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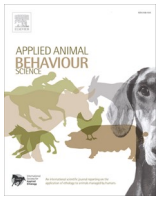

Is companion animal loss cat-astrophic? Responses of domestic cats to the loss of another companion animal

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ABSTRACT

The examination of grief in nonhuman animals has historically been limited to anecdotal evidence. Recent investigations suggest that the psychological experience of loss may be widespread within the animal kingdom. Many studies have examined caregiver grief following the death of a companion animal but few have examined how other companion animals respond to these deaths. We sought to examine predictors related to the response of surviving domestic cats, following the death of a companion animal within the same household. A total of 412 cat caregivers were surveyed regarding both caregivers' and surviving cats' (n = 452) relationship with the deceased pet as well as possible immediate and long-term behavioral changes following the loss of a companion animal within the household. Amount of time spent engaging in activities together in a typical day predicted caregiver reports of increases in grief-like behaviors and fearfulness in surviving cats. More positive relationships between the deceased animal and surviving cat predicted decreases in sleeping, eating, and playing. The longer the cat had lived with the deceased animal, the more the caregivers reported increases in attention-seeking following the death. However, higher levels of caregiver attachment also predicted reports of increases in attention seeking behavior, which may reflect anthropomorphism in the projection of caregiver grief onto surviving companion animals. Consistent with this hypothesis, caregivers who experienced greater grief were more likely to report increases in their surviving cats' sleep, spending time alone and hiding following the death. If caregivers reported avoidant attachment with the deceased cat, they reported greater decreases in grief-like behaviors in surviving cats following the death, suggesting that caregivers without strong, secure attachment binds were less likely to perceive that their surviving animals experienced grief. This is only the second known exploration of domestic cats' responses to the death of another companion animal and reveals that cats exhibit similar grief-like behavioral changes following such deaths compared to dogs examined in previous work. That is, they engaged less in sleeping, eating and playing but more in seeking attention from humans and other pets, hiding, spending time alone and appearing to look for their lost companions. Future work is needed to determine whether these results reflect caregivers projecting their own grief onto surviving animal companions or whether cats may also experience grief following companion loss.

1. Introduction

Grief in nonhuman animals has been discussed since Darwin (1998) and Brown (1879) independently noted primate behaviors resembling grief in response to separation or loss. Nevertheless, grief, mourning, and bereavement behaviors have remained understudied in nonhumans, with Bowlby (1961) and Pollock (1961) noting a lack of systematic study of mourning behaviors in nonhumans nearly 100 years after Darwin's observations. It is challenging to empirically investigate grief in nonhumans, with researchers historically reluctant to attribute complex emotions to nonhumans (Anderson, 2016; Brosnan and Vonk, 2019; Vonk et al., 2024). The examination of grief in nonhumans has thus depended upon anecdotes, with observations of withdrawal, apathy, rejection, hostility, lethargy, and attempts to recover the lost individual (Bowlby, 1961) noted in such species as jackdaws (Averill, 1968; Bowlby, 1961; Lorenz, 1952), geese (Averill, 1968; Bowlby, 1961; Lorenz, 1966), dogs (Averill, 1968; Bowlby, 1961; Lorenz, 1954; Pollock, 1961), and chimpanzees (Averill, 1968; Nissen, cited by Bowlby, 1961; Goodall, 1990; Pollock, 1961). Recently, the field of comparative thanatology - the systematic study of behavioral and psychological

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responses of nonhumans to death (Anderson, 2016) - has brought into focus responses to dead conspecifics in species such as elephants (Douglas-Hamilton et al., 2006), black-billed magpies (Miller and Brigham, 1988), western scrub-jays (Iglesias et al., 2012), dolphins (Bearzi et al., 2018, 2017; Jones et al., 2021), whales (Bearzi et al., 2017, 2018), and multiple species of primates (see Brosnan and Vonk, 2019 and Gonçalves and Carvalho, 2019 for reviews). These studies suggest that the psychological experience of loss may be widespread within the animal kingdom.

Grief has been posited as a biological component of bereavement behavior with phylogenetic evolutionary origins (Averill, 1968; Pollock, 1961). The "GRIEF" primary process emotional system, engaged following separation distress, is aroused by neurochemicals associated with social attachment and bonding, and has been mapped to similar regions in the brains of multiple mammalian species (Panskepp, 2010). Such findings suggest an adaptive significance for grief, with Averill (1968) hypothesizing the importance of grief in maintaining bonds and group cohesion in social species following loss. Although evolved from relatively asocial wild cats, domestic cats present an opportunity to examine grief for other companion animals given their presence in human households and a demonstrated flexible social structure with feral domestic cats often forming colonies (Bernstein, 2006; Crowell-Davis et al., 2004; Macdonald et al., 1987; 2000; Vitale Shreve and Udell, 2015). We surveyed companion cat caregivers for evidence of behavioral change following the loss of another companion animal in the household. If domestic cats show evidence of behavioral change in line with behaviors that have been shown to change with human grief, it is the first step to identifying their potential capacity for grief and might suggest that an evolutionary history of group-living is not a prerequisite for grief.

In the absence of the capacity for animals to directly communicate feelings of loss (Anderson, 2016), researchers interested in animal grief must rely on observations of animals' behavior and may rely on caregiver perceptions of changes in companion animal behaviors following loss, although these reports are likely biased. Caregiver perceptions have been instrumental in the identification of stress and emotional responses in nonhumans (Mariti et al., 2012; Morris et al., 2008). Recently, authors (Uccheddu et al., 2022; Walker et al., 2016) explored grief in surviving fellow companion animals by surveying caregiver perceptions with regard to notable behavioral changes in companion animals following companion loss within the same household. Domesticated dogs were perceived to have exhibited negative behavioral changes in activity level and emotion following the loss of a conspecific, including decreases in playing and eating as well as increases in fearfulness, vocalizations, and attention-seeking. Predictors of these changes included previous food sharing, the nature of relationship the conspecifics shared ("friendly" or "parental"), and the caregiver's reaction of grief or anger to the loss of the companion animal (Uccheddu et al., 2022). Similarly, companion dog and cat caregivers noted changes in affectionate and territorial behaviors with both species reported to exhibit increased attention seeking from caregivers as well as increased time spent in the deceased companion animal's "favorite spot." Dogs were described as decreasing the speed and volume of food consumption, whereas cats were reported to increase the volume and frequency of vocalizations following the loss (Walker et al., 2016). Whereas dogs, descended from pack animals, might reasonably respond more strongly to the death of a conspecific, cats under human care have adapted to live among conspecifics and their capacity to respond to the loss of a companion warrants further study. We investigated caregiver perceptions of immediate and long-term behavioral responses to companion animal death in domesticated cats. We examined various factors related to the relationship between the surviving and deceased animals and their caregivers, and the surviving animal's own history and exposure to the companion's death. Notably, we extended the previous work to include measures of caregiver attachment strength and attachment styles.

2. Method

2.1. Participants and procedure

The study was reviewed and approved by Oakland University's IRB (#FY2023–269). We recruited 637 cat caregivers from various online listservs and Facebook groups and a Psychology research participant pool at a midwestern university. Respondents needed to have had a companion animal die while at least one surviving cat also lived in their household. We eliminated data from 182 participants for whom data were incomplete, 37 that failed two or more attention checks, and 6 who were outliers on at least one variable. The remaining 412 pet caregivers had an average age of 31.93 years (SD = 16.36). The majority were female (n = 340, 82.5 %) and White (n = 340, 82.5 %). There were 384 pet caregivers that reported on a single cat and 28 that reported on a second cat.

Of the 452 cats (240 females, 197 males, 15 sex unreported) that lost a companion, 281 reacted to the death of another cat, while 171 reacted to the death of a dog.

2.2. Measures

Participants answered demographic questions as well as a series of questions about the pet they had lost and the surviving cat whose behavior was the focus of the study. For example, they indicated how long it had been since the pet's death, the circumstances of death, where the pet passed away, and whether the surviving cat witnessed the death. They indicated how they acquired the surviving pet, the role that cat played in their life, the surviving cat's age when their companion died, how long the pets had lived together at the time of death, and the early life experience of the surviving cat. Other measures included questions about how much time in an average day the surviving cat spent with the pet that died, alone, indoors/outdoors, and with people; the quality of the relationship with the deceased pet including adjectives such as distant, aggressive, warm and friendly, playful, competitive, nurturing and tolerant. Respondents rated these items on a 5-point scale from strongly disagree to strongly agree. Aggressive and competitive items were reverse scored and an average score was used in analyses, with higher scores indicating more positive relationships. Respondents were asked if the surviving cat was related to the pet that passed away. They were then asked how much time the two companion animals spent engaged in the following activities in the months prior to the death; sleeping, playing, fighting, sharing food or toys, grooming, interacting with the same person. Respondents used a 5-point scale from never to constantly to respond to this question and the average score across all behaviors was used as the "activities" measure in analyses.

For the outcome measures, participants used a 5-point scale to indicate how much the following behaviors of the surviving cat had changed (from much less than before to much more than before with scores of 3 indicating no change) both in the days immediately following the other pet's death and in the weeks or months (long-term) following the death; sleeping, eating, playing, vocalizing, spending time alone, hiding, seeking attention from humans, sitting or laying on or near humans, acting fearful, being curious, interaction with other pets in the home if applicable, grooming, appearing to be looking for the lost pet, sniffing areas where the other pet spent time. Respondents were also asked to indicate if they noticed any other interesting responses not captured in the preceding list and to describe those behaviors briefly.

Lastly, they completed the following pre-existing measures of attachment and grief:

2.2.1. CENSHARE pet attachment scale

The Center for the Study of Human-Animal Relationships and Environment Pet Attachment Scale (Holcomb, Williams and Richards, 1985) is a 27-item scale that measures maintenance and intimacy of relationships with companion animals. Respondents indicated how much items,

such as "You talk to your pet as a friend" described themselves and the surviving cat using a Likert scale of Almost Never (1) to Almost Always (4), α = 0.92.

2.2.2. The Companion Animal Bonding Scale (The CABS)

The Companion Animal Bonding Scale (Poresky et al., 1987) is an 8-item scale that captures caregiving activities with the surviving cat, including items such as "How often does your companion animal sleep in your room?" Respondents indicated how much each statement described themselves from Never (1) to Always (5), α = 0.84.

2.2.3. The Pet Attachment Questionnaire (PAQ)

This 26-item measure of attachment style (Zilcha-Mano et al., 2011) includes two subscales of 13 items each; Avoidant (α = 0.95) and Anxious (α = 0.88) attachment styles. An example item for avoidant attachment is "I feel distant from my pet." An example item for anxious attachment is "I need a lot of reassurance from my pet that it loves me." Participants responded regarding their attachment to the deceased pet on a 7-point Likert scale from strongly disagree to strongly agree.

2.2.4. Pet bereavement questionnaire

Pet bereavement was measured using the 16-item Pet Bereavement Questionnaire (Hunt and Padilla, 2006), which assesses the psychological impact of losing a pet, including grief, anger and guilt. We used only the total score here. Respondents indicated their agreement with statements such as "I cry when I think about my pet" with regard to the deceased pet using a scale of disagree strongly (1) to agree strongly (4), α =0.86.

Respondents were given the opportunity to repeat the survey for another surviving cat if desired.

2.3. Statistical analysis

We computed the bivariate zero-order correlations between the predictor and outcome variables and report these along with the descriptive statistics in Table 1.

We conducted exploratory factor analyses separately for the immediate behavioral change variables and the long-term behavioral variables. We performed an oblique Promax rotation with restrictions to Eigenvalues greater than 1.0 and no restrictions on the number of extracted factors, including all 14 behavior items for each analysis. We included items in components if the factor loadings were >.30. Where items were cross-loaded, we assigned them to the component with the higher positive factor loading, except in the case of hiding, which was assigned to "Grief" instead of "Sleep, Eat, Play" because it was a better conceptual fit for the Grief category.

We conducted eight linear regressions in which the eight components identified in the factor analyses were regressed on caregivers' avoidant and anxious attachment styles and grief for the deceased pet, attachment strength to the surviving cat, as well as the time the animals spent together in an average day (time), length of time they had lived together (length), time spent engaging in activities together (activities), relatedness, and quality of relationship score. Also entered into the regression equations were the surviving cats' sex (female = 1, male = 2), the deceased companion species (cat = 1, dog = 2), the number of cats and dogs that the caregiver had owned at the time of the death, and whether the cat witnessed the death. Because we conducted eight regressions, we applied a Bonferroni correction and used an alpha of.006 as the cut-off for significance. We examined the collinearity statistics for multicollinearity and found the VIFs to be acceptable.

3. Results

3.1. Descriptive statistics and correlations

Descriptive statistics and correlations between the predictors and each of the eight outcome variables are presented in Table 1. Avoidant attachment was negatively correlated with all outcomes except for long-term grief, whereas attachment strength was positively correlated with change in all behaviors except for immediate fear, long-term hiding, eating and playing. The caregiver's anxious attachment style and grief for the deceased pet were not strongly correlated with the outcomes. The animals' relationship, time spent engaging in activities, and length of time they had lived together were correlated with some, but not all, outcomes. Whether the animals were related, the surviving animal had witnessed the death, or the number of cats and dogs in the home at the time of death were not strongly correlated with reported behavioral change.

3.2. Factor analyses

The results of the two factor analyses were very similar, although the loadings resulted in slightly different components for immediate and long-term behavioral changes. For immediate changes, four components emerged, accounting for 60.95 % of the variance. The components were labelled as Attention-Seeking, Grief, Sleep Eat Play, and Fear (see

Table 1
Zero Order Correlations Between Predictors (rows) and Outcomes (columns) and Descriptive Statistics.

	Attention	Grief	Sleep Eat Play	Fear	Attention LT	Grief LT	Hide LT	Eat Play LT	Mean	SD
1. Avoidant	-0.243***	-0.280***	0.124*	-0.133***	-0.234***	-0.094	-0.101*	0.110*	1.849	1.010
2. Anxious	-0.099	-0.109*	0.101*	-0.058	-0.050	0.025	-0.051	0.002	2.889	1.081
3. Attachment	0.318***	0.244***	-0.097*	0.088	0.286***	0.141**	0.051	-0.036	0.026	0.915
4. Grief (PBQ)	-0.022	0.066	0.057	0.088	-0.032	0.079	0.125**	-0.070	2.441	0.507
5. Sex	-0.034	-0.052	-0.034	-0.066	-0.002	0.036	-0.004	-0.062	1.450	0.498
6. Species	-0.013	-0.048	0.031	-0.046	-0.029	-0.001	0.010	0.102*	1.380	0.486
7. Witnessed	0.172**	-0.025	0.052	0.088	0.141**	0.027	-0.014	0.073	1.220	0.413
8. Time	0.159**	-0.180***	0.108*	0.039	0.200***	0.076	0.097*	-0.088	2.360	1.237
9. Length	0.148**	-0.043	0.081	-0.050	0.200***	0.074	0.064	-0.117*	3.040	1.302
10. Activities	0.156**	0.327***	-0.131**	0.206***	0.095	0.161***	0.136**	-0.182***	18.268	4.528
11. Related	0.005	0.075	-0.041	0.052	-0.006	0.076	0.051	-0.037	0.128	0.334
12. Relationship	0.111	0.309***	-0.219***	0.173***	0.067	0.076	0.175***	-0.252***	3.654	0.829
13. #Cats	0.101	-0.011	0.045	-0.061	0.053	-0.023	0.004	0.008	2.020	3.107
14. # Dogs	-0.033	-0.033	0.065	-0.091	0.041	0.013	0.008	0.034	0.790	0.961
Mean	3.306	3.526	2.729	2.617	3.324	3.226	3.102	2.842		
SD	0.706	0.644	0.589	0.600	0.615	0.842	0.591	0.674		

Note.
SD = standard deviation, LT = long-term
* indicates $p<.05$,
** $p<.01$,
*** $p<.001$,

Table 2
Factor Structure and Factor Loadings of Immediate Behavioral Changes.

	Components			
Behavior	**Attention-Seeking**	**Grief**	**Sleep, Eat, Play**	**Fear**
Vocalizing	.594	.166	-.019	-.146
Seeking Attention from Humans	.882	.025	-.043	-.156
Time Near Humans	.881	.098	.008	-.253
Curious	.472	-.080	.234	.364
Interact with Animals	.650	-.165	.123	.196
Time Alone	-.391	.566	.362	-.026
Hide*	-.254	.394	.419	.076
Look for Deceased	.164	.724	.006	.165
Sniff Deceased Places	.328	.633	-.009	.135
Sleep	-.012	.192	.511	-.584
Eat	.022	-.349	.477	.081
Play	.053	-.592	.425	.061
Fear	.033	.211	.099	.447
Groom	.292	-.110	.243	.207
% Variance	25.785	17.554	9.620	7.989

* *Note*. Hiding loaded on to both "Grief" and "Sleep Eat Play." Although the factor loading was higher for "Sleep Eat Play," we included this item in the component "Grief," which was a better fit conceptually.

Table 2).

For long-term changes, four components emerged, accounting for 63.06 % of the total variance. The components were labelled as Attention-Seeking, Grief, Hide, and Eat Play (see Table 3). A comparison of Tables 2 and 3 reveal that the factor structure was similar for immediate and long-term behavioral changes with the exception that spending time alone and hiding were included in Grief for immediate change, but were included with sleep for long-term changes. It should be noted that these items cross-loaded on Grief and Hide. Eating and Playing comprised a fourth component for long-term changes, whereas they were included with sleep for immediate changes. Fear was a single-item component for immediate change but the factor loading was weak for long-term changes so it was not included in those analyses. Factor loadings for grooming were < 3.0 for both time-points, so grooming data were also not included in analyses. Eight variables were constructed from these components, taking the average of the items included in each component and standardizing that average score.

3.3. Linear regressions

3.3.1. Immediate changes in attention-seeking

The caregiver's strength of attachment to the surviving animal, (β =.266, t = 3.475, p <.001, 95 % CI:.123,.445), was the only predictor of reported changes in attention-seeking behaviors. The more attached the caregiver was to the surviving animal, the more they perceived that animal to seek out more attention from both humans and other animals in the days following the death.

3.3.2. Immediate changes in grief

Time spent in activities together predicted increases in reported grief-like behaviors, (β =.247, t = 4.412, p <.001, 95 % CI:.126,.354). If the caregiver had a high level of avoidant attachment to the deceased pet, they were more likely to predict decreases in grief-like behaviors following the death (β = −.255, t = −4.064, p =.001, 95 % CI: −.395, −.138) compared to before the death.

3.3.3. Immediate changes in sleeping, eating and playing

The relationship between the companion animals was the only significant predictor of decreases in sleeping, eating, and playing, (β = −.188, t = −3.058, p =.002, 95 % CI: −.310, −.067). The more positive the relationship between the animals, the more a decrease in sleeping, eating and playing after the death was reported.

3.3.4. Immediate Changes in Fear

Time spent in activities together was the only significant predictor of increases in fearfulness, (β =.179, t = 2.843, p =.005, 95 % CI:.054,.294). The more the animals had engaged in activities together prior to the death, the more fearful they were reported to be after the death.

3.3.5. Long-term changes in attention-seeking

The caregiver's strength of attachment to the surviving animal, (β =.262, t = 3.673, p <.001, 95 % CI:.130,.432) and the length of time the animals had lived together (β =.177, t = 3.045, p =.003, 95 % CI:.050,.232) were the only predictors of increases in long-term attention-seeking behaviors. The more attached the caregiver was to the surviving animal and the longer the animals had lived together, the more the caregivers perceived that animal to seek out more attention in the weeks and months following the death.

3.3.6. Long-term changes in grief

There were no significant predictors of changes in grief-like

Table 3
Factor Structure and Factor Loadings of Long-term Behavioral Changes.

	Components			
Behavior	**Attention-Seeking**	**Grief**	**Sleep, Alone, Hide**	**Eat, Play**
Vocalizing	.438	.203	-.019	-.146
Seeking Attention from Humans	.791	.148	.131	-.317
Time Near Humans	.737	.153	.058	-.354
Curious	.408	.057	-.099	.340
Interact with Animals	.573	-.017	-.018	.202
Time Alone	-.331	.363	.466	-.108
Hide*	-.248	.333	.434	.045
Look for Deceased	.001	.727	-.238	.182
Sniff Deceased Places	-.044	.672	-.338	.125
Sleep	.019	.189	.382	-.052
Eat	.181	-.092	.315	.329
Play	.388	-.233	.169	.430
Fear	-.006	.212	.245	.226
Groom	.245	.014	.031	.217
% Variance	25.964	16.640	10.770	9.684

behaviors in the weeks and months following the death.

3.3.7. Long-term changes in sleeping, spending time alone and hiding

The caregiver's grief was the only significant predictor of increases in sleeping, spending time alone, and hiding, (β =.171, t = 3.035, p =.003, 95 % CI:.061,.287). The more grief the caregiver reported having felt, the more they reported that the surviving animal slept, spent time alone, and hid more following the death compared to before.

3.3.8. Long-term changes in eating and playing

The relationship between the animals, (β = −.267, t = −4.493, p <.001, 95 % CI: −.389, −.152) was the only significant predictor of changes in eating and playing. The more positive the relationship between the animals, the more the caregivers reported significant decreases in eating and playing in the weeks and months following the death.

4. Discussion

Caregiver grief related to the death of a companion animal has been widely studied (e.g., Adams et al., 1999; Cleary et al., 2022; Chur--Hansen, 2010; Field et al., 2009; Jordan and Vonk, 2024; López-Cepero et al., 2024; O'Connor et al., 2022; Planchon et al., 2002; Wong et al., 2015; Wrobel and Dye, 2003), but little is known about whether other companion animals in the household also experience grief at the loss. We focused on caregiver assessments of behavioral changes in cats after the death of another cat or dog within the household. We found similar changes to those reported by Walker et al. (2016) in that cats showed increases in attention-seeking, vocalizing, and decreases in eating. Furthermore, aspects of the surviving cats' relationships with the deceased pet predicted immediate and long-term behavioral changes in the direction that would be expected if cats were capable of grief-like responses. Most notably, time that companion animals spent together engaged in daily activities predicted greater grief-like behaviors and fearfulness, while more positive relationships between the surviving and deceased animals predicted decreases in sleeping, eating and playing. The length of time the animals had lived together predicted increased attention seeking behaviors in the weeks and months following the companion's death. These results are consistent with those of Uccheddu et al. (2022) who found positive relationships (i.e., "friendly" and "parental") predicted negative behavioral changes in dogs following loss of a conspecific, suggesting that cats and dogs may respond similarly to the loss of a companion despite differences in their natural social structures and behavior.

Although cats evolved from a relatively asocial ancestor, domesticated cats are socially flexible and can live solitarily or in groups (Bernstein, 2006; Crowell-Davis et al., 2004; Macdonald et al., 1987; 2000; Vitale Shreve and Udell, 2015). Group congregation of free-ranging domesticated cats is a non-random structured social gathering of individuals that frequently seek out "preferred associates" (Bernstein, 2006; Crowell-Davis et al., 2004; Denny et al., 2002; Macdonald et al., 2000; Wolfe, 2001). "Preferred associates" exhibit a social bond through increased proximity-seeking and affiliative behavior, even in non-resource-seeking contexts (Crowell-Davis et al., 2004; Wolfe, 2001). Cats demonstrate increased proximity-seeking and decreased agonistic behavior with familiar cats due to prolonged cohabitation (Barry and Crowell-Davis, 1999; Curtis et al., 2003). Thus, it is not surprising that their relationship with their lost companion predicted greater behavioral response to loss.

Cats did not respond significantly differently to the loss of a companion dog or another cat. Despite different communication signals, dogs and cats can live peacefully together, due in part to a cat's

receptiveness to interacting with the dog, with the level of comfort a cat exhibits around a dog being more dependent upon the cat than the dog (Menchetti et al., 2020; Thomson et al., 2018). Menchetti et al. (2020) noted that many cats and dogs sharing a household were reported to sleep and play together. Therefore, cats could have also responded to losing a positive relationship with a dog as a possible interspecific "preferred associate."

Although our results are consistent with the idea that domestic cats respond to the loss of their animal companions, it is also possible that the caregivers' reports reflect bias such that caregivers are projecting their own feelings of loss onto surviving animals. Consistent with this perspective, caregivers with stronger attachments to surviving cats reported greater increases in attention-seeking behavior in their cats compared to caregivers lower in attachment. Furthermore, caregivers that reported feeling greater grief over the loss of their animal companions were also more likely to report that their surviving cats spent more time alone, sleeping, and hiding following the death compared to those that reported less grief. Finally, caregivers that had avoidant attachment styles with their deceased animal, attributed less grief-like behavior to their surviving cats compared to caregivers that did not exhibit avoidant attachment styles. Caring for companion animals can influence the belief that companion animals experience grief (Walker et al., 2023). Attachment strength has been related to grief following loss (Field, et al., 2009; López-Cepero et al., 2024) and greater adverse grieving experience has been linked to anthropomorphizing of companion animals (Behler et al., 2020; López-Cepero et al., 2024; Uccheddu et al., 2019). The relationship between attachment and grief following pet loss is mediated by higher levels of anthropomorphism in animal caregivers (Behler et al., 2020). Caregivers with higher levels of attachment to surviving pets may have projected grief behaviors onto them. Avoidant attachment has been associated with greater acceptance of a companion animal's death, with higher scores indicating indifference to the loss (Zilcha-Mano et al., 2011). Caregivers with greater avoidant attachment in the current study may have exhibited less difficulty accepting the loss of the pet and been less likely to project their feelings onto the surviving pet. The perceived responses of surviving cats should be interpreted tentatively due to this evidence of increased anthropomorphism in grieving pet caregivers.

In addition to the possibility that caregiver bias led them to report changes in their companion animals' behavior, it is likely that owners with stronger attachments to the deceased and surviving cats behaved differently following the death compared to those lower in attachment. In particular, highly attached caregivers may have altered their behavior toward the surviving cat in ways that influenced that cat's behavior. For example, more strongly attached and bereaved caregivers may have sought comfort from their surviving cats, spending more time with them and therefore being more attentive to changes in their behavior, or more likely to engage in behaviors like play or providing extra treats. In our study, it is not possible to remove the caregiver's influence from reports of the surviving cats' responses. It is possible that the caregivers' grief, rather than that of the cats themselves, altered the surviving cats' behaviors.

We predicted that more anxiously attached caregivers would be more likely to perceive strong responses in their cats, due to projecting their own feelings on to their surviving cats but anxious attachment style was not linked to perceptions of behavioral changes in surviving cats. Although somewhat surprising, this finding is consistent with other work showing stronger effects of avoidant attachment styles in terms of likelihood to surrender pets or to report problem behaviors and concerns with caring for companion animals (Vonk et al., 2023). Both avoidant and anxious attachment styles are negatively associated with beliefs in animal minds (Vonk et al., 2023). Such beliefs are associated with greater attribution of secondary emotion, but only avoidant attachment style predicts less attribution of primary emotions to cats (Vonk and Bouma, 2024). The current results are consistent in suggesting that those with avoidant attachment styles may be less sensitive to expression of emotion in cats, or perhaps less likely to over-attribute such emotions. There is a need to develop more objective means to assess the emotional states of animals, which will aid in differentiating between these explanations.

4.1. Limitations and future directions

Although we surveyed caregivers about many aspects of their companion animals, we did not ask about spay/neuter status. Spaying or neutering cats can increase the frequency of affiliative behaviors and decrease agonistic behaviors (Crowell-Davis et al., 1997; Finkler et al., 2011; Neville and Remfry, 1984; Vitale, 2022). Altered cats spend less time around conspecifics following the spay/neuter procedure (Cafazzo et al., 2019; Vitale, 2022). Future research examining loss should incorporate the examination of spay/neuter status for both animals. The most serious limitation of our study is that we relied on caregiver reports rather than direct observations of the animals before and after their companions' deaths. Given that pet deaths are not always anticipated well in advance, it is challenging to obtain relevant behavioral observations. Furthermore, if the death is anticipated, it is possible that conspecifics are reacting to cues of illness or injury in the weeks preceding the death. Nonetheless obtaining pre and post behavioral interaction data should be a priority for future work. Ideally, we would also have asked about changes in caregivers' own behavior following the loss.

4.2. Conclusions

Despite some limitations, the current study adds to the very limited data on social cognition of cats, especially with regard to their understanding of conspecifics and heterospecifics. Researchers are only beginning to address the paucity of empirical data on nonhuman understanding of death – particularly in cross-species interactions - and the current study adds to this growing area by showing that cats may be impacted by the death of companions and more strongly so when they have spent more time engaged in more activities and have more positive relationships with the lost companion. Our results are consistent with the idea that cats may experience the loss of companion animals in ways similar to what dogs experience despite having evolved from a less social ancestor and may contribute to shifts in our conceptualization of cats as asocial and aloof.

CRediT authorship contribution statement

Jennifer Vonk: Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Brittany Greene:** Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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