Can Pets Be Integrated into the Human Self? Exploring Memory Processing Advantages for Pet-Related Information

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Abstract

An increasing number of pets are entering human lives, and people are establishing stable human-pet relationships with them. To reveal the intrinsic foundation of good human-pet relationships, this article investigates the pet-self and the memory processing advantages of pet-related information through three studies. Study 1 employs a questionnaire method to preliminarily explore human-pet relationships in contemporary society, finding that compared to non-pet owners, pet owners integrate their pets into the self, preliminarily confirming the existence of the pet-self. Study 2 uses the classic R/K paradigm to investigate the processing characteristics of pet-related information among pet owners, finding that pet owners exhibit a stronger memory processing advantage for pet-related information, with recognition rates under pet reference significantly higher than those under celebrity reference and semantic reference, and similar to those under self-reference and mother reference. Study 3 further employs ERP technology to examine the electrophysiological characteristics of pet owners' processing of pet-related information, finding that the LPC amplitude evoked under pet reference is significantly higher than that under celebrity reference, significantly lower than that under self-reference, but similar to that under mother reference. The entire study reveals that in stable human-pet relationships, pet owners possess a special pet-self and exhibit a memory reference effect, but the pet-self remains at a certain distance from the individual' s core self.

Full Text

Can Pets Be Integrated into Human Self? An Exploration of Memory Processing Advantages for Pet-Related Information

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Abstract

As an increasing number of pets enter human lives, people establish stable human-pet relationships. To reveal the internal foundation of strong human-pet bonds, this paper investigates the pet self and memory processing advantages for pet-related information through three studies. Study 1 employed a questionnaire method to preliminarily explore contemporary human-pet relationships, finding that compared to non-pet owners, pet owners integrate their pets into the self, providing initial evidence for the existence of a pet self. Study 2 utilized the classic R/K paradigm to examine processing characteristics of pet-related information among pet owners, revealing that pet owners demonstrate stronger memory processing advantages for pet-related information. Recognition rates under pet reference were significantly higher than under celebrity reference and semantic reference, and comparable to those under self-reference and mother reference. Study 3 further employed ERP technology to investigate the electrophysiological characteristics of pet-related information processing, finding that the LPC amplitude evoked under pet reference was significantly higher than under celebrity reference, significantly lower than under self-reference, but similar to mother reference. Collectively, these studies reveal that in stable human-pet

relationships, pet owners develop a special pet self that exhibits a memory reference effect, though this pet self maintains some distance from the individual' s core self.

Keywords: pet owner; pet self; pet reference effect

Currently, approximately 59% of households in the United Kingdom (PFMA, 2021) and two-thirds of households in the United States (APPA, 2020) own at least one pet. Meanwhile, China' s pet population is growing rapidly, increasing from 94 million in 2018 to 187 million in 2024, with the pet economy reaching 345.3 billion yuan in 2024, representing a 5.8% year-over-year increase (CNPIA, 2024). As more pets enter people' s lives, they serve functions of companionship, emotional connection, and communication. Some pet owners consider their pets as family members, particularly for individuals living alone or empty-nest elderly, for whom pets serve as emotional outlets that compensate for affective deficits (Young et al., 2020), enhance well-being (Amiot & Bastian, 2015), and produce numerous psychological benefits.

Although human-pet relationships have received some attention in recent years, most research has focused on attachment relationships (Zilcha-Mano et al., 2011), psychological well-being (Kanat-Maymon et al., 2021), and attitudes toward pets (Ellingsen et al., 2010), while neglecting a crucial component in relationship construction—the self. The era' s diverse development has expanded human self-concept into a collection that includes oneself, significant others, and in-groups (Zhou & Su, 2008). The prevalence of pet adoption also encourages pet owners to attribute more human-like and in-group characteristics to pets, such as emotions (Topolski et al., 2013), rights, and moral status (Xu et al., 2023). When pet ownership collides with self-expansion, does it prompt humans to incorporate pets into the self? Based on contemporary social context, this paper explores whether pets, as cross-species beings lacking innate connection with humans, can be incorporated into the human "self" category.

1.1 The Relationship Between Pets and Self

Pets constitute an indispensable part of life for most pet owners. Keeping pets brings joy (Kanat-Maymon et al., 2021), reduces psychological isolation, satisfies emotional and social needs, and provides spiritual sustenance (Brown et al., 2016). Psychological kinship theory posits that humans tend to define kinship bonds through psychological connections rather than blood relations; even without actual genetic relationships, individuals may develop emotional attachments and behavioral patterns toward specific non-kin objects similar to those toward family members (Bailey, 1988). Due to long-term intimate interaction between pet owners and their pets, a special human-pet emotional attachment is established. Therefore, pet owners are likely to incorporate pets into their psychological kinship category, which represents a special form of human-pet "blood relationship" from an emotional perspective. Moreover, real-life reactions to pets also imply subtle human-pet relationships. For instance, pet owners may expe-

rience a series of negative emotions and consequences when pets die, such as anxiety, grief, or even psychological damage and trauma (Axelrod, 2020; Compitus, 2019). To alleviate the pain of losing a pet, an Australian company provides employees with "pet bereavement leave" (DailyMail, 2023). This indicates that pet owners find it difficult to sever acquired connections with pets, reflecting that pets have become part of their lives.

Self-expansion theory suggests that incorporating intimate significant others into the self serves as a means for self-enhancement, integrating the other' s resources, perspectives, and identities into the self, making significant others part of oneself to some extent (Aron et al., 2004). Current research on significant others has expanded to include mothers, fathers, spouses, children, aunts, etc. (Guan & Chi, 2006; Qi & Zhu, 2002; Yang et al., 2019; Wang et al., 2019). Combined with psychological kinship theory, given the intimate and important relationship between pet owners and their pets, pet owners are likely to incorporate pets into the self through relational self.

In summary, we propose Prediction 1: Compared to non-pet owners, pet owners are more willing to incorporate pets into the self.

1.2 Memory Processing Advantages of Pet-Reference Information

A crucial function of the self is to help individuals process self-related information (Sui & Gu, 2017), which also constitutes primary evidence for the existence of self-psychological representation. When individuals are in a self-related situation, the self-processing system is immediately activated, forming a special information processing pattern. Previous research has confirmed processing advantages for self-related information in attention, memory, and perception (Cunningham & Turk, 2017; Klein, 2012). Among these, memory processing advantage is the most prominent characteristic of self-representation. On one hand, individual memory is largely "self-referential" memory; on the other hand, much self-related knowledge is built upon memory (Klein, 2012). Therefore, memory provides an effective perspective for exploring the self. The self-reference effect (SRE) manifests as individuals' elaborative encoding of self-related materials, resulting in memory advantages during recall (Zhu & Zhang, 2001). SRE research has found that individuals incorporate significant others (parents, friends, children) into the self, demonstrated by memory processing advantages for information related to these identities (Guan & Chi, 2006; Qi & Zhu, 2002; Yang et al., 2019). In pet owners' minds, pets are already considered family members (Kubinyi et al., 2009). Does this cross-species animal, lacking innate connection with humans, influence individual self-cognitive aspects such as memory? This is one of our key research questions. Previous studies have examined information processing advantages for significant others but have not explored animal information reference processing. Therefore, investigating this question will help further expand understanding of self-reference processing and the self. Previous SRE research has shown that trait words encoded in self-reference contexts demonstrate powerful memory advantages compared to those encoded in

other-reference or semantic contexts (Symons & Johnson, 1997). For Chinese individuals, the mother concept has penetrated deeply into their hearts and become an unconscious component of the self (Wu et al., 2021), with memory effects for self-related stimuli showing no significant difference from those for mother-related stimuli, both significantly higher than for unfamiliar others or semantic stimuli (Zhu & Zhang, 2001). Based on this, we use self-information as the core self-reference, mother-information as significant other reference, and celebrity and semantic information as controls, adding pet-reference information to explore whether pets, like significant others, can produce a pet-reference processing advantage.

We propose Prediction 2: Pet owners will exhibit memory processing advantages for pet-related information. Compared to non-pet owners, pet owners will show significantly higher trait adjective recognition rates under pet-reference conditions than under celebrity and semantic conditions, with no significant differences from self-reference and mother-reference conditions.

1.3 Electrophysiological Characteristics of Pet-Reference Information Processing

This study also combines EEG technology to further explore which stage of cognitive processing this advantage occurs in. Previous research indicates that self-related components mainly include N200, P300, and LPC amplitudes. The N2 component reflects top-down information encoding and retrieval, with high self-related stimuli evoking smaller N2 amplitudes than low self-related stimuli (Chen et al., 2011). Additionally, one' s own handwriting (Folstein & van Petten, 2008) and highly self-related names (Zhong et al., 2014) have also been confirmed to evoke smaller N2 amplitudes. Some studies have found 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 judging personality trait words, individuals continuously allocate attentional resources to self-related information (Kotlewska & Nowicka, 2016). Additionally, the P300 component is also considered highly related to self-processing. P300 is associated with attentional allocation in decision-making or outcome evaluation (Gray et al., 2004) and high-level motivational/affective evaluation (Nieuwenhuis et al., 2005). Numerous studies have found that memory for one' s own name (Chen et al., 2011), mother' s name (Yuan et al., 2018), and highly self-related information (Li et al., 2016) evoke larger P3 amplitudes.

Reviewing previous research, personality trait word judgment tasks can reveal how individuals view themselves and their significant others and serve as an effective paradigm for exploring self-reference effects in ERP research (Bi et al., 2020). When performing trait word judgment tasks, participants need to match whether a word is suitable for describing themselves or others, a process primarily involving cognitive resource investment and allocation. Based on this,

this study employs ERP technology and personality trait word judgment tasks, focusing on P300 and LPC components evoked by self-processing, to further explore characteristics of pet-reference information processing. This aims to reveal how pet owners integrate pets into their self-concept and explain the psychological mechanisms underlying this attribution to some extent. By analyzing pet owners' personality trait descriptions of themselves and their pets, we can better understand the importance of pets in pet owners' lives and how this importance manifests in their psychological and behavioral performance.

We propose Prediction 3: In trait word judgment tasks, compared to celebrity reference, pet owners will evoke larger P300 and LPC amplitudes under pet reference.

In summary, three studies are proposed to explore the relationship between pets and pet owners' self and pet information processing advantages. Study 1 examines whether pet owners incorporate pets into the self; Study 2 investigates memory processing advantages for pet-related information among pet owners; Study 3 uses ERP technology to explore the electrophysiological basis of pet owners' memory processing advantages for pet information.

Study 1: The Relationship Between Pet Owners and Their Pets

2.1 Participants

Using snowball sampling technology, questionnaires were distributed across various social media platforms and completed through the Qualtrics platform. Based on participants' responses to the demographic question "Do you currently 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 (Mage = 19.73; SDage = 2.34).

2.2 Measures

(1) Self-Concept Questionnaire
The self-concept questionnaire was used to measure individuals' willingness to incorporate pets into the self. The questionnaire was adapted from container metaphor experiments (Wang et al., 2018). The inner circle in the questionnaire represents the individual' s self, while the outer circle includes some people or animals that may be important to the individual. Participants were asked to fill in the circle with people or things they were willing to include in the self, maintaining equal numbers inside and outside the circle. 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) was used to assess the degree to which individuals incorporate pets into the self. The IOS scale, developed by

Aron et al. (1991), measures the degree to which individuals incorporate others into the self and can be used in individual (Carpenter & Spottswood, 2013) and cross-group studies (Paolini et al., 2016). In this study, one circle in each pair represented "self" and the other represented "pet." The seven pairs of circles showed progressively increasing overlap, with greater overlap indicating closer connection between the individual and pet and higher degree of incorporation into the self.

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, $^{2}(1) = 17.65$, $p < 0.001$, indicating that compared to 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 Self

2.3.2 One-Way ANOVA Using the degree of incorporating pets into the self measured by the IOS scale as the dependent variable, ANOVA showed a significant main effect of participant type, $F(1, 331) = 69.87$, $p < 0.001$. Compared to non-pet owners ($M = 3.36 \pm 1.79$), pet owners ($M = 4.81 \pm 1.58$) showed greater overlap between pet and self, indicating deeper incorporation of pets into the self. The main effect of gender was not significant ($p > 0.05$).

2.4 Summary

Study 1 found that compared to non-pet owners, pet owners perceived greater overlap between pets and self and were more inclined to incorporate pets into the self. This preliminary finding suggests that a unique pet self may exist within pet owners'self-concept. Consistent with this, previous research has found that when pet owners view pets as family members, they more strongly perceive emotional support and social connection provided by pets, significantly enhancing their own well-being (McConnell et al., 2019). As pet owners and non-pet owners have non-overlapping social circles to some extent, people form different pet views that are continuously reinforced during this process. To further verify the existence of the pet self from a memory processing perspective, Study 2 adopted the classic R/K paradigm to examine whether pet owners would exhibit pet information processing advantages, namely the pet reference effect. If the pet reference effect emerges, it would provide further experimental evidence for the existence of pet owners' pet self.

Study 2: Memory Processing Advantages for Pet-Related Information

3.1 Participants

Using G*Power 3.1.7 for a priori analysis to determine sample size, for the between-subjects repeated measures ANOVA used in this study, with significance level $\alpha = 0.05$, medium effect size ($f = 0.25$), and desired statistical power of 80%, the minimum total sample size was 30. Participants were recruited from a university in Guangxi. The question "Do you currently own a pet?" was used to distinguish pet owners from non-pet owners. The final sample consisted of 52 participants (26 pet owners, 26 non-pet owners; 12 males, 40 females) with a mean age of 21.5 ± 0.30 years.

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 Wu and Zhou (2013), 400 medium-frequency (0.00023~0.00153) personality trait adjectives capable of describing Chinese people were selected from Liu Yuan' s *Modern Chinese Common Word Frequency Dictionary*. All words were two-character Chinese adjectives matched on valence, frequency, length, and familiarity. Sixty-one sophomore psychology majors (who did not participate in the formal experiment) evaluated whether the 400 personality adjectives could describe both people and animals. This yielded 310 two-character trait words. Ten were used for practice, and the remaining 300 trait words were divided into two groups of 150 words each (75 positive, 75 negative), balancing the trait words used across the five information types (self, mother, pet, celebrity, semantic) with random balanced order presentation.

3.4 Procedure

The experiment consisted of three phases: learning phase, distraction phase, and recognition phase. 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 types of information questions: self-reference (Is this word suitable for describing yourself?); mother reference (Is this word suitable for describing your mother?); pet reference (for pet owners: Is this word suitable for describing your pet? For non-pet owners: Is this word suitable for describing pets?); celebrity reference (Is this word suitable for describing Lu Xun?); semantic reference involved judging whether the personality adjective was 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 with random

duration of 300-500 ms appeared, 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 were required to make yes/no judgments based on the previously presented reference question ("yes" by pressing J, "no" by pressing F), with response keys balanced across participants. The stimulus disappeared automatically after the participant' s key press or after 1500 ms, followed by the next trial.

(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 on screen, some previously seen in the learning phase and some new words not previously presented. Participants first judged whether they had seen the adjective on screen before (press "Q" if seen, "P" if not seen). For "seen" adjectives, they further judged whether it was "Remember R" or "Know K." "Remember R" meant clearly remembering and being able to recall some detailed information about the word. "Know K" meant being certain the adjective appeared in the learning phase but being unable to recall specific details. During testing, all stimulus responses were "automatic + response disappearance." All learned adjectives and distractor adjectives were mixed and presented randomly for 2000 ms. After judging one adjective, the computer automatically presented the next word. A thank-you message appeared after testing concluded. Testing lasted approximately 40 minutes.

3.5 Results and Analysis

Figure 1 [Figure 1: see original paper] Experimental Flowchart

(1) Total Recognition Rate: A 2 (participant type: pet owner, non-pet owner) × 5 (information type: self, mother, pet, semantic, celebrity) repeated measures ANOVA on total 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 showed significantly higher recognition rates under self-reference and mother-reference than under pet-reference, semantic-reference, and celebrity-reference (ps < 0.01), with no significant differences between pet-reference and semantic-reference or celebrity-reference (ps > 0.05). Pet owners showed significantly higher recognition rates under self-reference ($p = 0.015$), pet-reference ($p < 0.001$), and mother-reference ($p = 0.006$) compared to semantic-reference, and significantly higher recognition rates under self-reference ($p = 0.004$), pet-reference ($p = 0.003$), and mother-reference ($p = 0.008$) compared to celebrity-reference. No significant differences were found between pet-reference and self-reference or mother-reference (ps > 0.05).

(2) R Recognition Rate: ANOVA showed a significant main effect of in-

formation 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 revealed that non-pet owners showed significantly higher recognition rates under self-reference and mother-reference than under pet-reference, semantic-reference, and celebrity-reference (ps < 0.01), with no significant differences between pet-reference and semantic-reference or celebrity-reference (ps > 0.05). Pet owners showed significantly higher recognition rates under self-reference ($p < 0.001$), pet-reference ($p = 0.001$), and mother-reference ($p < 0.001$) compared to semantic-reference and celebrity-reference, 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 and Gender: All main effects and interactions were not significant (ps > 0.05).

Table 2 Correct Recall Rates for Pet Owners and Non-Pet Owners Across Information Types

Information Type	Pet Owners	Non-Pet Owners
Self (R rate)	0.73 (0.02)	0.66 (0.03)
Self (K rate)	0.46 (0.04)	0.45 (0.04)
Mother (R rate)	0.69 (0.02)	0.65 (0.02)
Mother (K rate)	0.46 (0.04)	0.42 (0.03)
Pet (R rate)	0.62 (0.02)	0.37 (0.03)
Pet (K rate)	0.67 (0.03)	0.42 (0.04)
Celebrity (R rate)	0.60 (0.03)	0.58 (0.03)
Celebrity (K rate)	0.37 (0.04)	0.34 (0.04)
Semantic (R rate)	0.65 (0.03)	0.57 (0.04)
Semantic (K rate)	0.35 (0.04)	0.31 (0.04)

Note: Numbers in parentheses are standard deviations, the same below.

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. Using personality trait words to describe pets, pet owners' recognition rates under pet-reference were significantly higher than under celebrity-reference and semantic-reference, with no significant differences from self-reference and mother-reference. This indicates that pet owners exhibit pet-reference processing advantages similar to self-reference and mother-reference, suggesting that human-pet relationships have entered a new stage that seems to transcend the barrier between human and animal relationships. Previous ERP studies have found gradient differences in intimate other-reference effects, with information about others at different intimacy levels receiving different degrees of processing

(Bi, 2020). Study 2 found that pet owners exhibit the pet reference effect, but whether this processing advantage differs from that of mother and self remains unknown. Study 3 uses ERP technology with a personality trait word judgment paradigm to explore the electrophysiological basis of the pet self and the position of pets in pet owners' "self."

Study 3: Electrophysiological Characteristics of Pet-Reference Processing

4.1 Participants

Participant recruitment information was posted on social media platforms such as Weibo and Xiaohongshu. By asking three questions—whether they owned pets, type of pet, and duration of pet ownership—participants who had owned cats or dogs for more than one year were selected. The final sample consisted of 34 participants, all of whom had close recent contact with pets, incorporated pets into the self in the self-concept questionnaire, and scored above the median of 4 on human-pet relationship intimacy. Five participants were excluded due to excessive EEG artifacts, leaving 29 participants (6 males, 23 females) with a mean age of 21.21 ± 1.45 years. All participants were right-handed with normal or corrected-to-normal vision, had no head wounds, and had no recent injuries. Participants signed informed consent forms before the experiment.

4.2 Experimental Design

A single-factor within-subjects design was employed, with information type (self, mother, pet, celebrity) as the independent variable and amplitude and latency of selected electrode EEG components 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 degrees. All experimental stimuli were presented as black-background, white-text images in 32-point Song font at the center of the monitor screen. Participants were informed that this was a test of personality trait adjective judgment 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 four blocks, each including 80 adjective judgment trials. In each trial, a fixation cross "+" was first presented for 500 ms, followed by random presentation of one of four information processing questions: self-reference (Is this word suitable for describing yourself?); mother-reference (Is this word suitable for describing your mother?); pet-reference (Is this word suitable for describing your pet?); celebrity-reference (Is this word suitable for describing Lu Xun?). The question was presented for 2000 ms. After a 300 ms fixation cross, a black screen with random duration of 300-500 ms appeared, followed by a two-character adjective (e.g., "flexible") for 1500 ms as the stimulus, and finally a 1000 ms black

screen. After stimulus presentation, participants made yes/no judgments (“yes” by pressing 1, “no” by pressing 5). The stimulus disappeared automatically after the participant’ s key press or after 1500 ms, followed by the next trial.

4.4 Experimental Environment and Equipment

Figure 2 [Figure 2: see original paper] Experimental Flowchart

The experimental program was written using E-Prime. The formal experiment was conducted in an EEG laboratory with a quiet environment, appropriate lighting, and good ventilation, with separate rooms for the experimenter and participant. Two computers were used during the experiment, one for running the program and one for recording experimental data, along with a set of EEG collection and analysis software from EGI company and a 128-channel electrode cap.

4.5 Results and Analysis

EEG data from 128 electrodes using the Hydrocel Geodesic Sensor Net were collected and processed using Netstation Acquisition software version 4.4.2, with a sampling rate of 500 Hz. Electrode impedance was adjusted to below 50 kΩ before recording began. A bandpass filter of 0.1-100 Hz was set. Epochs were extracted starting 100 ms before target stimulus onset, with a duration of 1100 ms. Based on the grand average waveform characteristics across all participants, EEG data were analyzed (see Figures 3 and 4 [Figure 4: see original paper]). P300 (260-500 ms) and LPC (500-900 ms) components were measured and analyzed. Nine electrode sites were selected for analysis (F3, Fz, F4, C3, Cz, C4, P3, Pz, P4). Electrodes were recorded as: electrode location (frontal: F3, Fz, F4; central: C3, Cz, C4; parietal: P3, Pz, P4) and laterality (left hemisphere: F3, C3, P3; midline: Fz, Cz, Pz; right hemisphere: F4, C4, P4). Statistical analyses were performed using SPSS 24.0, analyzing amplitude and latency of P300 and LPC components, with ANOVA P-values corrected using the Greenhouse-Geisser method.

Figure 3 Waveforms for Four Information Types
Figure 4 Topographic Maps for Four Information Types

P300 (260-500 ms)
A 4 (information type: self, mother, pet, celebrity) × 3 (electrode location: frontal, central, parietal) × 3 (laterality: left, midline, right) repeated measures ANOVA on mean amplitude showed a significant main effect of information type, $F(3, 26) = 7.69$, $p < 0.001$, $p^2 = 0.22$. Pet-reference evoked significantly lower P300 amplitude than self-reference ($p = 0.005$) and mother-reference ($p = 0.05$), with no significant difference from celebrity-reference ($p > 0.05$). Self-reference and mother-reference did not differ significantly ($p > 0.05$). The main effect of electrode location was significant, $F(2, 27) = 33.51$, $p < 0.001$, $p^2 = 0.55$. Frontal sites evoked significantly higher P300 amplitude than central ($p < 0.001$) and parietal sites ($p < 0.001$), with central sites evoking significantly

lower amplitude than parietal sites ($p = 0.004$). No significant effects were found for laterality or any interactions (ps > 0.05).

A $4 \times 3 \times 3$ repeated measures ANOVA on latency showed no significant main effects or interactions (ps > 0.05).

LPC (500-900 ms)
A 4 (information type: self, mother, pet, celebrity) $\times$ 3 (electrode location: frontal, central, parietal) $\times$ 3 (laterality: left, midline, right) repeated measures ANOVA on mean amplitude showed a significant main effect of information type, $F(3, 26) = 11.94$, $p < 0.001$, $p^2 = 0.58$. Pet-reference evoked significantly lower LPC amplitude than self-reference ($p = 0.003$), significantly higher amplitude than celebrity-reference ($p = 0.01$), with no significant difference from mother-reference ($p > 0.05$). Celebrity-reference was significantly lower than self-reference and mother-reference (ps < 0.001), while self-reference and mother-reference did not differ significantly ($p > 0.05$). The main effect of electrode location was significant, $F(2, 27) = 14.19$, $p < 0.001$, $p^2 = 0.51$. Frontal sites evoked significantly higher LPC amplitude than 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).

A $4 \times 3 \times 3$ repeated measures ANOVA on latency showed no significant main effects or interactions (ps > 0.05).

4.6 Summary

This study used personality trait word judgment tasks to explore processing characteristics of the pet reference effect among pet owners. Results showed that in LPC, compared to celebrity-reference information, pet owners evoked larger LPC amplitude under pet-reference information, demonstrating a pet-reference processing advantage. Compared to self-reference information, pet owners evoked smaller LPC amplitude 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 perform self-reference processing, which is a deep-level cognitive evaluation process. When personality trait word judgment is difficult, participants need more time to evaluate and decide, which may lead to LPC component activation. LPC reflects cognitive re-evaluation processes—the deeper the attribution of personal meaning and relevance to self-related information, the more attentional resources are allocated (Rubianes et al., 2020). Consistent with this, Zhong et al. (2014) found through personality trait word judgment tasks that in occupational situation selection, self-reference processing evoked higher LPC amplitude than general other-reference processing, reflecting individual self-reference effects.

This study explored the relationship between pets and pet owners' self and

examined memory processing characteristics of pet-related information using behavioral experiments and ERP technology. Results revealed that pet owners exhibit memory processing advantages for pet-reference information, evoking larger LPC amplitude, providing solid behavioral and electrophysiological evidence for the existence of the pet self.

General Discussion

5.1 The Pet Reference Effect

Study 1 explored the relationship between pet owners' pets and their self, preliminarily confirming the existence of the pet self. Study 1 was an explicit test where individuals were aware of their attitudes toward pets. Psychological research indicates that explicit attitudes are easily influenced by social desirability and belong to the category of conscious processing, while implicit attitudes can better reflect individuals'true attitudes because they are unconscious and belong to 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 the existence of 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) rather than "K" responses (reflecting familiarity without recollection). Study 2 found that the pet reference effect appeared in "R"responses but not in "K"responses, indicating that when facing pet-related information, pet owners unconsciously connect pets with self-representation (Van den Bos et al., 2010), thereby exhibiting processing advantages.

Applebaum et al. (2023) assessed the association between pet ownership and cognitive abilities in American adults, finding that compared to adults without pets, individuals who had owned pets for more than five years performed better on short-term and delayed word recall tests. This suggests that for pet owners, communicating with pets provides good exercise for the brain. Research also indicates 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 studies demonstrate that pets benefit pet owners'brain health and memory abilities. Study 2 confirmed the existence of the pet reference effect, indicating that this memory processing advantage may be a cognitive benefit brought by self-expansion.

5.2 Electrophysiological Basis of Pet-Reference Processing

Although behavioral experiments revealed that pet owners exhibit processing advantages for pet-related information similar to self and mother-related information, further ERP research showed differences. Study 3 found that in the context of self-reference information, pet owners showed significant self-reference

effects, evoking larger late LPC amplitude. Further comparative analysis revealed that when processing pet-reference information, pet owners' responses were similar to mother-reference information, both evoking large late LPC components, suggesting that pets occupy an emotional status similar to relatives in pet owners' minds. However, LPC amplitude evoked by pet-reference information was lower than that evoked by self-reference information. The LPC component is considered an indicator reflecting individuals' deep processing of information (Zhang et al., 2019). Previous research indicates that the closer the reference object' s social distance to the individual, the larger the evoked P3 or LPC amplitude (Chen et al., 2011). This finding supports our results: the social distance between humans and pets is greater than that with celebrities, and pet owners perform elaborate processing of self, mother, and pet-reference information, with processing depth higher than for celebrity-reference information. The importance of significant others in individuals' lives changes continuously (Hatteberg, 2020). Bi (2020) combined behavioral experiments and ERP technology to find that left-behind children' s self includes grandmother but not mother. Zhang et al. (2019) found that the core of pregnant women' s family intimate relationships follows a differential pattern of self-reference and spouse-reference. Similarly, pet owners also incorporate pets into their hierarchical structure of important attachment relationships (Meehan et al., 2017), forming cognitive and behavioral memory processing advantages. This indicates that, on one hand, pet owners have formed a special pet self similar to the mother relational self; on the other hand, the pet self maintains some distance from the individual' s core self. In the P300 component, pet owners evoked larger P300 amplitude under both self-reference and mother-reference information, showing clear self-reference and mother-reference effects, but P300 amplitude under pet-reference information did not differ significantly from celebrity-reference. In self-research, the distinction between using P300 or LPC as research indicators depends on experimental task difficulty and required processing time. In this experiment, participants needed to process information with different reference objects, indicating that pet owners' representational advantages when processing pet-related information mainly manifest in later processing stages after 500 ms.

5.3 Pet Self and Relational Self

Based on the discovery of the pet reference effect, we propose that pet owners incorporate pets into the self, forming a pet self. The pet self is a special relational self-cognition formed by individuals during the pet-raising process and constitutes part of individual self-identity. 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 relational level, pet owners view pets as family members (Kubinyi et al., 2009) or even as their children (Berryman et al., 1985). At the moral level, pet owners endow pets with moral status and are more inclined to save their own pets in moral dilemmas (Xu et al., 2022). At the cognitive level, this study found that pet owners have incorporated pets into the

self, exhibiting pet reference effects in memory. Through interaction with pets, people not only satisfy needs for companionship and emotional communication but also unconsciously construct a special "relational self." Relational self theory posits that the self is partially defined by others, and individuals experience different selves with different significant others (Hatteberg, 2020). Relational self emphasizes maintaining relationships between self and others, with this self-schema covering close acquaintances such as mothers. This study found that pet owners evoked LPC amplitude under pet-reference information similar to mother-reference, further confirming that for pet owners who have established intimate human-pet relationships, pets have become an inseparable part, virtually "family." Pet owners of different ages incorporate pets as different types of intimate relationship objects (Meehan et al., 2017; Allan et al., 2009), but without exception, pets provide important emotional value and companionship for pet owners. However, the importance of individuals' attachment network members differs in distance from the core self—the closer to the core self, the greater the processing advantage and the more attentional resources allocated (Julal et al., 2017). Tipper (2011) found that people prefer to use kinship terms to represent meaningful connections rather than simply using pets to replace missing persons in the kinship network. Pets are living beings independent of pet owners' relatives but similar to relatives (Mollica & Piantadosi, 2022). Therefore, the pet self maintains some distance from the individual' s core self and cannot surpass mother in importance. In summary, we propose a schematic diagram of pet owners' self-structure (see Figure 5 [Figure 5: see original paper]).

5.4 Dynamic Construction of Pet Self

The formation of pet self is complex. In the early stage of human-pet relationships, pet owners may keep pets based on interest, alleviation of loneliness, or sense of responsibility (Tuan, 1984), but pets' psychological status has not yet reached a level closely connected with self-identity. As the human-pet relationship establishes, deep emotional attachment develops between humans and pets (Barker et al., 1997). This attachment is based not only on mutual dependence in daily interaction (Czerwinski et al., 2016) but also includes emotional support and comfort (Auger & Amiot, 2019). During this process, pets gradually transform from "it" to part of "us," becoming important characters in individuals' life narratives (Liu-Pham et al., 2022). Pet owners begin to view pets' needs, happiness, and even life and death as part of their own responsibilities, and the pet image is gradually incorporated and enriches pet owners' self-identity. Pet speciesism suggests that humans tend to endow pets with human traits, emotions, and even social roles, promoting integration between pets and pet owners' self. Pet owners may share pets' daily moments on social media, endow pets with "family member" status (Allen et al., 2019), and in some contexts, pets become symbolic markers of pet owners' identity. This strengthened identity makes the pet self' s position in individuals' self-concept more stable—pets are no longer merely pets but become manifestations of emotional sustenance, life meaning, and even self-worth. Ultimately, pets' death triggers negative emotions in pet

owners, producing anxiety, grief, and other emotions (Axelrod, 2020; Compitus, 2019). Pets' disappearance from pet owners' lives poses significant challenges to pet owners' self-identity. During this stage, the pet self gradually separates from pet owners' psychological structure, but the memories and emotions left behind often become important resources for individual growth and self-reconstruction. Pet owners gradually adapt to life without pets through mourning, commemoration, and repositioning, while completing another reconstruction of self-identity. In summary, the construction of pet self is a complex and dynamic process that continuously develops with the deepening of human-pet relationships and is influenced by multiple factors.

5.5 Future Directions

Self-research has primarily focused on self-structure, East-West cultural differences, etc., with few studies exploring human-pet relationships. This study proposes the concept of pet self through investigating pet owners' self-concept and memory reference processing. This pet self is similar to relational self—pet owners view pets as an indispensable part of themselves, and pet-related information receives prioritized and efficient processing during information processing. This paper extends pure relational self to pet self and self-research to the human-pet relationship domain, thereby contributing to deeper investigation of the relationship between self and memory and constructing self-related theory. This can help individuals better recognize that their self includes pets, more deeply analyze the positive effects of pets on physical and mental health, and this benign cognitive-emotional cycle also benefits greater harmony between humans and nature. However, this study has certain limitations. First, pet types were not differentiated. Some pets (e.g., dogs, cats) can have positive interactions with pet owners, while others (e.g., turtles) have much poorer interactivity. Different pet types cause different degrees of attachment, resulting in different degrees of pet self. Future research could differentiate pet types to further explore pet self formation under different pet types. Second, pet owner types were not differentiated, such as active versus passive pet owners. These two types of pet owners have different attachment levels to pets, and in some families, passive pet owners' attitudes toward pets 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 living in different cultures have vastly different attitudes toward animals, resulting in large differences in their pet self. For example, in some regions of China (e.g., Yulin) and some ethnic groups (e.g., Korean ethnicity), dog meat is considered a delicacy, and their attitudes toward pet dogs may differ greatly. Finally, comprehensive research on pets reveals that pet owners' feelings toward pets are complex—some consider pets their children, while others consider them friends. Based on previous research findings, different relational selves formed by different kinship relationships in human self differ and are at different distances from the core self. In summary, pet selves formed by different types of pet owners and their strengths differ, and

future research could explore this perspective in depth.

Conclusions

1. Pet owners incorporate pets into the self, forming a special pet self.
2. Pet owners exhibit pet information processing advantages in memory tasks, namely the pet reference effect.
3. The pet self is a relational self that maintains some distance from the core self.

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