
AI translation · View original & related papers at
chinaxiv.org/items/chinaxiv-202406.00246

Pet Owners' Pet-Self and Its Memory Processing Advantage

Authors: Xu Kepeng, Chen Jiali, Xue Hong, Ou Qianqian, Han Zhenhua, Zhang Jijia, Xu Yan, Zhang Shuyue, Zhang Shuyue

Date: 2024-06-15T00:00:00+00:00

Abstract

Positive human-pet relationships can bring numerous benefits to humans, yet the underlying mechanisms of intimate and significant human-pet relationships remain unclear. This article investigates pet owners' pet-self and its memory processing advantages through three studies. The results revealed: (1) Compared with non-pet owners, pet owners integrate pets into their self-concept, forming a pet-self, with anthropomorphism playing a mediating role. (2) Pet owners exhibit stronger memory processing advantages for pet-related information, with recognition rates under pet reference significantly higher than those under celebrity reference and semantic reference, and comparable to recognition rates under self-reference and mother reference. (3) The LPC amplitude evoked under pet reference was significantly higher than that under celebrity reference, yet similar to that under mother reference and significantly lower than that under self-reference. The overall study demonstrates that pet owners perceive pets as part of themselves, forming a pet-self and exhibiting a pet reference effect in memory; however, the pet-self remains at a certain distance from the core self.

Full Text

Preamble: Self-Check Report for Acta Psychologica Sinica

Please complete the following items and paste them on the first page of your manuscript.

1. List up to three innovative contributions of this study in the form of "Research Highlights," with a total word count not exceeding 200 words.

The goal of Acta Psychologica Sinica is to publish cutting-edge psychological research that is "both scientifically excellent and of particularly broad interest and significance." If your study only makes minor incremental contributions,

does not attempt to open new areas of inquiry, or propose unique and innovative perspectives—especially if it merely investigates algorithms or technologies without addressing clear psychological questions—such research has a low probability of acceptance and we recommend submitting to other journals.

Response: (1) This study extends the concept of relational self from human relationships to pet relationships by examining pet owners' self-concept and memory reference processing, thereby contributing to a deeper understanding of the relationship between self and memory, advancing self-related theory, and injecting new meaning into the Chinese differential mode of self in relationships. (2) This study found that in intimate human-pet relationships, pet owners tend to treat pets as significant others, forming a unique pet self. This pet self is essentially a relational self that remains at a certain distance from the core self and cannot surpass the mother in importance. (3) This study extends the significant other reference effect to pets for the first time, confirming the important influence of pets on pet owners and providing a reasonable explanation for the underlying mechanisms of intimate human-pet relationships.

2. Have you published or submitted any articles using the same data as this study? If yes, please attach them for review. (We do not encourage authors to publish multiple articles using the same data with identical variables, nor do we encourage splitting a series of related studies into multiple publications.)

3. Non-experimental, non-intervention studies in management, clinical, personality, and social psychology that rely solely on self-report (questionnaire) methods need to examine common method bias. What methods did you use to control or demonstrate that such bias would not affect the validity of your conclusions? What measures did you take? (For literature on common method bias, see: <http://journal.psych.ac.cn/xlkxjz/CN/abstract/abstract894.shtml>) Studies based on cross-sectional data, using only self-reports, and measured in convenience samples are easy to conduct but typically have limited innovative value and low probability of acceptance.

Response: This study employed behavioral experiments and ERP technology.

4. Did you report and analyze effect sizes (e.g., Cohen's d for t -tests, η^2 or f^2 for ANOVA, standardized regression coefficients)? (Many studies mechanically report effect sizes without necessary analysis or explanation, such as whether the effect size is small, medium, or large, or its theoretical/applied significance.) (Search "effect size calculator" on Google for convenient apps. For explanations of effect sizes in Chinese, see: <http://journal.psych.ac.cn/xlkxjz/CN/abstract/abstract1150.shtml>; in English: <http://www.uccs.edu/lbecker/effect-size.html>) Did you report 95% CIs for statistical analyses? (e.g., 95% CI for differences, correlation/regression coefficients) For calculations and graphing of confidence intervals, see <https://thenewstatistics.com/itns/esci/>

5. Please state the planned sample size and actual sample size. If they differ, please explain why. Previous psychological research has suffered from low statistical power due to insufficient sample sizes. We recommend explaining in the Methods section the basis for your sample size calculation. Sample size should be determined based on a justified effect size and desired power, with reporting of calculation software or procedures. For rationale and practices regarding sample size planning, see <https://osf.io/5awp4/>

Response: The experiment included 52 participants, with 26 pet owners and 26 non-pet owners. Using a two-factor mixed design, sensitivity analysis was conducted in G*Power 3.1. With a sample size of 52, significance level of 0.05, and desired power of 80%, the effect size was 0.15.

6. In hypothesis testing, if using Null Hypothesis Significance Testing (NHST), report exact p-values rather than p-value ranges (report ranges only when $p < 0.001$, otherwise report exact values). Does your paper meet this requirement? If using Bayes factors, have you reported their sensitivity to prior distribution assumptions?

7. If you excluded any data in statistical analysis, did you report this in the paper? What were the reasons? How would results change if these data were included? How were missing data handled? When using scales, did you delete any individual items? Why? How would results change if these items were included? Were any measured items or variables not reported? Why? Please indicate where in the paper this is addressed.

Response: In Study 3, 34 participants were recruited, but 5 were excluded due to excessive EEG artifacts, leaving 29 participants. This is fully reported in the Participants section of Study 3.

8. Are any experimental materials, scales, or questionnaires that have not undergone peer review attached at the end of the file for review? If not, please explain why. If this article is published, are you willing to share these materials with other researchers?

9. This journal requires authors to provide raw data. Please select one option:

() <https://osf.io/5qjus/>.

c) Raw data and programs have been shared on the Psychological Science Data Bank (<https://psych.scidb.cn/>)

d) If unable to provide, please explain reasons or provide relevant proof.

10. Is your study a clinical intervention or laboratory experiment?
Yes () No ()

If yes, please provide pre-registration number: 202406.00008

If no, please explain why.

Note: Clinical intervention or laboratory experiments should be pre-registered

before data collection. Other experimental studies are also encouraged to pre-register. Pre-registration requires stating all research hypotheses and their support, plus detailed experimental/intervention procedures. This journal's pre-registration website is <https://os.psych.ac.cn/preregister> (see "Download Center" on the journal website for instructions) or <https://osf.io/> or <https://aspredicted.org/>. Pre-registration significantly increases acceptance probability. For importance of pre-registration, see <https://osf.io/5awp4/>

11. If your study used human or animal subjects, was it approved by your institution's ethics committee? If yes, please send a scanned copy to the editorial office email. If no, please explain why.

12. Did you write a 400-500 word English abstract following the "English Abstract Writing Guidelines" posted on the editorial website? Has the English title and abstract been reviewed by a proficient English speaker or professionally edited by an SCI/SSCI editing service?

13. If the first author is a student, please have the advisor send a separate email to xuebao@psych.ac.cn stating they have read the paper and carefully reviewed it. Have you reminded your advisor to send this email? (The editorial office will only consider the manuscript for processing after receiving the advisor's email.)

Response: The advisor is the first author.

14. Please download and complete the "Manuscript Non-Confidentiality Certificate" from the "Download Center" on the right side of the journal website homepage, stamp it with the confidentiality office seal of the corresponding author's institution, and send a scanned copy to the editorial office email (xuebao@psych.ac.cn). If there is no confidentiality office seal, please use the institution's official seal. Have you sent the email?

Pet Owners' Pet Self and Memory Processing Advantages

Abstract

Good human-pet relationships can bring numerous benefits to humans, yet the internal mechanisms of intimate and important human-pet relationships remain unclear. This paper investigates pet owners' pet self and its memory processing advantages through three studies. The results show: (1) Compared with non-pet owners, pet owners integrate pets into their self-concept, forming a pet self, with anthropomorphism playing a mediating role. (2) Pet owners demonstrate stronger memory processing advantages for pet-related information, with recognition rates under pet reference significantly higher than under celebrity and semantic references, and similar to those under self and mother references. (3) The LPC amplitude evoked under pet reference is significantly higher than un-

der celebrity reference, similar to mother reference, but significantly lower than self reference. Overall, this research demonstrates that pet owners view pets as part of themselves, forming a pet self and exhibiting a pet reference effect in memory. However, the pet self is essentially a relational self that remains at a certain distance from the core self.

Keywords: pet owner; pet self; pet reference effect

With rapid economic development and changing lifestyles, an increasing number of pets have entered people's lives, playing important roles in companionship, emotional connection, and communication. Approximately 59% of UK households (PFMA, 2021) and two-thirds of US households (APPA, 2020) own at least one pet. China's pet population is growing rapidly, from 130 million in 2016 to 220 million in 2022 (ASKCI, 2022). Most pet owners consider pets as family members, revealing changes in contemporary Chinese family structures and reflecting modern emotional voids, particularly for people living alone away from home or empty-nest elderly lacking companionship. Pets serve as emotional outlets, even leading to social phenomena such as pet retirement and pet ownership influencing fertility intentions (Laurent-Simpson, 2017). Current research on human-pet relationships primarily focuses on pets' impact on human well-being (McConnell, Lloyd & Humphrey, 2019), human-pet attachment (Zilcha-Mano, Mikulincer, & Shaver, 2011), and people's attitudes toward pets (Ellingsen et al., 2010). As pets increasingly enter human life, their moral status is also undergoing subtle changes (Xu et al., 2023), yet few studies have examined the relationship between pets and individual self-concept. Research shows that as the human self expands, it can grow to include oneself, significant others, and in-groups (Zhou & Su, 2008). Pet owners increasingly tend to view pets as "individuals" with status similar to humans rather than ordinary "creatures," classifying pets as in-group members and incorporating them as part of the in-group. Pets are no longer merely objects to be fed and cared for but have become family members with emotional status and rights similar to family members (Kubinyi, Turcsán, & Miklósi, 2009), even regarded as their children (Berryman, Howells, & Lloyd-Evans, 1985). At this point, pets' characteristics, moral status, and other information are likely integrated into pet owners' self-concept, becoming part of the self.

1.1 The Relationship Between Pets and Pet Owners' Self-Concept

Pets are an indispensable part of most pet owners' lives, except for passive pet owners (those whose family members like pets but they themselves do not, passively accepting the situation). Therefore, "pet owners" in this paper mainly refers to those who actively and positively raise pets. Raising pets can bring joy (Kanat-Maymon et al., 2021), reduce psychological isolation, and fulfill emotional and social needs, providing spiritual sustenance (Brown et al., 2016). Psychological kinship theory posits that pet owners cognitively and behaviorally treat pets as family members regardless of actual genetic relationships (Bailey, 1988). Through long-term intimate coexistence, pet owners establish special

human-pet emotional attachments, viewing pets as psychological kin. From a relational perspective, this represents a special form of human-pet “blood relationship.” The intimate relationship between pets and owners may stem from the unconditional, non-judgmental love and acceptance owners receive from pets, fostering attachment security that extends interpersonal models to human-pet relationships (Green, Coy, & Mathews, 2018). Due to this extended social model, pet owners may experience a range of negative emotions when pets die, such as stress, anxiety, and grief; these emotions can even cause psychological damage, trauma, and in some cases trigger suicidal ideation (Axelrod, 2020; Compitus, 2019). To help alleviate the pain of losing a pet, an Australian company provides employees with “pet bereavement leave” (DailyMail, 2023). Overall, it is extremely difficult for pet owners to sever ties with pets, likely because they have already integrated pets into their self-concept.

Self-expansion theory posits that incorporating intimate significant others into the self is a means of self-enhancement, allowing resources, perspectives, and identities originally belonging to significant others to enter the self, making significant others part of the self to some extent (Aron et al., 2004). Currently, research on significant others has extended to mothers, fathers, spouses, parent-child relationships, aunts, etc. (Guan & Chi, 2006; Qi & Zhu, 2002; Yang et al., 2019; Wang et al., 2019). In fact, given the intimate and important relationship between pet owners and pets, pet owners likely incorporate pets into the self through relational self. However, triple self-construction theory only discusses self at the human level (Brewer & Gardner, 1996), without exploring whether other species can be included in the self. Pet owners already view their pets as individuals (not just pets) with the same social status as humans, thus forming a group consciousness of “we” (Allen et al., 2019; Epley et al., 2008). Under this consciousness, pet owners are likely to incorporate pets into the self, forming a unique pet self and showing special attachment relationships toward pets. Therefore, we propose:

H1: Participant type positively predicts individuals’ incorporation of pets into the self. Compared with non-pet owners, pet owners are more willing to incorporate pets into the self.

1.2 The Anthropomorphism Pathway to Pet Self

In addition to pet owner status being a necessary factor for pet self formation, anthropomorphic perception of pets also appears to play an important role. Anthropomorphism refers to attributing human traits to non-human entities and perceiving them as human (Aggarwal & McGill, 2007). Research also indicates that pet owners view pets as human (Irvine & Cilia, 2017), thereby achieving self-expansion through pets and making pets part of self-identity (Jyrinki & Leipämaa-Leskinen, 2006). The practice of keeping domestic animals as companions inevitably involves some degree of anthropomorphism: most owners name pets, talk to them, photograph them, treat their illnesses, and mourn them when they die (Serpell, 1996). Viewing pets as family members enhances pet owners’

well-being more than viewing them as merely human-related (McConnell, Lloyd & Humphrey, 2019). In long-term cohabitation, pet owners anthropomorphize pets and view them as life companions, completing a perspective shift from pets as animal “objects” to anthropomorphized “subjects,” with the purpose of pet ownership shifting from pets serving the self to the self serving pets (Paul et al., 2014). Compared with non-pet owners, pet owners are more willing to describe animals with personality adjectives and attribute emotional feelings and desires to pets (Kiesler, Lee, & Kramer, 2006). People choose which pets to keep primarily based on animals’ similarity to humans (Tisdell et al., 2006); for example, people are more willing to accept animals with mental capacities closer to humans, such as cats and dogs. Through anthropomorphic traits, interactions between pet owners and pets become richer and more meaningful, with pets becoming an indispensable part of owners’ emotional worlds. Unlike pet owners, non-pet owners do not actively seek contact with pets. Therefore, compared with non-pet owners, pet owners are more likely to anthropomorphize pets, and this anthropomorphic perception may influence whether individuals form a pet self. Accordingly, we propose:

H2: Anthropomorphism mediates the effect of participant type on incorporating pets into the self. Compared with non-pet owners, pet owners perceive pets as having more anthropomorphic traits and are more willing to incorporate pets into the self.

1.3 Memory Processing Advantages of the Pet Self

An important function of the self is to help individuals process self-related information (Sui & Gu, 2017). When individuals are in a self-related context, the self-processing system is immediately activated, forming a special information processing pattern. Previous research has confirmed that self-related information has processing advantages in attention, memory, and perception (Cunningham & Turk, 2017; Klein, 2012). Numerous studies have found a self-reference effect (SRE) in memory, showing that individuals have better memory for self-related stimuli (Jackson et al., 2019; Rogers et al., 1977). Bower and Gilligan’s (1979) autobiographical recall task also found self-reference processing advantages. Yaoi et al. (2021) noted that even when one’s own name appears as a transient stimulus, it can trigger the self-reference effect, which can be activated unconsciously and applied to other items (Yaoi et al., 2021). Research on SRE has extended to significant other reference effects, such as parents, friends, and parent-child relationships.

Research shows that pet owners view pets as human (Irvine & Cilia, 2017), and in pet owners’ minds, pets are already one of their family members (Kubinyi, Turcsán, & Miklósi, 2009). Therefore, if pet owners show memory processing advantages when facing pet-related information, it indicates that pets are similar to intimate others and part of pet owners’ self-concept. Thus, we propose Hypothesis 3: Pet owners will show pet advantages in information processing under pet reference. Compared with non-pet owners, pet owners’ adjective recognition

rates under pet reference will be significantly higher than under celebrity and semantic conditions, with no significant differences compared to self and mother reference conditions.

In recent years, neuropsychology (Turk et al., 2002), neuroimaging (Ng et al., 2010), and electrophysiological methods (Gray, 2004) have been widely applied to self-processing research. Neuroimaging studies show that specific brain structures such as the anterior cingulate cortex (ACC) and posterior cingulate cortex (PCC) are involved in self-reference processing (Gillihan & Farah, 2005). Additionally, event-related potentials (ERP), with their extremely high temporal resolution and special evoked potential characteristics, are widely used to study self, relational, and collective reference effect processing (Li et al., 2016; Zhong et al., 2014). Some studies find that self-knowledge judgment (Zhong et al., 2014), survival thoughts (Yuan et al., 2018), and self-related information (Tanguay et al., 2017) evoke larger LPC amplitudes, with LPC reflecting sustained cognitive resource investment and information storage (Fields & Kuperberg, 2016). When individuals judge personality trait words, they continuously allocate attentional resources to self-related information (Kotowska & Nowicka, 2016). Therefore, when pet owners process pet-related information, they may generate LPC components similar to self-judgment and mother-judgment. Thus, we propose Hypothesis 4: In personality trait word judgment tasks, compared with celebrity reference, pet owners will evoke larger LPC amplitudes under pet reference.

In summary, to test whether pet owners have a pet self, this research uses three studies to explore the relationship between pets and pet owners' self-concept and its memory processing advantages. Study 1 examines whether pet owners' pet self exists and the role of anthropomorphic perception in this pathway (testing H1, H2). Study 2 investigates pet owners' memory processing advantages under pet reference (testing H3). Study 3 uses ERP technology to explore the electrophysiological basis of pet owners' pet self memory processing advantages (testing H4).

Study 1: The Relationship Between Pet Self and Anthropomorphism

2.1 Participants

Using snowball sampling, participants were recruited online through Qualtrics. Based on responses to demographic questions “Do you own a pet?” and “Does your family own a pet?”, pet owners and non-pet owners were selected. The final sample size was $N = 332$, including 166 pet owners and 166 non-pet owners; 85.5% were female, aged 14-46 years ($M_{age} = 19.73$; $SD_{age} = 2.34$).

2.2 Measures

(1) Self-Concept Questionnaire

The self-concept questionnaire measured individuals' willingness to incorporate pets into the self. The questionnaire was adapted from container metaphor experiments (Wang et al., 2018). The inner circle represents the individual's self, while the outer circle includes people or animals potentially important to the individual. Participants were asked to fill the circle with people or things they were willing to include in the self, keeping the number inside and outside the circle equal. The questionnaire only focused on how participants placed pets, using a dichotomous scoring method (0 = outside the circle; 1 = inside the circle).

(2) IOS Scale

The Inclusion of Other in the Self Scale (IOS) assessed the degree to which individuals incorporated pets into the self. Developed by Aron et al. (1992), the IOS measures self-other overlap and can be used in individual (Carpenter & Spottswood, 2013) and cross-group research (Paolini et al., 2016). In this study, one circle in each pair represented "self" and the other represented "pet." Seven pairs of circles with increasing overlap were presented; greater overlap indicated closer connection between individual and pet and higher degree of incorporation into the self.

(3) Individual Differences in Anthropomorphism Questionnaire (IDAQ)

The IDAQ (Waytz et al., 2010) includes three common anthropomorphism targets: nonhuman animals, natural entities, and technological devices. Each target is assessed across five dimensions: consciousness, free will, intentions, mindedness, and emotions, totaling 15 items. Since this study only involved pet anthropomorphism, only the nonhuman animal target was measured, comprising 5 items scored on an 11-point scale from 0 ("not at all") to 10 ("very much"), with higher scores indicating stronger anthropomorphism tendencies. Cronbach's $\alpha = 0.89$ in this study.

2.3 Results

2.3.1 Chi-Square Analysis A chi-square analysis was conducted with whether individuals incorporated pets into the self as the dependent variable. Results showed a significant main effect of participant type ($\chi^2 = 17.65$, $p < 0.001$). Compared with non-pet owners, pet owners were more willing to incorporate pets into the self (see Table 1).

Table 1 Chi-square analysis of willingness to incorporate pets into the self

An ANOVA with IOS-measured degree of incorporating pets into the self as the dependent variable showed a significant main effect of participant type, $F(1, 331) = 69.87$, $p < 0.001$. Pet owners ($M = 4.81 \pm 1.58$) showed greater overlap between pet and self than non-pet owners ($M = 3.36 \pm 1.79$), indicating deeper

incorporation of pets into the self.

2.3.2 Mediation Analysis To test the mediating role of anthropomorphism between participant type and degree of incorporating pets into the self, Hayes' PROCESS 4.1 Model 4 was used. Results showed that participant type significantly predicted pet anthropomorphism ($a = 0.72$, $SE = 0.21$, $p < 0.001$). Anthropomorphism significantly predicted degree of incorporating pets into the self ($b = 0.26$, $SE = 0.05$, $p < 0.001$). The total effect of participant type on incorporating pets into the self was 1.55, with 95% CI [1.18, 1.91] not containing 0. The direct effect was 1.36, with 95% CI [1.01, 1.72] not containing 0, accounting for 88% of the total effect. The indirect effect through anthropomorphism was 0.19, with 95% CI [0.07, 0.33] not containing 0, indicating significant mediation accounting for 12% of the total effect. The mediation model is shown in Figure 1 [Figure 1: see original paper].

Figure 1. Mediating role of anthropomorphism between participant type and degree of incorporating pets into the self (Note: *** $p < 0.001$)

2.4 Summary

Study 1 found that compared with non-pet owners, pet owners perceive greater overlap between pets and self and are more inclined to incorporate pets into the self, with pet “anthropomorphism” playing a mediating role. When pet owners perceive pets as more anthropomorphic, they are more willing to incorporate them into the self. Study 1 preliminarily confirmed the existence of pet self in human-pet relationships and found that anthropomorphism plays an important role in pet self formation. Consistently, previous research found that viewing pets as family members enhances perceived social support from pets, thereby increasing owners' well-being (McConnell, Lloyd & Humphrey, 2019). Since pet owners and non-pet owners have non-overlapping social circles, people form different personal pet views that are continuously reinforced. Does pet self affect memory processing? Study 2 uses the classic R/K paradigm to examine whether pet owners show special pet information processing advantages—that is, the pet reference effect. If the pet reference effect emerges, it provides further experimental evidence for the existence of pet owners' pet self.

Study 2: The Pet Reference Effect in Memory

3.1 Participants

Fifty-two participants were recruited using random sampling, including 12 males and 40 females, with a mean age of 21.5 ± 0.30 years. Among them, 26 were pet owners and 26 were non-pet owners. Using a two-factor mixed design, sensitivity analysis in G*Power 3.1 with a sample size of 52, significance level of 0.05, and desired power of 80% yielded an effect size of 0.15.

3.2 Experimental Design

A 2 (participant type: pet owner, non-pet owner) \times 5 (information type: self, mother, pet, celebrity, semantic) mixed design was employed.

3.3 Materials

Based on Zhou et al. (2013), 400 two-character Chinese personality trait adjectives with moderate frequency (0.00023-0.00153) that could describe Chinese people were selected from the *Modern Chinese Word Frequency Dictionary*. All words were two-character Chinese adjectives matched on valence, frequency, length, and familiarity. Sixty-one sophomore psychology students (who did not participate in the formal experiment) evaluated whether the 400 adjectives could describe both people and animals. The final set included 310 two-character trait words. Ten were used for practice, and the remaining 300 were divided into two groups of 150 words each (75 positive, 75 negative), balanced across five information types (self, mother, pet, celebrity, semantic) with random balanced presentation order.

3.4 Procedure

The experiment consisted of three phases: learning, distraction, and recognition. The experimental flow is shown in Figure 2 [Figure 2: see original paper].

(1) Learning Phase: A fixation cross “+” was presented for 500 ms, followed by random presentation of one of four information type questions: self-reference (“Is this word suitable to describe yourself?”); mother reference (“Is this word suitable to describe your mother?”); pet reference (“Is this word suitable to describe your pet?”); celebrity reference (“Is this word suitable to describe Lu Xun?”); or semantic processing task requiring judgment of whether personality adjectives were positive or negative (“Is this a positive/negative word?”). The question was presented for 2000 ms. After a 300 ms fixation cross, a black screen appeared for a random duration of 300-500 ms, followed by a two-character adjective (e.g., “gentle”) for 1500 ms as the stimulus, and finally a 1000 ms black screen. After stimulus presentation, participants made yes/no judgments based on the preceding reference question (“yes” = J key, “no” = F key, counterbalanced across participants). The stimulus disappeared after the key press or after 1500 ms, then the next trial began.

(2) Distraction Phase: Participants completed a five-minute Raven’s reasoning test.

(3) Test Phase: Participants were informed that a series of adjectives would appear, some from the learning phase and some new. They first judged whether they had seen each adjective (“seen” = Q key, “not seen” = P key). For “seen” adjectives, they further judged whether they “Remembered (R)” or “Knew (K)” it. “Remember (R)” meant clearly recalling details about the word. “Know (K)” meant confirming the adjective appeared in the learning phase but being unable

to recall specific details. All stimuli were presented in “auto+response disappearance” mode, with learned and distractor adjectives mixed and randomly presented for 2000 ms. After each judgment, the next word appeared automatically. The test ended with a thank-you message. Testing lasted approximately 40 minutes.

3.5 Results and Analysis

(1) Overall Recognition Rate: A 2 (participant type: pet owner, non-pet owner) \times 5 (information type: self, mother, pet, semantic, celebrity) repeated measures ANOVA on overall recognition rate showed a significant main effect of information type, $F(1, 47) = 12.61$, $p < 0.001$, $p^2 = 0.20$. The main effect of participant type was not significant, $F(1, 47) = 0.90$, $p > 0.05$. The interaction between information type and participant type was significant, $F(1, 47) = 4.71$, $p = 0.001$, $p^2 = 0.09$. Simple effects analysis revealed that non-pet owners’ recognition rates under self-reference and mother-reference were significantly higher than under pet, semantic, and celebrity references, $ps < 0.01$, with no significant differences between pet reference and semantic or celebrity references, $ps > 0.05$. Pet owners’ recognition rates under self-reference ($p = 0.015$), pet reference ($p < 0.001$), and mother reference ($p = 0.006$) were significantly higher than under semantic reference; recognition rates under self-reference ($p = 0.004$), pet reference ($p = 0.003$), and mother reference ($p = 0.008$) were significantly higher than under celebrity reference; with no significant differences between pet reference and self-reference or mother reference, $ps > 0.05$.

(2) R Recognition Rate: ANOVA showed a significant main effect of information type, $F(1, 47) = 20.91$, $p < 0.001$, $p^2 = 0.30$. The main effect of participant type was not significant, $F(1, 47) = 0.07$, $p > 0.05$. The interaction between information type and participant type was marginally significant, $F(1, 47) = 2.35$, $p = 0.056$, $p^2 = 0.05$. Simple effects analysis found that non-pet owners’ R recognition rates under self-reference and mother reference were significantly higher than under pet, semantic, and celebrity references, $ps < 0.01$, with no significant differences between pet reference and semantic or celebrity references, $ps > 0.05$. Pet owners’ R recognition rates under self-reference ($p < 0.001$), pet reference ($p = 0.001$), and mother reference ($p < 0.001$) were significantly higher than under semantic and celebrity references, with no significant differences between pet reference and self-reference or mother reference, $ps > 0.05$. See Table 2 for detailed results.

(3) K Recognition Rate: All main effects and interactions were not significant, $ps > 0.05$.

Table 2 Correct recall rates for pet owners vs. non-pet owners across information types

Information Type	Pet Owners	Non-Pet Owners
	R Rate	K Rate
Self	0.73 (0.02)	0.46 (0.04)
Mother	0.69 (0.02)	0.46 (0.04)
Pet	0.62 (0.02)	0.37 (0.03)
Celebrity	0.60 (0.03)	0.37 (0.04)
Semantic	0.65 (0.03)	0.35 (0.04)

Note: Numbers in parentheses are standard deviations.

3.6 Summary

Study 2 confirmed the existence of the pet reference effect at the behavioral level, demonstrating that pet owners indeed incorporate pets into the self. When using personality trait words to describe pets, pet owners' recognition rates under pet reference were significantly higher than under celebrity and semantic references, with no significant differences compared to self-reference and mother reference. This indicates that pet owners showed pet reference processing advantages similar to self-reference and mother reference, reflecting that pet owners do anthropomorphize pets. ERP research has found gradient differences in significant other reference effects, with information about others of different intimacy levels receiving different degrees of processing (Bi, 2020). Study 2 found that pet owners showed a pet reference effect, but whether this processing advantage differs from mother and self processing advantages remains unknown. Study 3 uses ERP technology with a personality trait word judgment paradigm to explore the electrophysiological basis of pet self and pets' position in pet owners' "self."

Study 3: Electrophysiological Basis of Pet Self

4.1 Participants

Thirty-four participants were recruited, all of whom incorporated pets into the self on the self-concept questionnaire and had moderate-to-high human-pet relationship intimacy. Twenty-three participants (average age 21.21 ± 1.45 years) were included after excluding those with excessive EEG artifacts. All had owned pets for over one year and had recent intimate contact with pets. All were right-handed with normal or corrected-to-normal vision, no head injuries, and no recent injuries.

4.2 Design

A single-factor within-subjects design was used, with information type (self, mother, pet, celebrity) as the independent variable and ERP component amplitude and latency at selected electrodes as dependent variables.

4.3 Materials and Procedure

Materials were the same as in Study 2. Participants sat 120 cm from the monitor with horizontal and vertical viewing angles less than 5°. All stimuli were presented as black text on white background in 32-point Song font at the center of the screen. Participants were told this was a personality trait adjective judgment test and were asked to respond as quickly as possible whether each adjective matched the information type (see Figure 3 [Figure 3: see original paper]). The experiment consisted of 4 blocks, each including 80 adjective judgment trials. In each trial, a fixation cross “+” appeared for 500 ms, followed by random presentation of one of four reference questions: self-reference (“Is this word suitable to describe yourself?”); mother reference (“Is this word suitable to describe your mother?”); pet reference (“Is this word suitable to describe your pet?”); or celebrity reference (“Is this word suitable to describe Lu Xun?”). The question was presented for 2000 ms. After a 300 ms fixation cross, a black screen appeared for 300-500 ms, followed by a two-character adjective (e.g., “flexible”) for 1500 ms as the stimulus, and finally a 1000 ms black screen. Participants made yes/no judgments (“yes” = 1 key, “no” = 5 key). The stimulus disappeared after the key press or after 1500 ms, then the next trial began.

4.4 Environment and Apparatus

The experimental program was written in E-Prime. The formal experiment was conducted in an EEG laboratory with a quiet environment, appropriate lighting, and good ventilation, with the experimenter and participant in separate rooms. Two computers were used to run the program and record data, along with a 128-channel electrode cap and EEG acquisition and analysis software from EGI.

4.5 Results and Analysis

EEG data from 128 electrodes using the Hydrocel Geodesic Sensor Net were collected and processed with Netstation Acquisition software version 4.4.2 at a sampling rate of 500 Hz. Electrode impedance was adjusted below 50 k Ω before recording. A bandpass filter of 0.1-100 Hz was applied. Epochs were extracted starting 100 ms before stimulus onset and lasting 1100 ms. Based on grand-averaged waveforms across all participants, ERP data were analyzed (see Figure 4 [Figure 4: see original paper]). The LPC component (500-900 ms) was measured and analyzed at nine electrode sites (F3, Fz, F4, C3, Cz, C4, P3, Pz, P4). Electrodes were recorded as: electrode position (frontal: F3, Fz, F4; central: C3, Cz, C4; parietal: P3, Pz, P4) and laterality (left: F3, C3, P3; midline: Fz, Cz, Pz; right: F4, C4, P4). Statistical analyses were conducted in SPSS 24.0, analyzing LPC amplitude and latency with Greenhouse-Geisser correction for ANOVA p-values.

LPC (500-900 ms): A 4 (information type: self, mother, pet, celebrity) \times 3 (electrode position: frontal, central, parietal) \times 3 (laterality: left, midline, right) repeated measures ANOVA on mean amplitude showed a significant main

effect of information type, $F(3, 26) = 11.94$, $p < 0.001$, $p^2 = 0.58$. LPC amplitude under pet reference was significantly lower than under self-reference ($p = 0.003$), significantly higher than under celebrity reference ($p = 0.01$), and not significantly different from mother reference ($p > 0.05$). Celebrity reference was significantly lower than self-reference and mother reference ($ps < 0.001$), with no significant difference between self-reference and mother reference ($p > 0.05$).

The main effect of electrode position was significant, $F(2, 27) = 14.19$, $p < 0.001$, $p^2 = 0.51$. LPC amplitude at frontal sites was significantly higher than at central ($p < 0.001$) and parietal sites ($p < 0.001$), with no significant difference between central and parietal sites ($p > 0.05$). No significant effects were found for laterality or any interactions, $ps > 0.05$. Mean LPC amplitudes and standard deviations under each condition are shown in Table 3 .

A repeated measures ANOVA on latency with the same factors showed no significant main effects or interactions, $ps > 0.05$.

Table 3 Mean amplitude and standard deviation of LPC under each experimental condition ($M \pm SD$, V)

Information Type	Frontal	Central	Parietal
Self	0.28 (0.30)	0.25 (0.26)	0.22 (0.24)
Mother	0.24 (0.25)	0.23 (0.24)	0.20 (0.24)
Pet	0.28 (0.29)	0.27 (0.27)	0.25 (0.25)
Celebrity	0.29 (0.27)	0.27 (0.26)	0.25 (0.25)

4.6 Summary

This study used a personality trait word judgment task to explore relational self-reference effects under different information types, examining pet owners' pet reference processing characteristics. ERP results showed that compared with celebrity reference information, pet owners evoked larger LPC amplitudes under pet reference information, showing pet reference processing advantages. Compared with self-reference information, pet owners evoked smaller LPC amplitudes under pet reference information, with no significant difference from mother reference information. In self research, whether P300 or LPC is selected as the research indicator depends on task difficulty and required processing time. In personality trait word judgment, participants must engage in self-reference processing, a deep cognitive evaluation process. When personality trait word judgment is difficult, participants need more time for evaluation and decision-making, which may lead to LPC activation. LPC reflects cognitive re-evaluation processes; deeper attribution of personal meaning and relevance to self-related information leads to greater attentional resource allocation (Rubianes et al., 2020). Consistently, Yang (2012) found that relational self-reference processing evoked significantly higher LPC amplitudes than general other-reference processing in

personality trait word judgment tasks, and greater than individual self-reference processing amplitudes, showing relational and individual self-reference effects.

General Discussion

This research explored pet owners' pet self and the role of anthropomorphic perception, examining pet self memory processing characteristics through behavioral experiments and ERP technology. Results showed that pet owners exhibit memory processing advantages for pet reference information, evoking larger LPC amplitudes, providing solid behavioral and electrophysiological evidence for the existence of pet owners' pet self. The research also found that this pet self is essentially a relational self that has not surpassed the individual's core self in importance. Below we discuss these findings.

5.1 On Pet Owners' Pet Self

Study 1 explored the relationship between pet owners' pets and self, confirming the existence of pet self. Study 1 showed that when pet owners perceive higher anthropomorphism in pets, they are more willing to incorporate pets into the self. Barker et al. (1997) found that the relationship between pet owners and their dogs is similar to relationships with spouses, children, and parents. Auger and Amiot (2019) found that more human contact with pets leads to greater tolerance toward animals. Psychological kinship theory also proposes that pet owners cognitively and behaviorally treat pets as family members regardless of actual genetic relationships, through emotional attachment and daily interaction, viewing pets as psychological kin. From a relational perspective, this represents a special human-pet "blood relationship" (Bailey, 1988). Pets have such important status for pet owners because the silent communication and wordless companionship between individuals and pets provide a relaxing emotion that human companions cannot achieve (Friedmann, 2013). In contrast, non-pet owners do not actively seek contact with pets. Therefore, pet owners are more willing to view pets as significant others or family members, incorporating pets into the self.

Study 1 also found that anthropomorphism mediates the relationship between pet ownership status and degree of incorporating pets into the self. Pet owners act as parental figures, caring for pets. Interacting with pets activates pet owners' caregiving behavioral systems (Czerwinski et al., 2016), stimulating parental-like responsibility during pet care and generating anthropomorphic behaviors toward pets (e.g., talking to animals, dressing them up) (Czerwinski et al., 2016). At this point, pet owners no longer view pets as mere accessories or possessions but perceive closer relationships between pets and self. Research found that individuals more likely to anthropomorphize objects may be more willing to anthropomorphize pets, thereby establishing close relationships and increasing their well-being. People prioritize animals' characteristics, behaviors, and temperament when choosing pets (Curb et al., 2013). Bao and Schreer

(2016) found that dog owners anthropomorphize their pets more than cat owners, and anthropomorphizing pets predicts higher levels of positive emotions. These findings indicate that pets are not only extensions of pet owners' selves but are incorporated into the self like family members, becoming part of the self.

5.2 Pet Reference Effect

Study 1 was an explicit test where individuals were aware of their attitudes toward pets. Psychological research shows that explicit attitudes are susceptible to social desirability effects and belong to conscious processing, whereas implicit attitudes better reflect individuals' true attitudes because they are unconscious and involve automatic processing (Hahn & Goedderz, 2020). Therefore, the existence of pet owners' pet self also requires confirmation from implicit experimental results. Self or significant other reference effects can provide more solid experimental evidence for pet owners' pet self. Study 2 showed that pet owners exhibit processing advantages for pet-related information similar to self-related information, which can be termed the "Pet Reference Effect." Van den Bos et al. (2010) found that the self-reference effect occurs in "R" responses (reflecting recollection of encoded items) but not in "K" responses (reflecting familiarity without recollection). Study 2 found that the pet reference effect appeared in "R" responses but not in "K" responses. This indicates that when facing pet-related information, pet owners unconsciously connect pets with self-representations (Van den Bos et al., 2010), thereby showing processing advantages. Research found that individuals who have owned pets for more than five years have better short-term and delayed word recall scores than non-owners (Applebaum et al., 2023). This suggests that for pet owners, communicating with pets provides good brain exercise. Studies also show that pet ownership is associated with higher cognitive levels, with pet ownership reducing brain age by up to 15 years (McDonough et al., 2022). These findings indicate that pets benefit pet owners' brain health and memory abilities. Study 2's confirmation of the pet reference effect suggests that this memory processing advantage may be a cognitive benefit brought by self-expansion.

Study 2 found that anthropomorphism plays an important role in pet reference processing advantages. In long-term cohabitation with pets, naming pets and describing them with personality adjectives reflects high anthropomorphism that makes pets indispensable significant others (Liu-Pham et al., 2022), endowing pets with human traits and treating them as intimate attachment objects. Individuals show more prominent memory for attachment object-related information in attachment relationships (De Winter, Saleminck, & Bosmans, 2017), thus exhibiting memory processing advantages. Researchers found that "family member" status particularly enhances people's perception of pets' social support characteristics, beyond merely "human-related features" (McConnell, Lloyd & Humphrey, 2019). Similarly, Study 2 found that pet owners showed processing advantages under pet reference similar to mother reference, indicating that pet

owners have already viewed pets as family members. Family is a meaningful group that can improve well-being (McConnell, Lloyd & Humphrey, 2019). The concept of family endows pets with powerful psychological capacities, enabling them to be viewed as family members like parents and romantic partners.

5.3 Electrophysiological Basis of Pet Reference Processing

Although behavioral experiments found that pet owners showed processing advantages for pet-related information similar to self and mother-related information, ERP research revealed differences. Study 3 found that pet owners evoked larger LPC amplitudes under self-reference information, showing a clear self-reference effect. Compared with celebrity reference processing, pet owners' pet reference processing evoked larger late LPC components similar to mother reference, but significantly different from LPC amplitudes under self-reference information. This indicates that, on the one hand, pet owners have formed a special pet self that is similar to mother self as a relational self; on the other hand, there remains a certain distance between pet self and individual core self.

Research shows that the influence of significant others in individuals' lives continuously changes (Hatteberg, 2020). Bi (2020) combined behavioral experiments and ERP technology to find that left-behind children's selves include grandmothers but not mothers. Zhang et al. (2019) found that pregnant women's family intimate relationships follow a differential pattern with self-reference and spouse-reference at the core. Similarly, pet owners also incorporate pets into their hierarchical structure of important attachment relationships (Meehan, Massavelli & Pachana, 2017), forming cognitive and behavioral memory processing advantages.

5.4 Pet Self and Relational Self

During socialization, as self-schemas continuously develop and change, people incorporate significant others into the self. In intimate human-pet relationships, pet owners tend to treat pets as significant others, forming a pet self. At the psychological level, pets are viewed as substitute family members (Kubinyi, Turcsán, & Miklósi, 2009), even as their children (Berryman, Howells, & Lloyd-Evans, 1985). At the moral level, pet owners are more inclined to save their pets in moral dilemmas (Xu et al., 2022). At the cognitive level, this study found that pet owners exhibit pet reference effects, showing memory processing biases toward pet-related information. Chinese interpersonal relationships develop and exist in a differential pattern (Yuan & Guo, 2017), where relationships diffuse outward from the "self" center based on blood, geographic, and marital ties, with each layer representing relational distance. In modernization, modern Chinese interpersonal systems have diversified after incorporating interests and rationality, showing peripheral interest-based and core emotion-based characteristics (Xu, 2009). This diversification trend has led to differentiation in the traditional differential pattern, making interpersonal relationships more complex. This study found that pet owners have incorporated pets into the

self, forming a unique pet self. Through interaction with pets, individuals not only satisfy companionship and emotional communication needs but also unconsciously construct a special “relational self.” Relational self theory posits that the self is partially defined by others, with individuals experiencing different selves with different significant others (Hatteberg, 2020). Relational self emphasizes maintaining self-other relationships, with self-schemas encompassing close acquaintances like mothers. For pet owners, different age groups treat pets as different types of intimate relationships (Meehan et al., 2017; Allan et al., 2009), but without exception, pets provide important emotional value and companionship for pet owners (Friedmann, 2013). Pet owners form a special relational self through interaction with pets. However, attachment network members differ in importance and distance from the core self; the closer to the core self, the greater the processing advantage and more attentional resources allocated (Julal, Carnelley, & Rowe, 2017). Tipper (2011) found that people prefer using kinship terms to represent meaningful connections rather than simply replacing missing persons in kinship networks with pets. Pets are life forms independent of pet owners’ relatives but similar to relatives (Mollica & Piantadosi, 2022). Therefore, pet self remains at a certain distance from individual core self and cannot surpass the mother in importance.

5.5 Conclusion

Figure 5 [Figure 5: see original paper] Differential pattern of pet owners’ relationships

Self research has primarily focused on significant others and East-West cultural differences, rarely exploring human-pet relationships. This study extends relational self from human relationships to pet relationships and self research to the human-pet relationship domain, contributing to deeper understanding of self-memory relationships, constructing self-related theory, and injecting new meaning into Chinese differential patterns of self. This helps individuals better recognize that their self includes pets, enables deeper analysis of pets’ positive effects on physical and mental health, and promotes harmonious coexistence between humans and nature through this positive cognitive-emotional cycle. However, this study has limitations. First, it did not differentiate pet types. Some pets (e.g., dogs, cats) have positive interactions with owners, while others (e.g., turtles) have much poorer interactivity. Different pet types cause different degrees of attachment and thus different levels of pet self. Future research should differentiate pet types to further explore pet self formation across pet types. Second, it did not differentiate pet owner types, such as active vs. passive pet owners. These two types have different attachment levels toward pets, and in some families, passive pet owners’ attitudes may differ dramatically from active pet owners, resulting in large differences in their pet self. Third, cultural influences were not considered. Different countries and regions have different animal cultures, and people’s attitudes toward animals vary greatly across cultures, leading to large differences in pet self. For example, in some Chinese

regions (e.g., Yulin) and ethnic groups (e.g., Korean ethnicity), dog meat is considered a delicacy, and their attitudes toward pet dogs may differ greatly. Finally, this study focused on pet owners with more than one year of pet ownership. Self-expansion is a process, and future research could explore the process of pet self formation. These limitations represent directions for future research.

Key Findings: 1. Pet owners incorporate pets into the self, forming a special pet self. 2. Pet owners exhibit pet reference processing advantages in memory tasks, showing a pet reference effect. 3. Pet self is a relational self that remains at a certain distance from the core self.

References

- Aggarwal, P. & McGill, A. L. (2007). Is that car smiling at me? Schema congruity as a basis for evaluating anthropomorphized products. *Journal of Consumer Research*, 34(4), 468-479.
- Allan B. Guzman, D. S. Cucueco, I. B. V., Cuenco N. G. C. Cunanan, R. T. & Edgar J. E. (2009) Petmanship: Understanding elderly filipinos' self-perceived health and self esteem captured from their lived experiences with pet companions. *Educational Gerontology*, 35(11), 963-989.
- Allen, R., McConnell, E., Paige, L., & Brandon, T. H. (2019) We are family: Viewing pets as family members improves wellbeing. *Anthrozoös*, 32(4), 459-470.
- Aron, A., Aron, E. N., Tudor, M., & Nelson, G. (1991). Close relationships as including other in the self. *Journal of Personality and Social Psychology*, 60(2), 241.
- Aron A, McLaughlin-Volpe T, Mashek, D. et al. (2004). Including others in the self. *European Review of Social Psychology*, 15(4), 101-132.
- APPA. (2020). Pet industry market size & ownership statistics. Stamford, CT.
- Applebaum, J. W., Shieu, M. M., McDonald, S. E., Dunietz, G. L., & Braley, T. J. (2023). The impact of sustained ownership of a pet on cognitive health: A population-based study. *Journal of aging and health*, 35(3-4),
- Auger, B., & Amiot, C. E. (2019). Testing the roles of intergroup anxiety and inclusion of animals in the self as mechanisms that underpin the “pets as ambassadors” effect. *Anthrozoös*, 32(1), 5-21.
- ASKCI. Retrieved 2022 from www.ASKCI.com
- Axelrod, (2020). Grieving PsychCentral. <https://psychcentral.com/lib/grieving-the-loss-of-a-pet/>
- Barker, S. B, Barker, R. T, Dawson, K. S., ... et al. (1997) The use of the family life space diagram in establishing interconnectedness: a preliminary study of

sexual abuse survivors, their significant others, and pets. *Individual Psychology*, 53(4), 435-450.

Bao, K. J., & Schreer, J. (2016). Pets and happiness: Examining the association between pet ownership and wellbeing. *Anthrozoös*, 29(2), 283-296.

Bailey, K. G. (1988). Psychological kinship: Implications for the helping professions. *Psychotherapy Theory Research Practice Training*, 25(1), 132-141.

Berryman, J. C., Howells, K., & Lloyd-Evans, M. (1985). Pet owner attitudes to pets and people: A psychological study. *Vet. Rec.* 117(25-26), 659-661.

Bi, C., Oyserman, D., Lin, Y., Zhang, J., Chu, B., & Yang, H. (2020). Left behind, not alone: feeling, function and neurophysiological markers of self-expansion among left-behind children and not left-behind peers. *Social cognitive and affective neuroscience*, 15(4), 467-478.

Bower, G. H., & Gilligan, S. G. (1979). Remembering information related to one's self. *Journal of Research in Personality*, 13(4), 420-432.

Brewer, M. B., & Gardner, W. (1996). Who is this "We"? Levels of collective identity and self representations. *Journal of Personality and Social Psychology*, 71(1), 83-93.

Brown, C. M., Hengy, S. M., & McConnell, A. R. (2016). Thinking about cats or dogs provides relief from social rejection. *Anthrozoös*, 29(1), 47-58.

Carpenter, C. J. & Spottswood, E. L. (2013). Exploring romantic relationships on social networking sites using the self-expansion model. *Computers in Human Behavior*, 29(4), 1531-1537.

Compitus, K. (2019). Traumatic pet loss and the integration of attachment-based animal assisted therapy. *Journal of Psychotherapy Integration*, 29(2), 119-131.

Cunningham, S. J. & Turk, D. J. (2017). Editorial: A review of self-processing biases in cognition. *The Quarterly Journal of Experimental Psychology*, 70(6), 987-995.

Curb, L. A., Abramson, C. I., Grice, J. W., & Kennison, S. M. (2013). The relationship between personality match and pet satisfaction among dog owners. *Anthrozoös: A Multidisciplinary Journal of The Interactions of People & Animals*, 26(3), 395-404.

Czerwinski, V. H., Smith, B. P., Hynd, P. I., & Hazel, S. J. (2016). The influence of maternal care on stress-related behaviors in domestic dogs: What can we learn from the rodent literature? *Journal of Veterinary Behavior*, 14(1), 52-59.

Dailymail. Retrieved May 4 2023 from <http://www.dailymail.co.uk/>

De Winter, S., Salemink, E., & Bosmans, G. (2017). Interpretation bias in middle childhood attachment: Causal effects on attachment memories and scripts. *Behavior Research and Therapy*, 102(1), 1-37.

- Ellingsen, K., Zanella, A. J., Bjerkas, E., & Indrebo, A. (2010). The relationship between empathy, perception of pain and attitudes toward pets among Norwegian dog owners. *Anthrozoos*, 23(3), 231-243.
- Epley, N., Akalis, S., Waytz, A. & Cacioppo, J. T. (2008). Creating social connection through inferential reproduction: Loneliness and perceived agency in gadgets, gods, and greyhounds. *Psychological Science*, 19(2), 114-120.
- Fields, E. C., & Kuperberg, G. R. (2016). Dynamic effects of self-relevance and task on the neural processing of emotional words in context. *Frontiers in Psychology*, 6, 2003.
- Friedmann, E. (2013) The role of pets in enhancing human well-being: physiological. *The Waltham book of human-animal interaction: Benefits and responsibilities of pet ownership*.
- Gillihan, S., & Farah, M. (2005). Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience, *Psychological Bulletin*, 131(1), 76-97.
- Gray, H. Ambady, N. Lowenthal, W., & Deldin, P. (2004). P300 as an index of attention to self-relevant stimuli. *Journal of Experimental Social Psychology*, 40(2), 216-224.
- Green, J., Coy, A. E., & Mathews, M. A. (2018). Attachment anxiety and avoidance influence pet choice and pet-directed behaviors. *Anthrozoös*, 31(4), 475-494.
- Guan, Y. H., & Chi, Y. K. (2013). The effect of self-reference and mother-reference on personality traits memory. *Psychological Research*, 6(4), 27-33. (Guan Yanhua, Chi Yukai. (2013). The effect of self-reference and friend-reference on personality traits memory. *Psychological Science*, 29(2), 448-450.)
- Hatteberg, S. J. (2020). A tale of many Sources: The perceived benefits of significant other, similar other, and significant and similar other social support. *Sociological Perspectives*, 64(1), 37-57.
- Hahn, A., & Goedderz, A. (2020). Trait-unconsciousness, state-unconsciousness, preconsciousness, and social miscalibration in the context of implicit evaluation. *Social Cognition*, 38(Suppl), S115-S134.
- Irvine, L. & Cilia, L. (2017). More-than-human families: Pets, people and practices in multispecies households. *Sociology Compass*, 11(2), e12455.
- Jackson, J. D., Luu, C., Vigderman, A., Leshikar, E. D., Jacques, P. L., & Gutchess, A. (2019). Reduction of the self-reference effect in younger and older adults. *Psychology & neuroscience*, 12(2), 257-270.
- Julal, F. S., Carnelley, K. B., & Rowe, A. (2017). The relationship between attachment style and placement of parents in adults' attachment networks over time. *Attachment & Human Development*, 19(4), 1-25.

- Jyrinki, H., & Leipamaa-Leskinen, H., (2006). Pets as extended self in the context of pet food consumption. *European Advances in Consumer Research*, 7(7), 543-549.
- Kanat-Maymon, Y., Wolfson, S., Cohen, R., & Roth, G. (2021). The benefits of giving as well as receiving need support in human-pet relations. *Journal of Happiness Studies*, 22(2), 1441-1457.
- Kiesler, S., Lee, S. & Kramer, A. D. I. (2006). Relationship effects in psychological explanations of non-human behavior. *Anthrozoös*, 19(4), 335-352.
- Klein, S. B. (2012). A role for self-referential processing in tasks requiring participants to imagine survival on the savannah. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 38(5), 1234.
- Kotowska, I. & Nowicka, A. (2016). Present-self, past-self and the close-other: Neural correlates of assigning trait adjectives to oneself and others. *European Journal of Neuroscience*, 44(4), 2064-2071.
- Kubinyi, E., Turcsán, B., & Miklósi, Á. (2009). Dog and owner demographic characteristics and dog personality trait associations. *Behave Process*, 81(3), 392-401.
- Laurent-Simpson, A. (2017). “They make me not wanna have a child”: Effects of companion animals on fertility intentions of the childfree. *Social Inquiry*, 87(4), 586-607.
- Liu-Pham, R., Patterson, L., & Keefer, L. A. (2022). You get what you give: Pet relationships in a communal orientation framework. *Personality and Individual Differences*, 92(1), 69-73.
- Li, S. F., Xu, K. P., Xu, Q. Y., Xia, R. X., Ren, D. Y., & Zhou, A. B. (2016). Positive bias in self-appraisals from friend’s perspective: an event-related potential study. *Clinical neuroscience*, 27(9), 694-698.
- Li, R. B., (2015). Funeral ceremony, belief and village relationship construction. *Folklore Studies*, (3), 127-130. (Li Rubin. (2015). Funeral ceremony, belief and village relationship construction. *Folklore Studies*, (3), 127-130.)
- London, M., Sessa, V. I., & Shelley, L. A. (2023). Developing self-awareness: learning processes for self- and interpersonal growth. *Annual Review of Organizational Psychology and Organizational Behavior*. 10,
- Meehan, M., Massavelli, B., & Pachana, N. (2017). Using attachment theory and social support theory to examine and measure pets as sources of social support and attachment figures. *Anthrozoös*, 30(2), 273-289.
- McDonough, I. M., Erwin, H. B., Sin, N. L., & Allen, R. S. (2022). Pet ownership is associated with greater cognitive and brain health in a cross-sectional sample across the adult lifespan. *Frontiers in Aging Neuroscience*, 14, 953889.

Mollica, F., & Piantadosi, S. T. (2022). Logical word learning: The case of kinship. *Psychonomic Bulletin & Review*, 29(3), 766-799.

Ng, S., Han, L., Mao, L., & Lai, J. C. L. (2010). Dynamic bicultural brains: fMRI study of their flexible neural representation of self and significant others in response to culture primes. *Asian Journal of Social Psychology*, 13(2), 83-91.

Paolini, S., Wright, S. C., Dys-Steenbergen, O., & Favara, I. (2016). Self-Expansion and intergroup contact: Expectancies and motives to self-expand lead to greater interest in outgroup contact and more positive intergroup relations. *Journal of Social Issues*, 72(3), 450-471.

Paul, E. S., Moore, A., McAinsh, P., Symonds, E., McCune, S., & Bradshaw, J. W. S. (2014). Sociality motivation and anthropomorphic thinking about pets. *Anthrozoös: A multidisciplinary journal of the interactions of people and animals*, 27(4), 499-512.

PFMA. Retrieved 2021 from <https://www.ukpetfood.org/>

Qi, J. L., & Zhu, Y. (2002). The self-reference effect of Chinese college students. *Journal of Psychological Science*, 25(3), 275-278. (Qi Jianli, Zhu Ying. (2002). The self-reference effect of Chinese college students. *Psychological Science*, 25(3), 275-278.)

Rogers, T. B., Kuiper, N. A., & Irker, W. S. (1977) Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology*, 35(9), 677-688.

Rubianes, M., Muñoz, F., Casado, P., ... et al., (2020). Am I the same person across my life span? An event-related brain potentials study of the temporal perspective in self-identity. *Psychophysiology*, 58(1), e13692.

Serpell, J. A. (1996). Evidence for an association between pet behavior and owner attachment levels. *Applied Animal Behaviour Science*, 47(1-2), 49-60.

Sui, J., & Gu, X. (2017). Self as object: Emerging trends in self research. *Trends in Neurosciences*, 40(11),

Tanguay, A., Benton, L., Romio, L., Sievers, C., Davidson, P., & Renoult, L. (2018). The ERP correlates of self-knowledge: Are assessments of one's past, present, and future traits closer to semantic or episodic memory? *Neuropsychologia*, 110, 65-83.

Tipper, B. (2011). "A dog who I know quite well": everyday relationships between children and animals. *Children's Geographies*, 9(2), 145-165.

Turk, D., Heatherton, T., W. Kelley, M. Funnell, M. G., & Macrae, C. (2002). Mike or me? Self-recognition in a split-brain patient, *Nature Neuroscience*, 5(9), 841-842.

Van den Bos, M., Cunningham, S. J., Conway, M. A., & Turk, D. J. (2010). Mine to remember: the impact of ownership on recollective experience. *Quarterly*

Journal of Experimental Psychology, 63(3), 1065-1071.

Wang, X. X., Jiang, S., & Zhang, J. J. (2018) Effect of the spatial linguistic symbol on the container metaphor of seniority rules. *Acta Psychologica Sinica*, 50(9), 953-964. (Wang Xinxiao, Jiang Shan, Zhang Jijia. (2018). The effect of spatial linguistic symbols on the container metaphor of kinship relationships. *Acta Psychologica Sinica*, 50(9), 953-964.)

Wang, B., Fu, Y., Zhang, J. J. (2019) Influence of language and culture on retrieval-induced forgetting under the self-referential condition: Evidence from the Han and the Mosuo. *Acta Psychologica Sinica*, 51(4), 450-461. (Wang Bin, Fu Ya, Zhang Jijia. (2019). The influence of language and culture on retrieval-induced forgetting under the self-referential condition: Evidence from the Han and the Mosuo. *Acta Psychologica Sinica*, 51(4), 450-461.)

Waytz, A., Cacioppo, J., & Epley, N. (2010) Who sees human? The stability and importance of individual differences in anthropomorphism. *Perspectives on Psychological Science*. 5(3), 219-232.

Xu, K. P., Ou, Q. Q. Xue, H., Luo, D. L., Zhang, S. Y., & Xu, Y. (2023) Traditional pettism: The influence of pet ownership status, pet type, and pet properties on pet moral standing. *Acta Psychologica Sinica*, 55(10), 1662-1676. (Xu Kepeng, Ou Qianqian, Xue Hong, Luo Dongli, Zhang Shuyue, Xu Yan. (2023). Traditional pettism: The influence of pet ownership status, pet type, and pet properties on pet moral standing. *Acta Psychologica Sinica*, 55(10), 1662-1676.)

Xu, K. P., et al. (2022) Moral decision-making in pettism: The influence of animal type, pet ownership status and social distance. *PsyCh Journal*, 12, 54-72.

Xu, X. (2009). Core and Periphery: A case study of the restructuring of rural AIDS patients' social relationships in east part of Hubei province. *Sociological Studies*, 24(1), 64-95. (Xu Xiaojun. (2009). Core and periphery: A case study of the restructuring of rural AIDS patients' social relationships in the eastern part of Hubei province. *Sociological Studies*, 24(1), 64-95.)

Yang, Q. Feng, Y. R., & Zhang, J. J. (2019) The language and cultural differences of father-reference processing: Based on the retrieval-induced forgetting *Acta Psychologica Sinica*, 51(03), 304-315. (Yang Qun, Feng Yiran, Zhang Jijia. (2019). The language and cultural differences of father-reference processing: Evidence from retrieval-induced forgetting. *Acta Psychologica Sinica*, 51(03), 304-315.)

Yuan, W. Y., Zhang, X. X., Du, J., Li, H., & Yang, J. (2018). The effect of thoughts of death and thoughts of survival on self-referential processing: Evidence from ERPS. *Journal of Psychological Science*, 41(01), 38-44. (Yuan Wenyang, Zhang Xinxin, Du Jie, Li Hao, Yang Juan. (2018). The effect of thoughts of death and thoughts of survival on self-referential processing: Evidence from ERPs. *Psychological Science*, 41(01), 38-44.)

Yuan, X. J., & Guo, S. P. (2017). Differential mode of association in Chinese interpersonal relationship affection: Evidence from Extrinsic Affective Simon Task (EAST). *Journal of Psychological Science*, 40(3), 651-656. (Yuan Xiaojin, Guo Siping. (2017). Differential mode of association in Chinese interpersonal relationship affection: Evidence from Extrinsic Affective Simon Task (EAST). *Psychological Science*, 40(3), 651-656.)

Zhou, L., & Su, Y. J. (2008) The Role of Genuine Intimacy in the Lover-Reference Effect. *Acta Psychologica Sinica*, (04), 487-495. (Zhou Li, Su Yanjie. (2008). The role of genuine intimacy in the lover-reference effect. *Acta Psychologica Sinica*, (04), 487-495.)

Zhang, Y. Y., Fan, H. X., & Pan, M. (2019). The “Differential mode of association” of family intimate relationships and its effect on anxiety and depression of pregnant women. *Psychological Exploration*, 39(01), 90-96. (Zhang Yaya, Fan Hongxia, Pan Min. (2019). The “differential mode of association” of family intimate relationships and its effect on anxiety and depression of pregnant women. *Psychological Exploration*, 39(01), 90-96.)

Zhong, Y. P., Wang, X. A., Fan, W., et al. (2014). Self-reference effect in occupation selection conditions: Evidences from behavior and ERPs. *Chinese Journal of Clinical Psychology*, 22(2), 218-222. (Zhong Yiping, Wang Xi'ai, Fan Wei, et al. (2014). Self-reference effect in occupation selection conditions: Evidences from behavior and ERPs. *Chinese Journal of Clinical Psychology*, 22(2), 218-222.)

Zilcha-Mano, S., Mikulincer, M., & Shaver, P. R. (2011). An attachment perspective on human-pet relationships: Conceptualization and assessment of pet attachment orientations. *Journal of Research in Personality*, 45(5),

Appendix 1: Study 1 Questionnaires

Questionnaire Instructions: Dear student, hello! We are graduate students in psychology conducting research on pets. This study uses anonymous responses, and we will not disclose any of your information! Your answers are not right or wrong, they only reflect your true thoughts. Our team will protect your rights and data security as fundamental principles, and this will not affect your life or studies in any way. Please feel free to respond. Finally, we sincerely invite you to participate in this survey. If you have any questions, please contact us.

(1) Pet-Self Relationship Intimacy Scale

Instructions: In the figure below, Image 1 represents that you and your pet have almost no relationship, while Image 7 [Figure 7: see original paper] represents that you and your pet have the closest relationship. Please select the image that best matches your relationship with your pet based on actual circumstances.

(2) Self-Concept Questionnaire**Figure 3 IOS Scale**

In the figure below, the inner circle represents your own self, and the outer circle includes some people or animals that may be important to you. Please fill in the things you are willing to include in your self into the inner circle.

Figure 4 Self-Concept Scale**(3) Individual Differences in Anthropomorphism Questionnaire**

1. Do you think pets have free will? To what degree? (Free will refers to: the ability to choose what to do)
2. Do you think pets have their own intentions? To what degree? (Intention refers to: the idea of hoping to achieve a certain goal)
3. Do you think pets can experience emotions? To what degree?
4. Do you think pets have their own minds? To what degree?
5. Do you think pets have consciousness? To what degree? (Consciousness refers to: awareness of and attention to the external world and oneself)

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv — Machine translation. Verify with original.