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The Influence of Cognitive Vulnerabilities and Attributions of Animal Sentience on Willingness to Own Pets

Denise B. Dillon [a], Precious Lumagbas[b], and Kelli-Ann Lee[b]

[a]Tropical Futures Institute, School of Social and Health Sciences, James Cook University Singapore, Singapore; [b]College of Healthcare Sciences, James Cook University, Townsville, Australia

ABSTRACT

The biophilia hypothesis proposes that humans have an innate emotional connection with other living organisms. Willingness to own (WTO) animals as pets could thus be explained by anthropomorphic attributions to animals (AA) (i.e., attribution of human-like characteristics, such as affect, cognition, and sentience, to nonhuman animals), which is a form of biophilic tendency. However, we must also consider biophobic responses, such as perceptions of cognitive vulnerability (CV) (uncontrollability, unpredictability, danger, and disgust), which can predict fear toward animals and explain the uneven distribution of fear across populations. Hence, biophobia may explain differences in the WTO by virtue of fear. Through an online survey of 220 respondents, we investigated the efficacy of both CV and AA in predicting WTO across high-fear (HF, snake and spider) and low-fear (LF, cat and rabbit) animals. We also tested the mediating role of fear in the relationship between CV and WTO and the moderating role of fear in the relationship between AA and WTO. The results of this study yielded some meaningful understandings of WTO LF versus HF animals, highlighting the complexity of pet ownership motivations. Against expectations, mediation analyses indicated that fear plays no significant role in explaining the relationship between participants' perception of cats and rabbits as uncontrollable, unpredictable, dangerous, or disgusting and their willingness to own them. In contrast, for snakes and spiders, the relationships between perception of uncontrollability and WTO as well as perception of disgustingness and WTO were fully mediated by fear. Results further reveal that fear did not moderate the relationship between AA and WTO for either LF or HF animals. While fear can deter willingness to own some animals as pets, affect toward the animal can play a significant role in overriding those fears.

KEYWORDS

Anthropomorphic attributions to animals; biophilia; biophobia; cognitive vulnerability; human–animal interaction

CONTACT Denise B. Dillon denise.dillon@jcu.edu.au Tropical Futures Institute, James Cook University Singapore, 149 Sims Drive, 387380, Singapore

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The American Pet Products Association (2022) revealed that the majority (66%) of households within the United States (approximately 86.9 million households) own a pet. The primary focus of pet ownership research has been on its benefits and is mostly limited to typical pets, such as dogs and cats. Meanwhile, there is an increasing interest in the ownership of nontraditional pets such as snakes (Kusrini et al., 2021) despite their being commonly reported as one of the most feared species (Azevedo et al., 2022; Polák et al., 2016, 2019; Rádlová et al., 2020). Such an apparent discrepancy prompts the need to investigate the factors that affect the willingness to own different types of pets because perceptions about an animal can impact the care given to them.

Pet ownership refers to possessing, caring for, and having responsibility for the well-being of a domesticated animal that is kept for companionship or enjoyment (McConnell et al., 2011). This behavior can be understood through the biophilia hypothesis (Wilson, 1984, 1993), which posits that humans have natural emotional connections with nature (i.e., plants and animals). A wealth of evidence-based research indicates that interactions with nature can positively impact quality of life factors, such as physical health and activity (Herzog, 2011; Neill et al., 2023) and psychological wellbeing (Lem et al., 2016; Rhoades et al., 2015; Scoresby et al., 2021). Hence, pet ownership has wide-ranging benefits for different populations.

While there has been an increase in the ownership of atypical pets, such as snakes (La Laina et al., 2021) and spiders (Hauke & Herzig, 2021), the lower popularity of owning such pets might be attributable to biophobia (Kellert & Wilson, 1993). In contrast to the biophilia hypothesis, biophobia involves a natural, biologically based aversion/fear in humans toward certain types of animals that are considered to have potential danger and risk of harm (Ulrich, 1993). This survival mechanism is rooted in human evolutionary history and results in a partial inherent tendency to quickly associate negative information with some animals, followed by the maintenance of a long-lasting fear or intense avoidant response. For example, human fear of snakes or spiders due to their potentially venomous bite or sting served as a survival advantage in the past. Therefore, while not all snakes and spiders are dangerous per se because they are not all venomous, many people tend to avoid them to circumvent the risk of harm. In comparison with snakes and spiders, other animals, such as cats and rabbits, posed less threat in our evolutionary past. For instance, while it is possible for humans to be infected by bacteria or parasites from cats or rabbits, they have not been a threat to the extent of a pandemic or mortality at a large scale (Salisbury, 2022). Hence, there is a less aversive reaction in human beings toward such non-threatening animals.

Although biophobia offers some understanding of the fear of certain animals, it falls short in explaining variations in fear among individuals (Armfield, 2006). This is because not everyone has an innate fear of certain animals, such as snakes and spiders; some people willingly own them as pets, investing time and financial resources in their maintenance. Furthermore, although cats and rabbits did not serve as evolutionary threats in the past, there are still people who report fear toward them (Armfield & Mattiske, 1996).

Armfield (2006) proposed the Cognitive Vulnerability Model (CVM) as a framework that accounts for variations in fear levels across populations and found it to have better explanatory power for the variability of fear amongst populations than the harm-looming model (Armfield, 2007). The latter draws on the premise that fear of animals stems

from the anticipation that a threat is approaching rapidly, which draws on an assumption of speed and acceleration. Armfield contends that one's own perception of stimuli according to their properties is an essential factor in one's acquisition and maintenance of fear. These perceptions form a schema of vulnerability that embodies a framework through which an individual understands and reacts to stimuli. Armfield outlines four dimensions of perception: (a) Dangerousness pertains to the extent to which an individual believes that they are going to be harmed by the stimulus. It is the most common fear factor concerning animals. However, as fear can be evoked by seemingly non-dangerous stimuli such as caterpillars, maggots, and slugs, (b) disgustingness was also deemed another dimension of fear acquisition, which pertains to the extent to which a stimulus evokes associations with disease or uncleanness and thereby prompts disease avoidance. (c) Unpredictability relates to a lack of knowledge of a stimulus's identity, location, and movement. Unpredictability is closely related to uncertainty and was also found to be related to fear (Craske et al., 1993). (d) Uncontrollability pertains to the extent to which one believes a stimulus is capable of a reaction that can result in an unpleasant occurrence.

In a test of the CVM, Armfield (2007) revealed that all four vulnerabilities were significantly and positively associated with fear of animals, accounting for between 20% and 50% of the variance. Armfield's study further revealed that learning experiences with animals were not associated with the fear of animals. Therefore, the model helps account for the variations in fear across populations as it focuses on the perception of the stimulus that varies per person rather than on the inherent characteristics of the stimulus itself. It follows that the willingness to own (WTO) animals as pets might also be predicted by the CVM.

Notably, another study by Armfield (2006) showed that people perceive themselves as more vulnerable to some animals that evoke high levels of fear (e.g., snakes and mice) than to others that evoke little or low levels of fear (e.g., cats and birds). Thus, the relationship between perceived vulnerability and willingness to own is likely to be stronger for highly feared animals, where individuals are likely to perceive themselves as more vulnerable to those animals and are therefore less willing to own them, and vice versa.

Given that cognitive vulnerabilities account for fear, the relationship between vulnerabilities and WTO may be mediated by fear. The tendency to fear animals toward which one feels more vulnerable has also been shown in other studies. For instance, people with snake fear tend to overpredict the danger levels associated with a snake (Taylor & Rachman, 1994). Separately, spider-fearing participants who viewed realistic 3D animated videos of spiders moving on different paths and speeds perceived them to be highly uncontrollable and unpredictable despite watching videos in which the spiders were moving in predictable directions (Grill & Haberkamp, 2023). Moreover, in a study utilizing an implicit association task involving participants who reported snake and spider fears, participants were more likely to implicitly associate "dangerous" and "disgusting" with the relevant animal in their rapid associations (Teachman et al., 2001). Furthermore, with perceived vulnerability as a determinant of fear, it provides grounds to hypothesize that fear acts as a mediating factor between perceived vulnerability and the WTO. Higher perceived vulnerability should predict a higher level of fear, resulting in lower WTO for both HF and LF animals.

However, it is also likely that despite perceiving themselves as vulnerable to animals and feeling fear toward them, people could remain willing to own them as pets. For instance, rabbits are reported by their owners to display many problematic behaviors such as destructiveness (Crowell-Davis, 2007; González-Martínez et al., 2022). This makes it necessary to provide another explanation for the willingness to own pets.

Another factor that can help explain willingness to own pets is the tendency toward anthropomorphism, which is to attribute human-like characteristics to animals (Herzog & Galvin, 1997). The act of attributing mental states to animals is also known as animal mentation. This form of anthropomorphism concerns questions relating to the moral status of nonhuman animals (Herzog & Galvin, 1997) and how these beliefs influence behaviors toward animals, including how they are treated. This can also explain pet ownership willingness. Herzog and Galvin developed an 11-item instrument to capture perceptions of animals, including beliefs about their mental capacity as well as non-mental capacity (their attractiveness and the extent to which they are deserving of moral consideration) that may otherwise influence people's attitudes toward them. Their analysis revealed three underlying dimensions: cognition, affect, and sentience. Cognition pertains to the extent to which the individual believes that the animal is intelligent, conscious, can reason, and is aware of itself. Affect refers to an individual's attraction, affection, and preference for an animal species. Sentience is related to the extent to which individuals believe that animals have the capability to feel pain and suffering, which also influences the way they treat animals morally.

Various studies have confirmed that different perceptions of animals' cognition, affect, and sentience are related to varying attitudes toward them, and they are associated with the degree of attachment owners have to their respective companion animals (Su et al., 2018). This can be seen in the increased anthropomorphic tendencies of pet owners toward the species of their respective pets, whereby the owners are more likely to attribute human-like characteristics to their respective animals. For instance, Pongrácz and Szapu (2018) revealed that cat owners perceive that cats have appropriate socio-cognitive skills. Su et al. (2018) also showed that owners of dogs and cats in Japan see their animals as having the ability to experience primary emotions such as joy, anger, and sadness, and this was significantly and correlated with a higher level of attachment to the animal. Unexpectedly, the Japanese respondents also attributed the capacity to experience secondary emotions of jealousy and compassion, a finding that is inconsistent with those from Western countries. Furthermore, rabbit owners perceive their rabbits as having emotional capabilities comparable to those of humans (McMahon & Wigham, 2020). We acknowledge that further research is needed to determine the actual sentience of various animals as well as associated behaviors such as attachment, or associated emotions such as separation anxiety. Some research suggests that cats, for instance, can show attachment behaviors consistent with those observed in children's attachment to their primary caregivers (Edwards et al., 2007).

Anthropomorphic tendencies remain high even in owners of highly feared animals. For example, vertebrates such as snakes and invertebrates such as spiders are presumed to be mindless and often associated with a lack of consciousness (Kellert, 1993). Nonetheless, despite being rated as one of the least attractive animals by people of all age groups (Polák et al., 2016, 2019), some evidence indicates that children between 7 and 14

years, across multiple countries, like snakes and are willing to protect them (Ballouard et al., 2013). Importantly, snake owners have a more positive view toward them. An online survey of 222 reptile owners (Azevedo et al., 2022) investigated their motivations for owning reptiles as pets (16% were snake owners). The reptile owners were asked about common behaviors of their pets (e.g., attempting to climb the wall of their enclosure, shifting from a lighter to a darker area), and they were also asked to attribute motivations to the animal to engage in such behaviors. Eighty percent of the snake owners attributed stress/fear as the motivator behind the behavior. Snake owners also commonly cited pain and discomfort as the motivators behind these behaviors but were less likely to cite attempts to communicate. This suggests that snake owners acknowledge that their pets are sentient beings who can suffer. Hence, common-sense beliefs about animal mentation appear to have increased the WTO for both highly feared and less feared types of animals.

Fear can result in a range of attitudes and behaviors. As such, fear may also moderate the relationship between anthropomorphic attributions to animals and the WTO. For instance, the level of fear toward the animal is likely to attenuate anthropomorphic attributions and consequently result in a weaker WTO. Although owners of animals tend to attribute more human-like characteristics to such animals, this tendency may not be present in non-pet owners and individuals who are highly fearful of that animal.

Teachman et al. (2001) reported that snake-fearing individuals have a higher tendency to implicitly attribute negative attributions to snakes compared with those without such fear, and there was a strong positive correlation between explicitly self-reported fear and implicit associations evoked through the task.

On the other hand, although aggression is a commonly reported behavior for cats abandoned in shelters (Vitale, 2018), favorable anthropomorphic attributions to domestic animals such as cats and dogs are reasonably common (Eddy et al., 1993). Through an eye-tracking method while humans watched brief cat videos, it was found that pet owners liked videos showing cats engaging in human-like behavior (Prachapokpong & Huang, 2024), and the interplay of such behavior with visible affection significantly influenced preferences and engagement of the viewers. Indeed, some argue that evolutionary selection has led to humans being able to interpret emotional states (including fear) of other, non-human, species, with anthropomorphism and empathy both playing a part in that (Bahlig-Pieren & Turner, 1999). Additionally, many people find domestic animals to be cute, and they believe that they can feel emotions as well as respond to moods and emotions within their human owners (Bahlig-Pieren & Turner, 1999). Therefore, the moderating effect of fear on the relationship between anthropomorphic attributions to animals and willingness to own them should be stronger for highly feared animals than for less-feared ones.

Notably, other factors may also influence WTO animals, such as pets, including current pet ownership, age, and gender. The desire for social support is another factor beyond the scope of the current study (Podberscek et al., 2005; Serpell, 1986, 2002). In terms of current pet ownership, individuals who already own pets are likely to be more familiar with the responsibilities and care required for pet ownership (Westgarth et al., 2010). This familiarity may increase their WTO to include other animals as pets, including snakes and spiders, owing to their experience. It was also found that pet owners tend

to have increased care for wildlife and are generally concerned about animal welfare, ensuring that they are not compromised (Shuttlewood et al., 2016). As such, current pet owners may be more willing than non-pet owners to own highly feared animals.

Age and gender may also influence WTO highly feared animals as pets. In a study in Germany and France, Schaper et al. (2009) examined the presence of bites and stings of exotic/atypical pets and found that the average age of these pet owners was 36 years and most were male. Although females were found to seek more emotional support and companionship from pet ownership (Maurer, 2022), compared with males, they were also found to show greater fear of snakes and spiders (Prokop & Fančovičová, 2013), indicating a higher propensity to own LF animals than HF animals. Furthermore, while it has been reported that snakes are more likely to be owned by men than by women (Kusrini et al., 2021), some research suggests that schoolchildren aged between 7 and 14 years have favorable attitudes toward snakes, and that there is no gender difference (Ballouard et al., 2013). It thus appears that younger individuals tend to have more benign attitudes toward animals, suggesting a propensity to treat all animals, regardless of their species or traits, with kindness and empathy (Ballouard et al., 2013). As such, it is important to consider these factors as they may influence differences in the WTO between low- and high-fear animals.

The present study explored the predictive capability of cognitive vulnerabilities (CV) on willingness to own (WTO), as well as anthropomorphic attributions (AA) on the WTO across HF (snakes and spiders) and LF animals (cats and rabbits). It also aimed to investigate whether fear mediates the relationship between CV and the WTO and whether fear moderates the relationship between AA and the WTO.

In a mediated relationship, the independent variable (i.e., 4 x CV dimensions) affects the mediator variable (i.e., fear), and the mediator variable influences the dependent variable (i.e., WTO). At first inspection, we might expect that CV dimensions each directly influence WTO, but we need to consider that CV dimensions differentially affect fear, and fear might also be expected to directly influence WTO.

Moderation instead involves an inconstant relationship between two constructs such that the relationship depends on a third variable. Based on findings relating to differential attitudes to animals based on their inherent stimulus features, and the level of actual threat posed by them, we expected that fear as the moderator variable would affect the strength of the relationship between AA and WTO.

The present study proposed the following hypotheses:

(1) CV will significantly and negatively predict WTO for both HF animals and LF animals.
(2) The relationship between CV and the WTO is mediated by fear and is observed in both HF and LF animals.
(3) AA in animals will significantly and positively predict WTO for both HF and LF animals.
(4) Fear moderates the relationship between AA and WTO for both HF and LF animals.

Methods

Ethical approval for the study was obtained from the James Cook University (JCU) Human Research Ethics Committee (H9129).

Design

This study employed a correlational and predictive research design. The predictor variables in the study were cognitive vulnerability (CV) and anthropomorphic attributions (AA) toward animals, while the outcome variable was willingness to own (WTO). Fear was investigated as the third variable acting as the mediator between cognitive vulnerability and WTO and as the moderator for the effects of anthropomorphic attributions on WTO. The type of animal was considered an independent variable in the study with two levels: high fear (HF, snake and spider) and low fear (LF, cat and rabbit).

Participants

Three hundred and forty-one respondents were recruited for an online survey through convenience and snowball sampling; 121 datasets (35%) were excluded from the analyses because they were mostly incomplete. The final sample consisted of 220 participants (68.6% female; 83.6% pet owners); nine identified as non-binary/third gender and one preferred not to disclose. Their ages ranged between 18 and 64 years ($M = 34.1$ years, $SD = 10.96$). The sample included students from James Cook University (JCU) and other universities in Singapore and Malaysia, who were recruited through e-mail via a specified person of contact, as well as community participants.

Materials

The study was conducted in the form of a 38-item survey. It included demographic questions (gender, age, and pet ownership status) and the following validated measures that were completed for each of the four specified animals.

Perceived cognitive vulnerability was measured using a 14-item scale established by Armfield (2007). It includes subscales that measure perceived disgust (four items), uncontrollability (three items), unpredictability (three items), and dangerousness (four items). Items are measured on a 7-point scale (1 = strongly disagree; 7 = strongly agree) with several reverse-scored items. The mean scores were calculated for each subscale and for overall perceived cognitive vulnerability for use in the analyses. Higher mean scores indicate higher perceived vulnerability toward the animal.

Animal attributions in the form of beliefs about animal mentation were measured using the 11-item animal attribution scale established by Herzog and Galvin (1997). It consists of three subscales: cognition (five items), affect (three items), and sentience (three items). Items are measured on a 5-point scale for each animal, with each subscale capturing increasing attribution (1 = none, 2 = little, 3 = moderate, 4 = high degree, 5 = human-like). Thus, higher mean scores indicate higher attribution to animals of the specific subscale component.

Individual levels of fear were measured for each of the four animals (cat, rabbit, snake, and spider) following Armfield and Mattiske (1996), using a single item on a 7-point scale (1 = none; 7 = terror). Higher scores indicate higher fear of the animal, and a composite mean score was calculated for HF and LF animals, respectively.

Willingness to own an animal as a pet was measured using a single item for each of the four animals on a 10-point scale (0 = not at all willing; 10 = extremely willing). Hence,

higher scores indicate a higher willingness to own the animal, and a composite mean score was calculated for HF and LF animals, respectively.

Procedure

The study was administered through Qualtrics (https://www.qualtrics.com) and took approximately 15–30 min to complete. The survey link was disseminated through various avenues, including SONA Research Participation Management software (Sona Systems, https://www.sona-systems.com), posters on campus via QR codes, social media, and e-mail. Participants who accessed the link reached a prefatory information page that contained a brief description of the study, details of eligibility, and ethical considerations such as anonymity. This was followed by an informed consent confirmation to continue the survey, proceeding with demographic questions and subsequently with measures related to each animal (cat, rabbit, snake, and spider). The items in each of the multi-item measures were randomized to avoid order effects.

Data Analysis

For cognitive vulnerability (CV), eight models were conducted for the mediation analysis for each CV factor (disgust, uncontrollability, unpredictability and dangerousness) to examine the mediating effect of fear on CV and willingness to own (WTO). Four models were conducted separately for LF and another four models for HF.

For animal attributions, six models were used for moderation analysis. Separate models were run for each subscale of the animal attributions scale (cognition, affect, & sentience) (AA). Three models were run for LF and another three models for HF.

Results

Reliability analyses were conducted to check the internal consistency of the scales. For CV, Cronbach's $\alpha = 0.78$ (Cat), 0.74 (Rabbit), 0.88 (Snake), 0.85 (Spider). For AA, Cronbach's $\alpha = 0.86$ (Cat), 0.86 (Rabbit), 0.85 (Snake), 0.87 (Spider). PROCESS Macro version 4.2 was run through IBM SPSS Statistics 29 to conduct mediation and moderation analyses.

Descriptive analysis was conducted to investigate the mean scores for LF versus HF animals across various measures, and these are summarized in Table 1. The descriptive statistics indicate that perceived cognitive vulnerability appears stronger in response to HF animals (snakes and spiders) than to LF animals (cats and rabbits) ($t_{(3)} = -3.74$, $p = 0.03$); in contrast, anthropomorphic attributions appear stronger in response to LF than to HF animals ($t_{(2)} = 7.78$, $p = 0.02$).

In line with Armfield's (2006) finding that animals such as snakes and spiders tend to be more feared than animals such as cats and rabbits because of their evolutionary threat significance, the mean fear score for HF animals was significantly higher than for LF animals ($t_{(201)} = 13.57$, $p = < 0.001$) (Table 1). Surprisingly, despite the general difference in the mean fear scores between the two animal groups, there was no significant difference in the sample's mean ratings for their willingness to own either group of animals as pets ($t_{(187)} = 0.19$, $p = 0.84$).

Table 1. Descriptive statistics for outcome and predictor variables for low-fear and high-fear animals.

			Low fear		High fear	
Measure	Variables	Min–Max	*M*	*SE*	*M*	*SE*
Willingness to own		0–10	6.84	1.87	6.91	2.23
Fear		1–7	1.41	0.05	2.56	0.10
Cognitive vulnerability	Disgustingness	1–7	2.37	0.06	3.18	0.07
	Uncontrollability	1–7	1.96	0.06	2.89	0.09
	Unpredictability	1–7	3.73	0.03	3.89	0.03
	Dangerousness	1–7	2.01	0.06	2.64	0.08
Anthropomorphic attributions	Cognition	1–5	3.47	0.03	2.67	0.05
	Affect	1–5	3.73	0.05	3.00	0.05
	Sentience	1–5	4.33	0.03	3.82	0.05

Mahalanobis distances (20.52 for CV models and 18.47 for AA models, both at $p < 0.001$), leverage values, *Z*-scores (|3|), and box plots were inspected and indicated outliers in the data. Owing to the sensitivity of the regression analyses to outliers, they were excluded from the analysis. In total, 10 responses were excluded, and 209 responses were included for data analysis. Skewness and kurtosis values indicated that all data were within the normal range. None of the correlations between the variables exceeded 0.85, and multicollinearity was not present. There was no significant relationship between the perceived uncontrollability of LF animals and WTO LF animals or between the perceived unpredictability of the same. However, the Pearson correlation values for the remaining variables of interest indicated that the linearity assumption was met.

The Mediating Role of Fear on the Relationship Between CV and WTO

Low Fear

The results for the mediation analyses concerning LF animals (i.e., cats and rabbits) indicated no evidence for a mediating effect of fear on the relationships between the four CV factors and WTO ($b = -0.52$, $p < 0.05$). As displayed in Figure 1, this was evident in the nonsignificant indirect effects across all the models as observed on the bias-corrected bootstrap confidence interval based on 5,000 bootstrap samples, which included zero: uncontrollability ($ab_1 = -0.05$, Boot $SE = 0.04$, CI[–0.15, 0.03]), unpredictability ($ab_2 = -0.03$, Boot $SE = 0.07$, CI[–0.20, 0.10]), dangerousness ($ab_3 = -0.09$, Boot $SE = 0.07$, CI[–0.25, 0.01]), disgustingness ($ab_4 = -0.06$, Boot $SE = 0.05$, CI[–0.18, 0.01]).

While fear had a significant direct effect on willingness to own LF animals ($b = -0.52$, $p = 0.0496$), it did not mediate the relationship between the CV factors and WTO. This indicates that fear plays no significant role in explaining the relationship between participants' perception of cats and rabbits as uncontrollable, unpredictable, dangerous, or disgusting and their willingness to own them. Furthermore, only perception of disgustingness toward LF animals had a significant direct effect on WTO, suggesting that when fear is considered, every 1 unit increase in perception of disgust in LF animals is associated with a 1.29 unit decrease in WTO ($SE = 0.22$, $t = -5.89$, $p < 0.001$, CI [–1.73, –0.86]). Moreover, disgustingness was also the only variable that had a significant total effect across all the CV variables. Thus, when fear is not considered, only the perception of disgustingness had a negative association with WTO LF animals, whereby a 1 unit

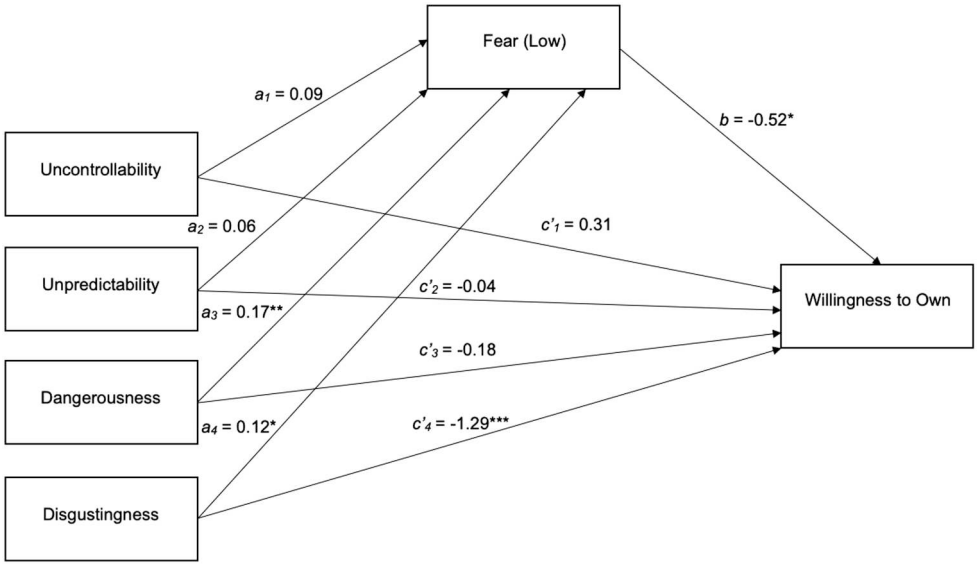

Figure 1. Path diagram of the mediation models – Low-fear animals. Covariates were the remaining three cognitive vulnerabilities not assigned as the independent variable in each model. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

increase in perceived disgustingness of LF animals is associated with a 1.35 unit decrease in WTO ($SE = 0.22$, $t = 6.19$, $p < 0.001$, CI [–1.78, –0.92]).

In contrast to Armfield (2007), the current study reveals that only perceived dangerousness and disgustingness were positively associated with fear for LF animals. Perceived uncontrollability ($a_1 = 0.09$, $p = 0.11$) and unpredictability ($a_2 = 0.06$, $p = 0.56$) were not significantly associated with fear.

High Fear

For snakes and spiders, the relationships between perception of uncontrollability and WTO as well as perception of disgustingness and WTO were fully mediated by fear. As displayed in Figure 2, this is evident on the observed bias-corrected bootstrap confidence interval for the indirect effects for uncontrollability and disgustingness based on 5,000 bootstrap samples, which were completely below zero: uncontrollability: ($ab_1 = –0.32$, Boot $SE = 0.11$, CI [–0.53, –0.12]), disgustingness: ($ab_4 = –0.33$, Boot $SE = 0.13$, CI [–0.61, –0.10]), as well as their non-significant direct effects (see c_1 and c_4 on Figure 2).

In contrast, there was no evidence for a mediating effect of fear for the relationships between either perceived unpredictability ($a_2 = 0.03$, $p = 0.88$) and WTO or perceived dangerousness ($a_3 = –0.11$, $p = 0.21$) and WTO. This is evident in the non-significant indirect effects on both perceived unpredictability and perceived dangerousness models as observed on the bias corrected bootstrap confidence interval based on 5,000 bootstrap samples, which included zero: perceived unpredictability ($ab_2 = –0.02$, Boot $SE = 0.12$, CI [–0.27, 0.21]) and perceived dangerousness ($ab_3 = –0.08$, Boot $SE = 0.07$, CI [–0.23, 0.05]).

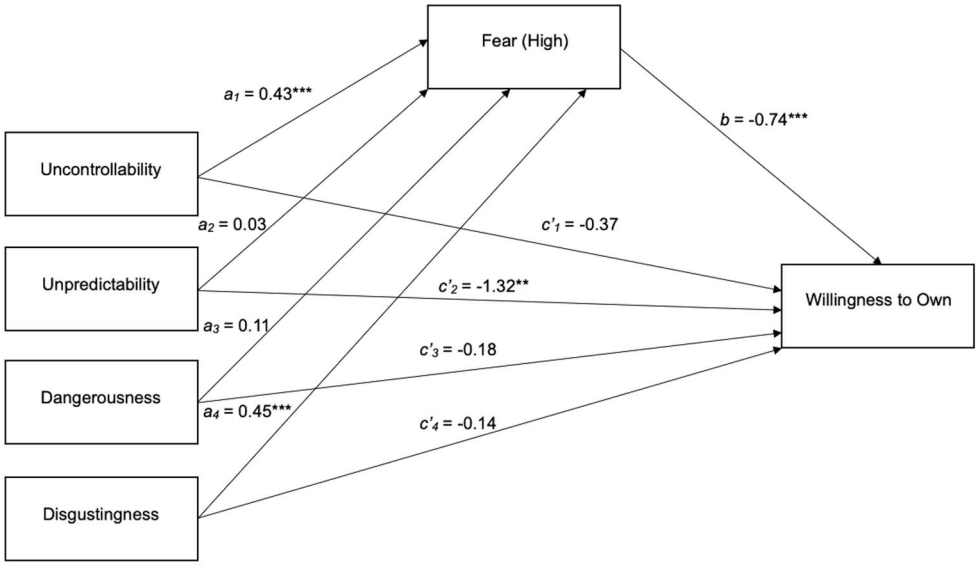

Figure 2. Path diagram of the mediation models – High-fear animals. Covariates were the remaining three cognitive vulnerabilities not assigned as the independent variable in each model. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

In contrast to the results for LF animals, where only perceived disgust had a significant direct effect on WTO, only perceived unpredictability of HF animals had a significant direct effect on WTO (see Figure 2), suggesting that when fear is considered, every 1 unit increase in perception of unpredictability in HF animals is associated with a 1.32 unit decrease in WTO ($SE = 0.46$, $t = -2.86$, $p < 0.01$, CI [−2.23, −0.41]). However, its effect on WTO was not mediated by fear. Not considering fear, only perceived uncontrollability ($c = -0.69$, $SE = 0.22$, $t = -3.20$, $p < 0.01$, CI [−1.12, −0.27]) and perceived unpredictability ($c = -1.34$, $SE = 0.48$, $t = -2.81$, $p < 0.01$, CI [−2.23, −0.40]) were significantly and negatively associated with WTO. Notably, the impact of perceived disgustingness on WTO was only present through fear ($ab_4 = -0.33$, $SE = 0.13$, CI [−0.61, 0.10]). Overall, these results indicate that the relationship between the perception of uncontrollability of snakes and spiders and WTO them, as well as perception of disgustingness of snakes and spiders and WTO them, is fully attributable to fear. The results suggest that the reason why perceived uncontrollability and perceived disgust toward snakes and spiders are negatively associated with willingness to own them is at least partially due to fear.

As such, these results are only partially in line with the Hypothesis 1. Only some CV factors significantly and negatively predict WTO, and these varied per animal group. For LF animals (cats and rabbits), perceptions of disgustingness significantly and negatively predicted willingness to own them. On the other hand, it was perceptions of HF animals (snakes and spiders) as uncontrollable and unpredictable that significantly and negatively predicted willingness to own them. Further, the results are not in line with Hypothesis 2 as the mediating role of fear on the relationship between CV and WTO was only observed in HF animals and only for perceptions of uncontrollability and disgustingness.

The Relationship Between AA and WTO

Hypothesis 3 predicted that AA in animals will significantly and positively predict WTO across LF and HF animals. Three models were conducted separately for each LF (Table 2) and HF (Table 3) animal, including fear for each model.

Low Fear

Across all of the multiple linear regression analyses conducted, each overall model was significantly useful in predicting WTO. For Cognition ($F_{(2,\ 196)} = 5.51$, $p = 0.005$, adjusted $R^2 = 0.44$), the model indicates that, in combination, the tendency to attribute cognitive abilities to LF animals and fear toward them accounted for 44% of the variance in WTO. For Affect ($F_{(2,\ 196)} = 58.33$, $p < 0.001$, adjusted $R^2 = 0.37$), the model indicates that, in combination, the tendency for attraction, affection, and preference for LF animals and fear toward them accounted for 37% of the variance in WTO. And for Sentience ($F_{(2,\ 196)} = 5.72$, $p = 0.004$, adjusted $R^2 = 0.05$), the model indicates that, in combination, the tendency to believe that LF animals have the capability to feel pain and suffering and fear toward them accounted for 5% of the variance in WTO. Across all of the models, all AA factors significantly and positively predicted WTO. However, fear did not predict WTO.

High Fear

Across all of the multiple linear regression analyses conducted, each overall model was significantly useful in predicting WTO. For Cognition ($F_{(2,\ 186)} = 42.83$, $p < 0.001$, adjusted $R^2 = 0.31$), the model indicates that, in combination, the tendency to attribute cognitive abilities to HF animals and fear toward them accounted for 31% of the variance in WTO. For Affect ($F_{(2,\ 186)} = 75.80$, $p < 0.001$, adjusted $R^2 = 0.44$), the model indicates that in combination the tendency for attraction, affection, and preference for HF animals and fear toward them accounted for 44% of the variance in WTO. And for Sentience ($F_{(2,\ 186)} = 43.12$, $p < 0.001$, adjusted $R^2 = 0.31$), the model indicates that in combination, the tendency to believe that HF animals have the capability to feel pain and suffering and fear toward them accounted for 31% of the variance in WTO.

Across all the models, fear significantly and positively predicted WTO. This contrasts with the multiple linear regression analysis results for LF animals. Furthermore, not all AA factors significantly and positively predicted WTO for HF animals. Only Affect significantly and positively predicted WTO, indicating that a 1 unit increase in affect is associated with a 2.07 increase in WTO snakes and spiders.

Table 2. Multiple linear regression on the relationship between AA and WTO – Low-fear animals.

Model	Variables	*b*	*SE*	95% CI	*β*	*t*	*p*
1	Cognition	0.91	0.32	[0.28, 1.55]	0.20	2.85	0.005**
	Fear	−0.45	0.31	[−1.07, 0.17]	−0.10	−1.43	0.16
2	Affect	2.27	0.22	[1.85, 2.70]	0.60	10.60	< 0.001***
	Fear	−0.27	0.26	[−0.78, 0.23]	−0.06	−1.07	0.29
3	Sentience	1.05	0.36	[0.34, 1.76]	0.20	2.93	0.004**
	Fear	−0.50	0.31	[−1.12, 0.12]	−0.11	−1.60	0.111

Note: AA = anthropomorphic attributions; WTO = willingness to own. **$p < 0.01$, ***$p < 0.001$.

Table 3. Multiple linear regression on the relationship between AA and WTO – High-fear animals.

Model	Variables	*b*	*SE*	95% CI	*β*	*t*	*p*
1	Cognition	−0.35	0.29	[−0.92, 0.22]	−0.07	−1.20	0.23
	Fear	−1.38	0.15	[−1.68, −1.09]	−0.57	−9.24	< 0.001***
2	Affect	2.07	0.30	[1.47, 2.66]	0.48	6.85	< 0.001***
	Fear	−0.60	0.17	[−0.94, −0.27]	−0.25	−3.54	< 0.001***
3	Sentience	0.39	0.29	[−0.18, 0.95]	0.09	1.36	0.18
	Fear	−1.30	0.15	[−1.60, −1.00]	−0.54	−8.63	< 0.001***

Note: AA = anthropomorphic attributions; WTO = willingness to own. ***$p < 0.001$.

The results for all the multiple linear regression analyses were only partially in line with Hypothesis 3 as the results varied per animal type: for LF, all AA factors significantly and positively predicted WTO, while for HF, only Affect significantly and positively predicted WTO.

The Moderating Role of Fear on the Relationship Between AA and WTO

Hypothesis 4 predicted that fear would moderate the relationship between animal attributions (cognition, affect, sentience) and willingness to own (LF/HF animals). Three moderation analyses each were conducted to investigate the moderating effect of fear on the relationship between each animal attribution on willingness to own (LF/HF animals), controlling for each AA that was not assigned as the independent variable in each model.

Low Fear

Each overall effect model was statistically significant (Table 4), but there was no significant interaction between each animal attribution and fear across the three moderation models. In summary, the impact of animal attributions on willingness to own LF animals was the same regardless of the fear level toward LF animals.

High Fear

Similar findings were observed for HF animals in the moderation analysis (Table 5). While each overall effect model was statistically significant, there was consistently no significant effect for the interaction between each animal attribution and fear on willingness to own HF animals. The impact of animal attributions on willingness to own HF animals was the same regardless of the fear level toward HF animals.

Table 4. The moderating role of fear on the relationship between AA and WTO – Low-fear animals.

		F	*df*	*p*	R^2
Cognition		29.56	(5, 199)	< 0.001**	0.43
Affect		29.30	(5, 199)	< 0.001**	0.42
Sentience		29.94	(5, 199)	< 0.001**	0.43
	b	*t*	*df*	*p*	95% CI
Cognition*fear	−0.42	−0.95	(199)	0.35	[−1.30, 0.46]
Affect*fear	0.11	0.40	(199)	0.69	[−0.45, 0.68]
Sentience*fear	0.58	1.41	(199)	0.16	[−0.23, 1.40]

Note: AA = anthropomorphic attributions; WTO = willingness to own. **$p < 0.01$.

Table 5. The moderating role of fear on the relationship between AA and WTO – High-fear animals.

		F	*df*	*p*	R^2
Cognition		47.40	(5, 190)	< 0.001**	0.56
Affect		47.64	(5, 190)	< 0.001**	0.56
Sentience		49.04	(5, 190)	< 0.001**	0.56
	b	*t*	*df*	*p*	95% CI
Cognition*fear	–0.12	–0.62	(190)	0.54	[–0.51, 0.27]
Affect*fear	–0.14	–0.96	(190)	0.34	[–0.15, 0.43]
Sentience*fear	0.31	2.01	(190)	0.05	[0.01, 0.60]

Note: AA = anthropomorphic attributions; WTO = willingness to own. **$p < 0.01$.

As such, these results for the moderation analysis are also not in line with Hypothesis 4. They indicate that fear did not moderate the relationship between AA and WTO for either LF or HF animals.

Discussion

With the advent of pet ownership of atypical animals such as snakes and spiders, which pose an adaptive threat to humans, discrepancies arise between the threat stimulus and willingness to own these animals as pets, thereby prompting the need to investigate factors that influence this choice. The current study examined the difference between willingness to own LF animals (cats and rabbits) and HF animals (snakes and spiders) on the basis of two sets of factors. One set of factors was cognitive vulnerabilities (CV): perceptions of dangerousness, disgustingness, uncontrollability, and unpredictability. Another set of factors was animal attributions (AA): perceptions of cognition, affect, and sentience. The results of this study yielded some meaningful understandings of willingness to own LF versus HF animals, highlighting the complexity of pet ownership motivations.

The findings partially support the hypothesis that CV would significantly and negatively predict WTO for both LF and HF animals. As per the CV model, each CV factor accounts for fear, which is related to aversion to fearful stimuli as a form of adaptive response (Krypotos et al., 2015). As fearful stimuli tend to evoke negative emotions, their avoidance would alleviate the negative emotions they provoke (Mowrer, 1939). Hence, a significant and negative association between CV factors and WTO are as expected, as the WTO would imply physical closeness and increased interaction with a stimulus that can potentially evoke discomfort. Furthermore, the results for LF animals further highlight the perceptions of individuals of cats and rabbits, which influences their attitudes toward them (such as WTO) rather than the animal's characteristics in itself. However, as aforementioned, only some CV factors were significantly and negatively related to WTO, with perceived disgustingness for LF animals and perceived uncontrollability and unpredictability for HF animals.

The results for HF animals are, in some ways, not surprising given the evolutionary threat significance of snakes and spiders (Martens et al., 2016; New & German, 2015). The human cognitive system is predisposed to quickly associate attentional resources with snakes and spiders (Van Strien, Eijlers, et al., 2014; Van Strien, Franken, et al., 2014). Furthermore, infants exhibit larger pupillary dilatation when exposed to pictures

of snakes versus fish and to pictures of spiders versus flowers (Hoehl et al., 2017). As such, this suggests that there is an innate, evolutionary sense of wariness/readiness toward these animals, which may thereby amplify perceived vulnerability toward them, leading to increased concerns about owning them as pets.

Previous studies show that HF animals tend to elicit more disgust, which is associated with lower willingness to approach them (Ouimet et al., 2017; Teachman & Woody, 2003), but the current findings emphasize the importance of perceived uncontrollability and unpredictability rather than disgustingness in the context of WTO snakes and spiders. Furthermore, perceived uncontrollability plays a significant role in pet ownership decisions (Kim & Chun, 2021).

In contrast, some of the results for LF animals are surprising. Cats and rabbits are commonly perceived as domesticated animals (Crespo & Faytong-Haro, 2022; Maurer, 2022; Rathish et al., 2022), which may explain why there was no statistically significant negative relationship between perceiving them as uncontrollable and WTO them. Additionally, the element of uncontrollability of cats appears to feature as an attraction and source of amusement in many cat videos (e.g., cats pushing objects off shelves, or jumping out and attacking people or other animals), and some argue that despite domestication cats might still be considered wild rather than tamed (Salisbury, 2022).

In contrast, the significant negative association between perception of LF animals as disgusting and WTO them is unsurprising, but it is plausible that cultural influences or other less-explored factors (Bahlig-Pieren & Turner, 1999; Zsido et al., 2022) could contribute to this aspect of pet aversion in cats and rabbits, warranting further investigation. Another plausible explanation for the lack of a significant relationship for either uncontrollability or disgustingness could be a floor effect, whereby there might be little actual variability amongst the sample. It may be more likely that this explanation applies to uncontrollability, given the relatively lower standard error across both LF and HF animals, as reported in Table 1.

Mediation findings reveal that fear does not always explain the relationship between cognitive vulnerabilities and WTO. In part, the mediation findings revealed that not all CV factors were associated with fear, as would be expected from the CV model. In the present study, associations of each CV factor with fear varied across animal group: for LF animals, only dangerousness and disgustingness were significantly and positively associated with fear, while for HF animals, only uncontrollability and disgustingness were positively associated with fear. This partial replication suggests that CV factors account for some variability in fear as proposed by Armfield (2006; Armfield & Mattiske, 1996).

Given that not all CV factors were significant and positively associated with fear, it follows that fear did not mediate the relationship between each CV factor and WTO uniformly, with the variability depending on the animal type. Specifically, fear only had a mediation effect for HF animals, fully explaining the significant and negative relationship between perception of HF animals as uncontrollable and WTO them and perception of them as disgusting and WTO. This suggests that while fear plays a critical mediating role in specific cases, the overall dynamics between the factors can differ depending on the animal type (LF or HF).

Considering the consistent significant and negative relationship between fear and WTO, along with its ability to mediate the relationship between some CV factors and WTO in HF animals, it somewhat suggests that fear is a crucial factor that negatively influences WTO. However, in the presence of other factors, this relationship becomes more complex. This is evident in the moderation analysis, wherein fear did moderate the relationship between each AA factor and WTO across LF and HF animals. Based on the results, regardless of fear, increased perception of the cognitive abilities of LF, as well as affect toward them, predicted a higher WTO. Furthermore, stronger likeness and attraction toward HF animals significantly predicted WTO, regardless of fear. These findings suggest that the isolated association of fear with WTO means that people may be less willing to own animals the more they fear them.

Attitudes toward animals are influenced by the animals' physical and behavioral characteristics (Powell & Ardaiolo, 2016): those with more human-like behaviors are more likely to be owned as pets (Rodriguez et al., 2021). In the context of this study, it helps to explain the positive relationship between affect toward LF animals and the WTO. It has been shown that people are attracted to infant-like features, such as large eyes and bulging cheeks (Archer & Monton, 2011), both of which can be present in cats and rabbits.

Although snakes were previously assumed to lack the physical characteristics that are attractive to humans (Azevedo et al., 2022), the results of the current study suggest that our predominantly Asian sample may perceive them differently. Research also shows that some snakes possess physical characteristics that people like, such as bright colors and complex disrupted patterns (Landová et al., 2018). As previously mentioned, cats and rabbits are commonly perceived to be domesticated and controllable, and these animals have some infant-like features. People may thereby be more inclined to overcome their fear toward them and are more willing to own them as pets. As for HF animals, this suggests underlying factors that may influence this relationship. Notably, a non-government organization in Singapore, Animal Concerns Research & Education (ACRES), shared the recruitment invitation for the current study on their LinkedIn page, suggesting that a number of animal advocates/conservationists completed the survey. Hence, this may partially explain the association between affect toward snakes and spiders and their WTO, regardless of fear.

Nevertheless, it suggests that those who hold an affinity for and interest in cats, rabbits, snakes, and spiders are more inclined to overcome their fears associated with them in the context of deciding to own them as pets. Research shows that exposure to an initially feared stimulus can reduce the fear elicited by that stimulus. For example, a study showed that fear of spiders was reduced with just an hour of direct exposure to them (Kashdan et al., 2012). Following this reduction in fear, it is possible for individuals to develop more affinity for the feared animal and potentially increase their interest in their welfare. On the other hand, the results may also suggest a lack of genuine interest in their welfare, potentially wanting to own them for utilitarian purposes (see Serpell, 2004). In their study in Indonesia, Kusrini et al. (2021) found that one of the reasons for keeping snakes as pets was curiosity. Regardless of the underlying motives of potential owners, the findings highlight that pet ownership decisions are strongly influenced by

affect toward the animals to the extent that the decision remains unchanged despite fear of the animal.

Limitations and Future Research Direction

The current study grouped animals into LF and HF animals and obtained the WTO score by averaging across the two specific animals selected to represent each category. This may be a potential limitation as there may be differences amongst people who want to own snakes versus wanting to own spiders, as well as for cats versus rabbits. For instance, the mean scores for WTO snakes appeared to be much higher than WTO spiders. Likewise, the scores for each CV factor were also averaged per animal group. This approach assumes uniformity in CV perceptions across each category, whereas Armfield (2007) investigated the perception of each animal independently.

The main objective of the current study was to examine the influence of cognitive vulnerabilities and of animal sentience on willingness to own the two groups of animals. As per the previous literature, pet ownership and willingness to own LF animals have been extensively researched relative to pet ownership and willingness to own HF animals such as snakes and spiders. The present study aimed to explore the predictive capability of perceptions of both HF animals and LF animals in order to gain meaningful insight into some differences between the two animal groups with respect to willingness to own them, which is a unique feature of the study. Nonetheless, our data were sufficient to run separate mediation analyses for each of the four species, and a summary of those findings is available as online supplemental material (Figures S1–4, Table S1). In summary, the individual results largely align with the composite findings, with only a few notable deviations.

Examining the relationship between fear and willingness to own HF animals in isolation reveals a generally negative relationship. However, this relationship becomes more complex in consideration of other CV factors as well as animal type (LF or HF). Given that fear mediates the negative relationship between perceiving HF animals as disgusting and WTO them as well as perceiving them as uncontrollable and WTO them, this suggests the potential for educational interventions or initiatives that target perceptions of disgust and uncontrollableness, which could help reduce fear, potentially leading to greater openness toward owning HF animals. While further research is needed to confirm this effect, such approaches may provide a promising direction for fostering more positive attitudes toward HF animals.

Conclusion

The results of this study reveal the complexity of pet ownership decisions. It reveals that while fear deters willingness to own pets, affect toward the animal plays a significant role in overriding those fears. The findings shed light on the importance of educating the public and potential pet owners on responsible pet ownership, especially on atypical pets such as snakes and spiders. The results of the current study can be used by animal welfare organizations and educational institutions to focus on education and outreach programs in efforts to cultivate positive perceptions of cognition and sentience toward

these atypical pets, ultimately advancing their welfare and cultivating a more knowledgeable attitude toward their ownership and conservation.

Data Availability Statement

Research data supporting this publication are available from the Research Data JCU repository located at https://doi.org/10.25903/tvcv-c322.

Disclosure Statement

No potential conflict of interest was reported by the authors.

ORCID

Denise B. Dillon http://orcid.org/0000-0003-0191-7841

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