness, emotional stability, extraversion, and conscientiousness and high rates of owner-directed aggression, stranger-directed fear and urination when left alone, although the authors report that the results account for less than 10% of the variance in behaviour scores.

Research indicates that dog behaviour is influenced by the personality trait neuroticism, characterised by emotional instability and low stress-tolerance (Eysenck 1963) and integral to mood and anxiety disorders (Jylhä and Isometsä 2006; Griffith et al. 2010), suggesting further investigation into these conditions. Kis et al. (2012) found that owners scoring highly for neuroticism may negatively affect dog trainability, as owners were less effective at command giving. Similarly, Kotrschal et al. (2009) found that owners with neuroticism did not affect dog cortisol levels, refuting the claim that high anxiety in owners causes dog anxiety, but did affect trainability, specifically the ability to learn simple tricks and complete a task involving walking over a wire bridge; however, the sample was made up of only 22 subjects and all dogs were male, rendering the results ungeneralisable. Gobbo and Zupan (2020) report that dog aggression, measured by the highly validated C-BARQ, was significantly associated with owner neuroticism; on the contrary, Konok et al. (2015) found no significant effect of neuroticism on separation-related disorder (SRD) in dogs, refuting the assumption that dogs may display more ‘needy’ behaviours in response to a similar insecurity in neurotic owners. However, the insignificant finding may partly be due to lack of diagnostic criteria for SRD, and results in such studies are undermined by the higher prevalence of neuroticism amongst females (Lynn and Martin 1997), who make up the majority of samples in such research.

In a case study of a ‘restless’ Alsatian, O’Farrell (1995) describes an association between canine displacement activities and owner neuroticism, measured by The Eysenck Personality Inventory, which reliably differentiates between neurotic patients and healthy controls (Eysenck and Eysenck 1964). The study considers owner projection of unconscious conflict onto the dog, and the role of low self-worth
characteristic of neuroticism in ensuing dog behaviour; self-esteem is also a risk factor for anxiety and depression, as well as other conditions including eating disorders and substance abuse (Mann et al. 2004). Case study findings are not generalisable, and certain personality types are more likely to choose certain breeds, which may confound results, for example owners scoring highly for psychoticism are more likely to select dogs bred for purposes which incorporate aggressive behaviour, such as guard dogs (Wells and Hepper 2012). Nonetheless, the linkage of psychoanalytic theory with dog behaviour displays the merit of qualitative exploration into the topic, inspiring further research, however such research must consider the myriad of other variables influencing behaviour, notably genetics and early life experiences.

Outside of personality, an association is implied between owner psychological functioning and dog behaviour, but research is limited. In a longitudinal study of 63 search-and-rescue dog-owner teams, owner depression and post-traumatic stress disorder predicted separation anxiety and attachment problems (Hunt et al. 2012), and owner anxiety negatively affects trainability (Kis et al. 2012). Shoesmith et al. (2021) conclude that owner mental health has both positive and negative effects on companion animal behaviour and welfare, but these results were mediated by the COVID-19 lockdowns, thus not applicable outside of this context. Dodman et al. (2018) found an association between male depression and dog aggression, although this is undermined by the sample being only 9% male. Such findings indicate the hypothesis that owner psychological variables may affect dog behaviour, but no study has, yet, focussed on owner anxiety, depression and self-esteem and examined owner beliefs into any possible association.

This study aimed to investigate dog behaviour as a consequence of owner characteristics beyond personality; within the current literature, many studies are correlational, thus ineffective to disclose meaningful relationships; hence the current study will address these research gaps. However, it must be noted that many influences on dog behaviour cannot be controlled for, including genetics, the environment and early life experiences.

**Methodology**

**Participants**

Participants were opportunistically and snowball sampled using online forums and Facebook groups. Participants were required to be over 18 and dog owners, i.e., the main caregiver to a dog in multi-person households.

**Questionnaires**

Google Forms was used to collate the 4 self-report questionnaires in their original format, followed by the three open questions, accessed via a link (in Supplementary Information). Data collection spanned 4 months to allow for adequate sampling.
The four self-report questionnaires utilised were the BDI (Beck et al. 1961), a 21-item inventory measuring characteristic attitudes and symptoms of depression. Reliability and validity have been previously established and internal consistency is high, ranging from .73 to .92 with a mean of .86. (Beck et al. 1988). The RSE (Rosenberg 1965), a 10-item scale that measures global self-worth by assessing positive and negative feelings about the self. It has received substantial psychometric evaluation across the literature and has high construct validity (Robins et al. 2001). The GAD-7 (Spitzer et al. 2006), a 7-item instrument assessing the severity of GAD, with proven sensitivity and specificity in diagnosing panic disorder, social phobia, social anxiety disorder and post-traumatic stress disorder (Kroenke et al. 2007).

Lastly, the C-BARQ (Hsu and Serpell 2003), publicly available online, contains 100 items using 5-point ordinal rating scales assessing dog temperament and behavioural problems, with fourteen sub-scales of behaviour (Fig. 1).

Its 22 miscellaneous items were not included in order to reduce the number of questions to prevent attrition. The C-BARQ has established validity and reliability and has been extensively evaluated (Barnard et al. 2012; Duffy and Serpell 2012; Stellato et al. 2017).

The three open questions, created to elucidate beliefs on the perceived dog-human bond and provide insight over and above the statistical analyses were:

1. How would you describe your relationship with your dog?
2. To what extent do you think you influence your dog’s behaviour?
3. How do you think your dog responds to your emotions?

**Quantitative data analysis**

Multiple linear regression analyses were conducted in the R environment (v.4.0.0; R Core Team 2020) to determine whether scores on the BDI, RSE and GAD-7 are significant predictors of C-BARQ scores. Confounding variables controlled for in the models were dog age, sex, breed, rescue status, owner gender, owner nationality and number of dogs in the household. P-values below 0.01 were used to identify significant predictors, based on the high number of significant results produced when using p < 0.05 and to garner stronger evidence against the null hypothesis. Standard error was reported in order to determine whether 95% prediction interval was achieved.

Visual examination of plots was carried out to ensure model assumptions were met: Q-Q plots and histograms revealed C-BARQ scores to be normally distributed and scatterplots revealed the assumption of homogeneity of variance was met (see Normality Plots, Supplementary Information). Correlations were performed between each independent variable and there was no multicollinearity between independent variables. Some associations between each of the three psychological variables and each of the C-BARQ variables were non-linear however according to central limit theorem, if a sample size is sufficiently large, sampling distribution will be normal (Kwak and Kim 2017).

**Qualitative data analysis**
Text responses were inputted into CATMA (Gius et al. 2021), and themes generated via conceptual content analysis, using an inductive method, themes added flexibly throughout. Terms consisting of words and phrases that both explicitly stated the theme, as well as implicit words and phrases, were counted. Common words such as “and” were included in phrases where required to make sense in context of the theme. Word frequency analyses and wordclouds were created. Theme frequency was not calculated, as giving greater emphasis to more frequent themes violates the assumption that every opinion counts equally, although this could be considered in future research.

**Ethical considerations**

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University Centre Askham Bryan (February 2021/UCAB2021/HC/047).

Preceding the questionnaires was an information sheet and consent form. To identify potential at-risk individuals, participants were unable to proceed and recommended to see their GP if they did not check a box confirming that if they had mental health problems, they had informed a health professional. Participants were informed that questions may evoke anxiety, that quotes may be used in dissemination of the research, that participation was entirely voluntary, and they may withdraw at any time. Questionnaire data remained anonymous and confidential, accessible only by the researchers, participants identifiable only by gender, nationality, number of dogs in their household and their dog's age, sex and rescue status. A debrief outlined resources and advised participants to see their GP if struggling mentally.

**Results**

506 responses were collected. 9 responses were excluded from analysis, due to missing and anomalous data, therefore 497 responses were used for analysis. 82% of respondents were female; 14% were male. 7 respondents chose ‘prefer not to say’ regarding gender, and 7 selected ‘other’. A range of nationalities were represented, to investigate possible cultural differences, with participants classified according to the following nations: Africa, Asia, Britain, Canada, Europe, Ireland, Oceania, South America, USA and unspecified. Average dog age was 6.2 years (oldest 16; youngest 0.5; range 18.5). 52% dogs were female, 48% were male. Average number of dogs in households was 1.7 (Min. 1, Max. 6; range 6). Dog breeds were categorised according to frequency of each specific breed (see supplementary information), breed mixes were categorised according to whether a dominant breed was stated or not, if not a dog would be categorised under ‘Mix’. 47% of dogs were rescues.

**Quantitative analysis**

Average C-BARQ scores can be seen in Table 1. Average score on the GAD-7 was 7 out of a possible 21, with 147 participants scoring 10 or more, the cut-off for moderate anxiety. Average score on the BDI was 15.34 out of a possible 63, with 151 participants scoring 21 or more, the cut-off for moderate depression.
Average score on the RSE was 24.02 out of a possible 40, with higher scores indicating higher self-esteem.

### Table 1

<table>
<thead>
<tr>
<th>C-BARQ scores.</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Population average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stranger-directed aggression</td>
<td>0.98</td>
<td>0.93</td>
<td>0.59</td>
</tr>
<tr>
<td>Owner-directed aggression</td>
<td>0.30</td>
<td>0.66</td>
<td>0.19</td>
</tr>
<tr>
<td>Dog-directed aggression</td>
<td>1.56</td>
<td>1.26</td>
<td>0.97</td>
</tr>
<tr>
<td>Familiar dog aggression/dog rivalry</td>
<td>0.47</td>
<td>0.86</td>
<td>0.62</td>
</tr>
<tr>
<td>Stranger-directed fear</td>
<td>0.88</td>
<td>1.11</td>
<td>0.63</td>
</tr>
<tr>
<td>Non-social fear</td>
<td>1.28</td>
<td>0.90</td>
<td>0.76</td>
</tr>
<tr>
<td>Dog-directed fear</td>
<td>1.40</td>
<td>1.09</td>
<td>0.72</td>
</tr>
<tr>
<td>Touch sensitivity</td>
<td>1.31</td>
<td>1.12</td>
<td>0.68</td>
</tr>
<tr>
<td>Separation-related behaviour</td>
<td>1.00</td>
<td>0.88</td>
<td>0.56</td>
</tr>
<tr>
<td>Attachment and attention-seeking</td>
<td>2.78</td>
<td>0.84</td>
<td>1.91</td>
</tr>
<tr>
<td>Trainability</td>
<td>1.68</td>
<td>0.77</td>
<td>2.56</td>
</tr>
<tr>
<td>Chasing</td>
<td>2.32</td>
<td>1.23</td>
<td>2.09</td>
</tr>
<tr>
<td>Energy level</td>
<td>2.16</td>
<td>0.91</td>
<td>1.95</td>
</tr>
</tbody>
</table>

Multiple linear regression was carried out between each outcome variable of the C-BARQ and owner levels of anxiety, depression and self-esteem as measured by the GAD-7, BDI and RSE, controlling for owner gender, nationality, dog sex, number of dogs in the household, dog breed, and rescue dog status. Areas of significance with p values, $r^2$ value and standard error are summarised in Table 2. Significant associations are visually depicted in added variable plots (Figs. 2 and 3) which display the relationship between the response variable and significant predictor variable of a model whilst controlling for the presence of other predictor variables in the model.
Table 2
All areas of significance within the models. Letters a) to q) denote the corresponding plot in Figs. 2 and 3.

<table>
<thead>
<tr>
<th>Model</th>
<th>Significant predictors</th>
<th>Significance level</th>
<th>$R^2$</th>
<th>Residual standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment and attention-seeking</td>
<td>Anxiety (a)</td>
<td>p = &lt; 0.001, scores increased by 0.02 as anxiety scores increase by 1</td>
<td>0.048</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>Depression (b)</td>
<td>p = 0.006, scores increased by 0.009 as depression scores increase by 1</td>
<td>0.03</td>
<td>0.83</td>
</tr>
<tr>
<td>Separation-related behaviour</td>
<td>Anxiety (c), dog sex</td>
<td>p = &lt; 0.001, scores increased by 0.026 as anxiety scores increase by 1</td>
<td>0.065</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>p = 0.002, females predict higher scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depression (d), dog sex</td>
<td>p = &lt; 0.001, scores increased by 0.013 as depression scores increase by 1</td>
<td>0.067</td>
<td>0.847</td>
</tr>
<tr>
<td></td>
<td></td>
<td>p = 0.004, females predict higher scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stranger-directed aggression</td>
<td>Anxiety (e)</td>
<td>p = &lt; 0.001, scores increased by 0.03 as anxiety scores increase by 1</td>
<td>0.033</td>
<td>0.919</td>
</tr>
<tr>
<td></td>
<td>Depression (f)</td>
<td>p = &lt; 0.001, scores increased by 0.014 as depression scores increase by 1</td>
<td>0.026</td>
<td>0.922</td>
</tr>
<tr>
<td>Dog rivalry</td>
<td>Number of dogs in household (Anxiety model)</td>
<td>p = &lt; 0.001, scores increased by 0.138 with every extra dog in the household</td>
<td>0.015</td>
<td>0.858</td>
</tr>
<tr>
<td>Stranger-directed fear</td>
<td>Anxiety (g), dog age</td>
<td>p = &lt; 0.001, scores increased by 0.041 as anxiety scores increased</td>
<td>0.075</td>
<td>1.072</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ages 3.42 (p = 0.009) and 9.5 (p = 0.004), predict decreased scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depression (h), dog age</td>
<td>p = &lt; 0.001, scores increased by 0.022 as depression scores increase by 1</td>
<td>0.079</td>
<td>1.069</td>
</tr>
<tr>
<td></td>
<td></td>
<td>p = 0.009 (age 3.42), p = 0.004 (age 9.5), predict decreased scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dog age (Self-esteem model)</td>
<td>p = 0.004 (age 9.5), predicts decreased scores</td>
<td>0.03</td>
<td>1.098</td>
</tr>
<tr>
<td>Non-social fear</td>
<td>Anxiety (i)</td>
<td>p = &lt; 0.001, scores increased by 0.041 as anxiety scores increase by 1</td>
<td>0.092</td>
<td>0.858</td>
</tr>
<tr>
<td></td>
<td>Depression (j)</td>
<td>p = 0.01, scores increased by 0.019 as depression scores increase by 1</td>
<td>0.081</td>
<td>0.863</td>
</tr>
<tr>
<td></td>
<td>Self-esteem (k)</td>
<td>p = 0.01, scores decreased by 0.045 as self-esteem scores increase by 1</td>
<td>0.039</td>
<td>0.883</td>
</tr>
<tr>
<td>Model</td>
<td>Significant predictors</td>
<td>Significance level</td>
<td>$r^2$</td>
<td>Residual standard error</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Dog-directed fear</td>
<td>Anxiety (l)</td>
<td>$p = 0.01$, scores increased by 0.041 as anxiety scores increase by 1</td>
<td>0.092</td>
<td>0.858</td>
</tr>
<tr>
<td></td>
<td>Depression (m)</td>
<td>$p = 0.01$, scores increase by 0.013 as depression scores increase by 1</td>
<td>0.045</td>
<td>1.067</td>
</tr>
<tr>
<td>Trainability</td>
<td>Rescue status (Anxiety model)</td>
<td>$p &lt; 0.001$, rescue dogs predict higher scores</td>
<td>0.007</td>
<td>0.776</td>
</tr>
<tr>
<td></td>
<td>Rescue status (Self-esteem model)</td>
<td>$p &lt; 0.001$, rescue dogs predict higher scores</td>
<td>0.002</td>
<td>0.778</td>
</tr>
<tr>
<td>Chasing</td>
<td>Dog age (Anxiety model)</td>
<td>$p = 0.005$ (age 12), $p = 0.005$ (age 13), $p = 0.01$ (age 3.08), predict decreased scores</td>
<td>0.071</td>
<td>1.195</td>
</tr>
<tr>
<td>Excitability</td>
<td>Anxiety (n), dog age</td>
<td>$p = 0.004$, scores increased by 0.022 as anxiety scores increase by 1</td>
<td>0.065</td>
<td>0.942</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$p &lt; 0.001$ (age 19), predicts decreased scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depression (o), dog age</td>
<td>$p &lt; 0.001$, scores increased by 0.014 as depression scores increase by 1</td>
<td>0.076</td>
<td>0.937</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$p &lt; 0.001$ (age 19), predicts decreased scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dog age (Self-esteem model)</td>
<td>$p &lt; 0.001$ (age 19), predicts decreased scores</td>
<td>0.057</td>
<td>0.946</td>
</tr>
<tr>
<td>Touch sensitivity</td>
<td>Anxiety (p)</td>
<td>$p &lt; 0.001$, scores increased by 0.044 as anxiety scores increase by 1</td>
<td>0.028</td>
<td>1.108</td>
</tr>
<tr>
<td></td>
<td>Depression (q)</td>
<td>$p &lt; 0.001$, scores increased by 0.019 as depression scores increase by 1</td>
<td>0.014</td>
<td>1.116</td>
</tr>
<tr>
<td>Energy level</td>
<td>Rescue status, Anxiety model</td>
<td>$p &lt; 0.001$, non-rescues predict higher scores</td>
<td>0.135</td>
<td>0.839</td>
</tr>
<tr>
<td></td>
<td>Rescue status, Depression model</td>
<td>$p &lt; 0.001$, non-rescues predict higher scores</td>
<td>0.132</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Qualitative analysis

Fourteen themes were identified within the text (see Fig. 4) (original qualitative answers extracted from Google Forms in Supplementary Information). Following thematic analysis, wordclouds were produced for each question (Figs. 5, 6 and 7) to visually represent the most recurring words and provide a succinct representation of the results. A common theme was a strong bond between dog and owner and subsequent positive emotion, for example ‘I still cannot process how much I love him’. There was frequent
mention of emotional support; some respondents referred to their dog being a reason to live, for example ‘without her presence and caring heart, I wouldn’t be here’, evidencing the role of dogs as protective factors to owner mental difficulty, for example, ‘she keeps me as normal as I can be’.

Many participants confirmed that their dogs were responsive to their mood, evidenced by the sub-themes of responsiveness specifically to anxiety and depression, owner perception as to whether this responsiveness is positive or negative, the ‘mirroring’ of owner emotion, and dog emotional dependence on owner, for example several respondents referred to their dogs as their ‘shadow’. Many owners revealed a pragmatic, realistic view of their bond, and shared a balanced and collaborative relationship, evidence that a strong bond must not necessarily involve high emotion and dependency. Sharing activities was a recurring theme, with one respondent describing their dog as their ‘adventure buddy’. Several negative themes also emerged, highlighting owner perceived difficulties within the human-dog bond, including a weak bond, unrealistic expectations placed on pet dogs and owner guilt.

Discussion

This study aimed to explore the effect of owner depression, anxiety and self-esteem levels on dog behaviour, and further elucidate owner beliefs around how their psychological state influences their dog’s behaviour. The results of the regression analyses provide support for the original hypothesis where owner anxiety and depression appear to positively predict increased levels of dog attachment and attention-seeking, separation-related behaviour, stranger-directed aggression, stranger-directed fear, non-social fear, dog-directed fear, touch sensitivity and excitability, and decreasing levels of self-esteem appear to predict dog non-social fear: all of which can be categorised under behaviours motivated by fear, including excitability, increased levels of which correlate with separation-relation disorder (McGreevy and Masters 2008). It must be noted that in these models $r^2$ values were very low, with the models only explaining a fraction of the variance in C-BARQ scores, however, standard error values were all sufficiently low to assume 95% confidence interval. The open question responses provided insight into these associations and provide foundations to develop theoretical explanations. Anxiety was the most frequently referred to mental condition, and subjects largely reported it being a factor in increased anxiety-related behaviour in their dogs, for example ‘I know she picks up on my stress and anxiety…she breathes heavily and wants to be active or petted’, implying proximity-seeking. Depression was associated with more passive behaviours, for example ‘I have noticed as my depression has worsened, her activity levels and overall energy has lessened’.

The finding that owner anxiety predicts fear-related behaviours is in line with existing research, for example that low owner emotional stability predicts dog aggression and fear behaviours (Dodman et al. 2018), and recently, Pereira et al. (2021) who found that owner anxiety predicted increased anxiety-related behaviour in dogs. The authors also used the C-BARQ, however the focus was on trait anxiety, thus direct comparison cannot be made; nevertheless, comprehensive mediation and moderation analyses were conducted and revealed an almost 100% direct effect of owners’ trait anxiety on dogs’ fear and anxiety. In contrary to existing research (O’Farrell 1995; Dodman et al. 2018), the current study did not find a
significant association between anxiety and owner-directed aggression, conflicting with Dodman et al. (2018) who reported that dogs with anxious owners may learn that they can assert themselves aggressively.

This is the first study that implies associations between owner depression levels and certain dog behaviours. One reason may be lack of motivation to interact with a pet dog, which reinforces negative feelings, evident in many responses to the open questions, for example 'I think I enable bad behaviour by not being strict enough and being too lazy and tired to stick with a training routine'. Other researchers have reported low mood in dog owners is associated with their perceived failure to meet their dogs' expectations and their dogs' unwanted behaviour (Barcelos et al. 2020), therefore depression could be a consequence rather than a causal factor in the development of dog behaviour, which may also be the case for other psychological problems. Indeed, dog behavioural issues relating to fear and anxiety can have negative impacts on owner wellbeing (Bradley and Bennett 2015). The significant association between depression and dog aggression found in the current study has been implicated once previously, purported to be a result of depression-induced anger outbursts and increased risk-taking and subsequent punitive treatment, however this was in men only (Dodman et al. 2018) whilst in the current study, there was no significant effect of gender.

Strong attachment to pet dogs, as frequently referred to in the qualitative data, likely underpins several mechanisms which may affect behaviour. The recurring theme of dogs 'mirroring' owner emotion suggests owners may exert psychological influence over their dogs via emotion contagion, the shifting of emotional state to that of another animal, which has been observed in dogs (Panksepp 2011; Sümegi et al. 2014). Strong attachment may also lead to overprotectiveness, which may impact on canine anxiety if dogs are unable to socialise normally and exhibit natural behaviours (Pereira et al. 2021), akin to overprotective child-directed parenting (van Herwijnen et al. 2018). Contrarily, owner frustration at their dog's behaviour, such as 'I get very upset and embarrassed when he doesn't recall or behave as I want' implies anxious or avoidant attachment style and could lead to resentment and subsequent negative behavioural outcomes (Zilcha-Mano et al. 2011).

As previously discussed, neuroticism is implicated in several studies on dog behaviour, and is closely related to anxiety and depression (Griffith et al. 2010). Therefore, the current results may be explained by elements of neuroticism present in the sample, for example, emotional dependency, a facet of neuroticism (Kotrschal et al. 2009) and a recurring theme in the qualitative data. Emotional dependency may cause anxious attachments in dogs (Fallani et al. 2006), exacerbating anxiety and proximity-seeking behaviours and decreasing independent play behaviour, through consistently high levels of attention and reassurance (Rehn et al. 2014), for example ‘...she's a Velcro dog...unfortunately I do think I encourage that as I like having her close’. Neurotic tendencies may also cause inconsistent owner behaviour, for example whilst perceiving their dogs as sources of emotional support, neurotic owners also consider their dogs as a burden (Lyckberg 2014). Such inconsistency may facilitate differential reinforcement, although this is highly dependent on dog individuality and response to specific reinforcers (Hall et al. 2015).
Decreasing levels of self-esteem as a predictor of dog non-social fear may have a basis in anxiety levels: low self-esteem generates anxiety, whilst increased self-esteem provides a buffer against anxiety (Rosenberg 1962; Pyszczynski et al. 2004), thus it would follow that lower self-esteem may incite and exacerbate canine anxiety. Whilst there is a considerable amount of research focussing on the benefits pet-owning has on self-esteem, for example self-esteem and self-acceptance increases with owning a dog, being able to care for it, and sharing activities (Barcelos et al. 2020), behavioural outcomes are not considered, suggesting an area for further research.

Anthropomorphism may cause behavioural problems through misinterpretation of behaviour (O'Farrell 1997; Sueur et al. 2021), however such studies investigating anthropomorphism have inherent bias due to subjects’ status as pet owners or interest in pets. The high prevalence of anthropomorphism in responses emphasising dogs as emotional supporters is consistent with the finding that anthropomorphism is more likely in individuals with anxious attachment styles and low distress tolerance (Norberg et al. 2018). Placing unrealistic human expectations on our dogs, for example a dog being described as ‘my only real friend...I tend to want too much from her, amounts she can't bear’, may compromise welfare if dogs are unable to express ethological needs. Misinterpretation of behaviour, however, can be entirely harmless, for example many responses referred to dogs ‘comforting’ crying owners which is likely due to reinforcement of owner attention, however still represents anthropocentric thinking in assuming dog behaviour revolves around the owner.

Being female was a significant predictor of separation-related behaviour, contrary to most existing research (e.g. Bradshaw et al. 2002; van Rooy et al. 2018), however some studies note no sex difference (Wright and Nesselrote 1987; Palestrini et al. 2010). Increased dog rivalry with increasing number of dogs in one household corresponds with existing research, for example Duffy et al. (2008). Against the original hypothesis, no significance was found between owner psychological variables and trainability. Research suggests that owner anxiety negatively affects trainability (Kis et al. 2012), possibly due to such owners failing to reward their dogs consistently. Kotrschal et al. (2009) found that owners with high neuroticism negatively affected dog’s ability to learn simple tricks and complete a cognitive task; however, the sample was made up of only 22 subjects and all dogs were male. Further research is required to investigate this association.

**Strengths, limitations and implications**

Owner psychology is one factor within the complex interplay of differentials affecting dog behaviour, including management practises (Tami et al. 2008), dog personality (Dubé et al. 2020) and early social environment (Harvey et al. 2016); as one respondent stated, ‘I can't tell if [her] aloofness is from the breed, from her past, or from my mental health’. Furthermore, the significance of these results may be undermined by age of dog at acquisition and length of time living with current owner, areas which may be controlled for in future research. Owner mental health may affect dog behaviour secondary to physiological or attentional changes: owner hormonal state affects stress physiology of dogs (Buttner et al. 2015), and dogs respond physically and emotionally to owner attentional engagement (Kaminski et al.
A fundamental basis for behaviour is training method (Bennett and Rohlf 2007): negative training is associated with increased stress and pessimism (de Castro et al. 2020), and increased anxiety and fear (Arhant et al. 2010) although these effects were found exclusively in small dogs, reducing generalisability. Another confounding factor to consider in future research is dog role: several respondents owned certified therapy dogs, and research suggests that pet dogs may be more anxiously attached to owners than service dogs (Fallani et al. 2006). The study context must also be noted: research (e.g. Bowen et al. 2020) has documented the changes in companion animal behaviour owing to increased owner presence and infrequent socialisation during the COVID-19 lockdowns, and impact of COVID-19 on behaviour was a theme elicited by the content analysis.

The extensive use of self-report means that potential reporting bias is unavoidable. Whilst the C-BARQ enabled structured assessment of dog behaviour based on objective observations, pet owners attribute a range of emotion to their animals (Martens et al. 2016) and inferences are made without behavioural evidence, thus a structured behavioural assessment is necessary. In utilising self-report from owners with mental health problems, further bias may emerge from projection of feelings, for example ‘I got a divorce four years ago and after my ex moved out, my dog became extremely depressed’, or mood changes resulting in over- or under-emphasis of behaviours. Nonetheless, some respondents did attempt to evidence their inferences, with behavioural evidence a recurring theme in the qualitative analysis, for example, ‘when I’m anxious she’s more barking [sic] and jumpy...[she] sits on my feet if I’m having a panic attack’. Unlike a dyadic relationship, the term ‘bond’ is anthropocentric, merely describing one individual’s bond to another (Ainsworth 1989), thus questioning owners on the human-dog bond incites inherent bias. Indeed, there is a discrepancy between owner and dog perception of strength of the human-dog bond (Rehn et al. 2013), although this was based on the Monash Dog Owner Relationship Scale which is very subjective, with questionable ecological validity.

Multiple regression is highly effective at delineating relationships whilst controlling for confounding variables, and including qualitative data allowed useful interpretation beyond the statistical outcomes. However, regression is optimal with continuous variables, and in the present study the dependent variable was ordinal data; nonetheless, treating ordinal variables as numeric is appropriate, if there are at least five values largely equally spaced on the spectrum of possible values and other assumptions of regression are met (Norman 2010). Significance of random ages, and that non-rescue dogs had significantly higher energy levels and rescue dogs had significantly higher trainability scores, may represent overfitting of the regression models, the significance representing random error: indeed, the models had low adjusted $r^2$ values. However, including standard error allowed precision of the predictors to be assessed (Alexopoulus 2010).

Large sample size and low number of questionnaires reduces the risk of eliciting significance by chance alone, however a problem with large datasets is the eliciting of false positives (for example, Kim 2019). Additionally, only 29.6% of the sample scored moderately or higher for anxiety, and 30.4% scored moderately or higher for depression, thus future research should recruit a sample better representative of such issues. Furthermore, the sample were predominantly female, a recurring problem in this area of
research: a more balanced sample would be optimal, especially as existing research implies an effect of owner gender on dog personality and dog behaviour, for example dogs with female owners being less sociable and active (Kotrschal et al. 2009).

It would be erroneous to consider the aims and results of this study in a negative light, assuming that poor mental health causes behavioural issues in pet dogs. In fact, the opposite may be true: research indicates that interactions and close bonds shared with animals increases empathy (Hawkins et al. 2017; Malcolm et al. 2018), thus those respondents struggling with their mental health and relying on their dogs for social and emotional support may be more empathic toward their welfare. This is evidenced in the responses by increased self-improvement for the sake of a pet, for example ‘I can be anxious and controlling at times...at times it has likely had a negative influence on her so I make a conscious effort not to let it affect her’.

This research has significant implications. Behavioural problems in pet dogs can result in a lifetime in kennels or euthanasia (Patronek et al. 1996), and are, along with the need for more attention than owners can provide, a primary reason for relinquishment (Diesel et al. 2010). However, behaviour alone is often not the primary determining factor in relinquishment (Patronek et al. 2021): also significant is owner miseducation in dog behaviour, emphasising the role of owner attitude (Powell et al. 2021). Dog behavioural problems are especially salient as a result of the Coronavirus pandemic: in a survey of over 6000 owners, Dogs Trust (2020) found that, during lockdown, 26% of pet dogs had developed at least one new behavioural issue, and an 82% increase in barking and whining. Understanding associations between owner psychology and dog behaviour would enhance dog behaviour treatment programmes and increase the emphasis on owner role, for example through relationship-centred training facilitates effective behaviour modification through prioritising empathy, compassion, and commitment elements of the bond (Clothier 2002). This may also enhance owner wellbeing by encouraging them to address any psychological issues, creating an interconnected approach to the optimisation of wellbeing for both members of the dyad (Pereira et al. 2021; One Health 2022).

**Conclusions**

Regression analyses revealed that owner anxiety, depression and self-esteem can predict dog behaviour, specifically aggression, fear/anxiety, attachment, separation-related behaviour and excitability. The qualitative data enabled the formation of themes to explicate these findings; particularly recurrent themes concerned strong attachment, dogs enhancing owner wellbeing and expectations placed on pet dogs. Determining that owner psychological variables affect pet dog behaviour provides a means of understanding and enhancing welfare of both dog and owner through psychological support. The findings provoke insightful theoretical explanations however the associations between owner variables and dog behaviour are complex, and exact cause and consequence is difficult to quantify. Further research into other psychological variables is necessary with more balanced samples and behavioural observation, and further consideration must be applied to confounding factors influencing dog behaviour including genetics, life experiences and age of acquisition. Nonetheless, it is clear owners exert a vast
influence on their pet dogs’ behaviour and welfare, owing to the inherent value of our pet dogs in providing us with companionship and emotional support, underlining the importance of the owner's emotional wellbeing in the human-dog bond.

Declarations
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Author contributions
Conceptualisation: HC and LL; Methodology: HC and LL; Formal analysis and investigation: HC; Writing – original draft preparation: HC; Writing – review and editing: LL; Supervision: LL.

Data availability
All data generated or analysed during this study are included in this published article and its supplementary information files.

References


**Figures**
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stranger-directed aggression</td>
<td>Threatening or hostile responses to strangers approaching or invading the dog’s or owner’s personal space, territory, or home range</td>
</tr>
<tr>
<td>Owner-directed aggression</td>
<td>Threatening or hostile responses to the owner or other members of the household when challenged, manhandled, stared at, stopped over, or when approached while in possession of food or objects</td>
</tr>
<tr>
<td>Dog-directed aggression</td>
<td>Threatening or hostile responses when approached by unfamiliar dogs</td>
</tr>
<tr>
<td>Dog rivalry</td>
<td>Threatening or hostile responses to other familiar dogs in the same household</td>
</tr>
<tr>
<td>Stranger-directed fear</td>
<td>Fearful or wary responses when approached by strangers</td>
</tr>
<tr>
<td>Non-social fear</td>
<td>Fearful or wary responses to sudden or loud noises, traffic, and unfamiliar objects and situations</td>
</tr>
<tr>
<td>Dog-directed fear</td>
<td>Fearful or wary responses when approached by unfamiliar dogs</td>
</tr>
<tr>
<td>Separation-related behaviour</td>
<td>Vocalizing and/or destructiveness when separated from the owner, often accompanied or preceded by behavioral and autonomic signs of anxiety including restlessness, loss of appetite, trembling, and excessive salivation</td>
</tr>
<tr>
<td>Attachment and attention-seeking</td>
<td>Maintaining close proximity to the owner or other members of the household, soliciting attention or attention, and displaying agitation when the owner gives attention to third parties</td>
</tr>
<tr>
<td>Trainability</td>
<td>Willingness to attend to the owner, obey simple commands, learn quickly, fetch objects, respond positively to correction, and ignore distracting stimuli</td>
</tr>
<tr>
<td>Chasing</td>
<td>Chasing cats, birds, and/or other small animals, given the opportunity</td>
</tr>
<tr>
<td>Excitability</td>
<td>Displaying strong reactions to potentially exciting or arousing events, such as going for walks or car trips, doorbells, arrival of visitors, and the owner arriving home; has difficulty settling down after such events</td>
</tr>
<tr>
<td>Touch sensitivity</td>
<td>Fearful or wary responses to potentially painful procedures, including bathing, grooming, nail-clipping, and veterinary examinations</td>
</tr>
<tr>
<td>Energy level</td>
<td>Energetic, “always on the go”, and/or playful</td>
</tr>
</tbody>
</table>

**Figure 1**

C-BARQ categories (Hsu and Serpell 2003)
Figure 2

Added variable plots of each significant independent variable score against scores for attachment and attention-seeking, separation-related behaviour, stranger-directed aggression and stranger-directed fear, whilst controlling for the other predictor variables in the model.
Figure 3

Added variable plots of each significant independent variable score against scores for non-social fear, dog-directed fear and excitability, whilst controlling for the other predictor variables in the model.
Strong bond
- Dog considered 'friend' or family
- Owner identifies as dog's 'chosen person'
- Owner and dog enjoy shared activities
- Owner adapts self for dog's benefit (i.e. lifestyle or mood changes
- Emphasis on perceived closeness of owner and dog

Dog enhances owner physical wellbeing

Dog enhances owner emotional wellbeing
- Dog is attentive if owner cries
- Emphasis on owner gratitude for dog
- Shared trauma/history between owner and dog
- Owner has emotional dependence on dog

Dog is a certified therapy dog

Owner perceives a weak bond between themselves and dog
- Dog classified as 'pet only'
- Owner emphasis on boundaries to maintain owner-pet relationship

Owner acknowledges disadvantages in the human-dog relationship

Owner has pragmatic and realistic view of human-dog relationship

Dog is responsive to owner mood
- Positively
- Negatively
- Dog 'mirrors' owner emotion
- Dog is emotionally dependent on owner
- Dog responsive to owner anxiety and/or depression
- Behaviour/physiological evidence of responsiveness to owner mood

Dog is unresponsive to owner mood
- Owner feels their emotion is not substantial enough to affect their dog
- Dog is independent
- Age/type/nature as factors in unresponsiveness to owner mood

Owner engages in training dog

Owner feels guilt and/or pressure as a result of owning dog

Emphasis placed on high owner expectations of dog in human-dog relationship

Owner and dog share a balanced, collaborative relationship

Owner compares current dog to previous dog(s) or other known dog(s)

Impact of COVID-19

Figure 4

Themes and subthemes within the qualitative data responses
Figure 5

Wordcloud representing answers to Q1 ‘How would you describe your relationship with your dog’ of words with a frequency of 5 or greater, pronouns and common English words removed.
Figure 6

Wordcloud representing answers to Q2 ‘To what extent do you think you influence your dog’s behaviour?’ of words with a frequency of 5 or greater, pronouns and common English words removed
Figure 7

Wordcloud representing answers to Q3 ‘How do you think your dog responds to your emotions?’ with words with a frequency of 5 or greater, pronouns and common English words removed

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CleaneddataOwnerpsychologicalcharacteristicspredictdogbehaviouraltraits.xlsx
- Supplementaryinformation1.docx