







Types of Environmental Enrichments Offered for Cats and their Association with Housing Features and Cat Personality

Luana da Silva Gonçalves ^a, Daiana de Souza Machado ^b, Isadora de Castro Travnik ^c, and Aline Cristina Sant' Anna ^d

^aPrograma de Pós-graduação em Biodiversidade e Conservação da Natureza, Universidade Federal de Juiz de Fora, Juiz de Fora, Brasil; ^bPrograma de Pós-graduação em Psicologia Experimental, Instituto de Psicologia, Universidade de São Paulo, São Paulo, Brasil; ^cLaboratório de Bem-estar Animal, Universidade Federal do Paraná, Curitiba, Brasil; ^dFaculdade de Ciências Agrárias e Veterinárias, Unesp Campus de Jaboticabal, São Paulo, Brasil

ABSTRACT

Environmental enrichment designed in accordance with the cats' individuality and household characteristics is one of the most effective and widely used tools to enhance feline welfare. This study aimed to evaluate the types of environmental enrichments provided by cat guardians and their associations with housing features and cat personality. An online questionnaire was developed including questions about types of enrichment provided, housing features (indoor vs. outdoor, house vs. apartment), and a scale with 18 personality traits. A total of 3,083 responses were collected. Most of the guardians declared to provide environmental enrichment items for their cats. The items most offered were play interaction (77.4%), access to a balcony and/or window with a protective net (72.7%), places to hide (54.5%), and toys (46.0%). The items with lower frequencies were water fountains (34.5%), self-groomers (11.3%), outdoor walks on a leash (6.5%), and food puzzles (3.5%). The choice of enrichment items was more related to housing features than to the cat's personality. Enrichment provision was more associated with indoor housing and cats living in apartments than with cats living outdoors and in houses.

ARTICLE HISTORY

Received 27 September 2023
Accepted 23 December 2024


KEYWORDS

Behavior; domestic cats; temperament; welfare

Introduction

The growing number of domestic cats in Brazil and all over the world elevates the importance of a discussion regarding how these animals are kept by their guardians, as well as raises concerns regarding their welfare. According to data collected by the Instituto PET Brasil (2022), so far, the country currently has 27.1 million pet cats, being the third most common species in Brazilian households, behind dogs (58.1 million) and birds (41 million). Between 2020 and 2021, a growth in pet cats of 6% was recorded. Some authors suggest that the increase in people's preference for cats as companion animals occurs as a result of modern life, a process called verticalization (Foreman-Worsley et al., 2021). Thus, a busy routine, combined with long working hours and small living spaces, may lead people to choose cats, driven by the belief that they require less care (Downey & Ellis, 2008; Grigg & Kogan, 2019). As a result, more cats live in small spaces and are left alone for long periods. Most are exclusively confined in the house (indoors) and/or share their living space with other animals (Sonntag & Overall, 2014). By keeping the cat indoors only, guardians can avoid problems such as cat poisoning, being run over, and contagion of diseases, among others. However, if their behavioral demands are not met, their welfare may also be compromised (Rochlitz, 2004a,

CONTACT Aline Cristina Sant' Anna  aline.santanna@unesp.br  Departamento de Zootecnia, FCAV - Unesp, Campus de Jaboticabal. Road Prof Paulo Donato Castellane Castellane S/N - Vila Industrial, 14884-900, Jaboticabal, São Paulo, Brasil

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/10888705.2024.2448339>.

2004b). One of the factors that can affect the welfare of cats kept indoors is the absence of environmental enrichment (Ellis, 2009).

Environmental enrichment can be defined as interventions to promote opportunities for interactions and environmental complexity (Westropp & Buffington, 2004). These interventions can be related to food provision, social, structural, sensory, and cognitive. It provides mental and physical stimuli, enhances the development of a normal behavioral repertoire, and prevention and/or reduction of behavioral problems (Alho et al., 2016; Strickler & Shull, 2014; Westropp & Buffington, 2004).

A monotonous and predictable environment can contribute to illness and behavioral problems, reducing levels of animal welfare (Buffington & Bain, 2020). Cats left alone for long periods during the day are more likely to develop separation-related problems and may have several behavioral problems in the guardians' absence (Machado, Oliveira, et al., 2020). The level of welfare is also related to multiple other factors, such as types of social relationships, characteristics of the environment, and availability of resources, such as water, food, litter boxes, and environmental enrichment (Foreman-Worsley et al., 2021; Windschnurer et al., 2022).

A survey evaluating care practices and interactions of guardians with their cats in two environments, indoor and outdoor, revealed that many cats in Brazil are raised exclusively indoors (Machado, et al., 2020; Machado et al., 2021). Outdoor cats benefit from a dynamic environment naturally rich in stimuli, with less predictability and more space for exploration. In contrast, indoor cats lack these benefits, making the provision of enrichment crucial. Without adequate enrichment, indoor environments may fail to provide the necessary stimuli to maintain good welfare levels, potentially leading to behavioral problems (Windschnurer et al., 2022). Environmental enrichment items provide opportunities for indoor cats to express their natural behavioral repertoire, such as playful and hunting behaviors (Casey & Bradshaw, 2005; Ellis, 2009; Windschnurer et al., 2022).

However, much of the research investigating the effectiveness of environmental enrichment focuses on studying cat populations in general. They generally overlook the different emotional states and personalities among individual cats. These factors can influence how cats respond to enrichment interventions (Ellis, 2009). An exception is the study by Ellis et al. (2021), which examined the effects of providing a hiding box or shelf on the behavior and fecal glucocorticoid metabolites of bold and shy cats housed in single cages. Their findings highlight the important role that personality plays in cats' responses to environmental enrichment.

In addition to environmental enrichment, assessing cats' personalities (or temperaments) can also serve as a valuable tool to enhance care practices and improve animal welfare. These terms are sometimes used with different meanings by some authors, with personality defined as individual differences in behavior that remain stable over time and across contexts (Briffa & Weiss, 2010; Gartner et al., 2014). In turn, temperament refers to individual reactions to challenging situations that emerge early in life and are influenced by genetics (Ha & Ha, 2017; MacKay & Haskell, 2015). However, the choice of the term is often influenced more by tradition within each field of study than by their conceptual distinctions, as discussed by MacKay and Haskell (2015). In this study, we will use the term "personality" as it is more commonly applied in the domestic cat studies cited in this paper.

Despite the most cited personality definition presupposing the stability of an animal's personality, there are several studies suggesting that personality traits can change according to the environment to which cats are exposed. For example, a questionnaire survey with guardians revealed the influence of cats' environment (indoors or outdoors) on their personality, as indoor cats can be less active and more aggressive toward their conspecifics (Leech et al., 2022). Cats without companions of the same species, for example, were classified by their guardians as more aggressive with conspecifics and humans, lonelier, and more fearful (Leech et al., 2022). For shelter animals, a relationship was demonstrated between the availability of environmental enrichment and personality (Kry & Casey, 2007). Those who had access to environmental enrichment were more likely to be adopted, as they got closer to people and spent less time resting. These characteristics were associated with cats with

more favorable personalities (Kry & Casey, 2007). However, there is still a gap in the literature regarding the types of environmental enrichment used for owned cats, as well as the relationship between environmental enrichment use and their personality (Dantas-Divers et al., 2011; Ellis et al., 2017; McCobb et al., 2005). It is not known whether the guardian takes into account the cat's personality when deciding to offer different types of environmental enrichment.

Therefore, the present study aimed to: i) analyze the prevalence of different types of enrichment used in Brazilian households; ii) evaluate the relationship between the type of enrichment available and the personality of the cats as described by their guardians; iii) assess the relationships between housing features and the use of environmental enrichment. Our hypotheses were as follows: i) cat guardians would provide different types of environmental enrichment items for their cats; ii) guardians would report offering different enrichment items based on their cats' personalities, for example, providing hiding places for more fearful cats and play items, like toys, for more extroverted cats; iii) the use of enrichment items would be greater for indoor cats than for those kept outdoors.

Materials and methods

Ethical statement

An online questionnaire was sent to cat guardians residing in Brazil. As this is an opinion survey in which respondents did not provide any personally identifiable information, being guaranteed anonymity, it was not submitted to a Human Ethics Committee in accordance with Resolution CNS 510/2016. Respondents were advised about the confidentiality of information collected from research participants, research objectives, and that there was no financial compensation involved in answering the questionnaire. The informed consent was obtained from all subjects involved in the study by clicking on an agreement statement on the online questionnaire.

Questionnaire application and structure

The questionnaire was distributed through various social networks, including WhatsApp, Instagram, Facebook, and e-mail, initiating a virtual snowball sampling, where one participant invites another to answer the questionnaire (Creswell & Poth, 2016). Data collection took place from April 13 to June 1 2021. Only participants who owned at least one cat could participate in the research. Respondents under 18 years of age and who had recently acquired their cats (less than two months) were excluded from the sample. Guardians who had more than one animal were asked to respond based on which cat they had the longest. The questionnaire was prepared based on the available literature and made available in Portuguese through the Google FormsTM tool (Supplementary File 1).

The first section of the questionnaire enquired as to the respondents' sociodemographic data (state, city, age, gender, level of education, whether they had a child or other animals, how many cats the guardian had, and how long the cat lived with him/her) and the cat's demographics (sex, age, neuter status, breed, body condition score, and if it had any type of health problem). The second section included housing features, asking about cat outdoor access (indoor *vs.* outdoor), type of residence (house, apartment, farm, or other type), and the number of litter boxes. The third section was divided into three main parts: questions about behavioral problems (out-of-box elimination of urine and feces, urine spraying, destructive behavior, excessive grooming, excessive vocalization, pica syndrome, separation-related problems, and excessive aggression). Next, the availability and use of the following types of environmental enrichment items were enquired about: scratching posts, high places, hiding places, toys, play interaction (guardians played with their cat), cat self-groomers, water fountains, grass, supervised outdoor walks on a leash, access to balconies and/or windows with nets (e.g., nylon nets used for safety reasons, allowing visual contact with the exterior but preventing cats from falling), access to top of walls and gates, catnip, playing with other animals of the house (if had

any), and food puzzles. The answers could be: “yes, he/she does have and always uses it;” “yes, he/she does have, but barely uses it;” or “no, he/she does not have.”

Finally, the survey asked about the cat’s personality traits. We used the personality questionnaire developed by Feaver et al. (1986), which consisted of 18 items (traits): active, aggressive, agile, curious, equable with cats, excitable, fearful of cats, fearful of people, hostile with cats, hostile with people, playful, sociable with cats, sociable with people, solitary, tense, vocal, voracious, and watchful (Feaver et al., 1986). Translation and back-translation processes were previously conducted, and minor wording adjustments were made to improve understanding in the items “equable with cats” and “watchful” (in this paper, we used “calm with cats” and “curious”) (Supplementary File 2 – English version of the questionnaire). In the study by Feaver et al. (1986), the items were quantified in a 14 cm visual analog scale. In a more recent study, Litchfield et al. (2017) used part of Feaver’s questionnaire combined with other instruments, applying a 7-point Likert scale (Likert, 1932), ranging from “not at all” to “very much so” to develop an online instrument for assessing cats’ personality. In our study, to facilitate the use of Google FormsTM, we opted not to use the visual analog scale, but instead used a 7-point Likert scale, ranging from 1: “Does not define my cat” to 7: “Perfectly defines my cat.” In this case, the guardians considered their perceptions to answer how much they agreed with the expression of each personality trait.

Statistical analyses

First, the relative and absolute frequencies for sociodemographic data of the guardians, cats, and the types of environmental enrichment were obtained. Then, a Principal Component Analysis (PCA) was performed to extract the main personality dimensions reported. Scores of animals in PCA1 (termed “friendly;” Table 2) were multiplied by -1 to rank them from friendly (higher values) to unfriendly (lower values).

We used chi-square tests in contingency tables (or Fisher’s exact test in 2×2 tables) to estimate the associations between environmental enrichment and the housing features (indoor vs. outdoor and type of residence). Pearson’s Correlation Coefficients were used to evaluate the relationships between the personality dimensions found (normally distributed or approximated a bell-shaped curve) and the frequencies of provision and use of environmental enrichment items.

Results

Sociodemographic profile of guardians and their cats

There were 3,083 responses in total. Most guardians were between 18 and 35 years old (60.3%), female (91.1%), and had undergraduate (42.3%) or graduate degrees (34.9%). Regarding the cats, 46.3% were males and 53.7% females. Almost 90.0% of the cats were neutered. Most of the cats were adults, between 8 months and 10 years old (82.7%), and 96.6% of them were characterized as mixed-breed cats.

Most of the cats were kept indoors (58.1%), as reported by their guardians, who mentioned that their cats did not have outdoor access and were not taken outside for walks. Most of the guardians lived in houses (57.2%) or apartments (40.5%), with few of them living in farms (1.8%), or other types of residences (0.5%). Regarding the number of litter boxes available for the cat, most of the guardians answered that the cat had two or more litter boxes (46.6%), or only one litter box (41.0%) (Figure 1).

Frequency of environmental enrichment use

The questionnaire included multiple-choice questions about the types of environmental enrichment provided. All guardians interviewed reported offering at least one type of environmental enrichment for their cats. The most provided and used enrichment was play interaction (higher frequencies of

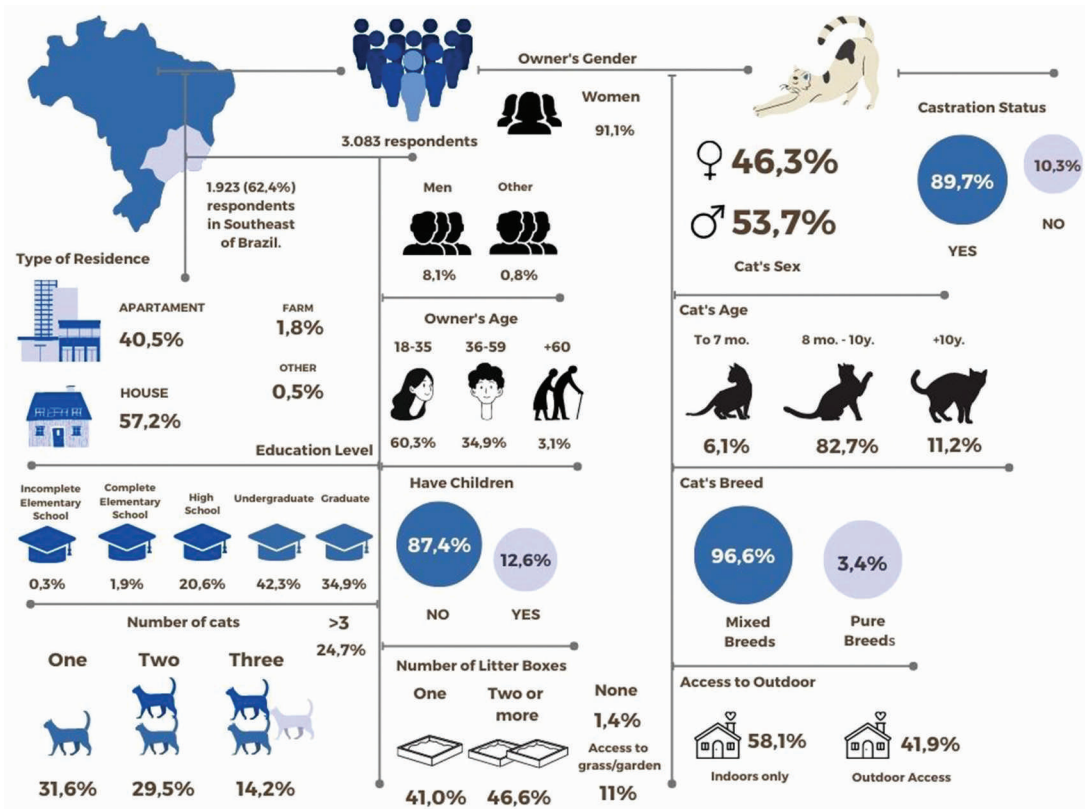


Figure 1. Sociodemographic profile of cat guardians (n = 3,083) and their cats.

“yes, he/she does have and always uses it”) (77.4%), followed by access to a balcony and/or window with net (72.7%), access to hiding places (54.5%), toys (46.0%), access to high places (41.7%), and access to the top of walls and gates (40.9%) (Table 1). On the other hand, items with lower frequencies were self-groomers (11.3%), outdoor walks on a leash (6.5%), and food puzzles (3.5%), as reported by the guardians (Table 1).

Principal component analysis (PCA) for personality traits

Four Principal Components were reported, which together explained 54.4% of the total variance of the data. The first Principal Component (PC1) was characterized as “friendly,” with higher positive loadings (above 0.5) for the items playful (0.6), sociable with cats (0.6) calm with cats (0.5), curious (0.5), and sociable with people (0.5), and negative for solitary (-0.6). The PC2 was characterized as “explorer,” with higher positive loadings for attentive (0.6), agile (0.6), active (0.5), and curious (0.5). The PC3 was regarded as “fearful of people” with loading above 0.5 only for this item (0.6); while PC4 had higher loadings only for “voracious” (0.6) (Table 2).

Correlation between environmental enrichment and personality

Pearson’s correlation coefficients were used to analyze the relationships between cats’ personalities and the frequencies of use of environmental enrichment. PC1 (“friendly”) showed a low and positive correlation with the use of scratching posts ($r = 0.10, p \leq 0.001$), access to high places ($r = 0.12, p \leq 0.001$), hiding places ($r = 0.12, p \leq 0.001$), toys ($r = 0.25, p \leq 0.001$), play interaction ($r = 0.24,$

Table 1. Absolute and relative (%) frequencies of types of environmental enrichment used.

Type of Environmental Enrichment	Frequency (n = 3,083)	Percentual (%)
Cat scratching post		
Yes, he/she does and always uses	1130	36.7
Yes, he/she does, but barely uses or never uses	947	30.7
No, he/she does not have	1006	32.6
High places		
Yes, he/she does have access, and always goes up	1287	41.7
Yes, he/she does, but barely go up	718	23.3
No, he/she does not have access	1078	35.0
Hiding places		
Yes, he/she does have access and always uses	1680	54.5
Yes, he/she does, but barely uses	737	23.9
No, he/she does not have access	666	21.6
Access to toys		
Yes, he/she does and always plays	1417	46.0
Yes, he/she does, but barely plays or never plays	1253	40.6
No, he/she does not have	413	13.4
Play interaction		
I always play with my cat	2385	77.4
I barely play with my cat	671	21.8
I never play with my cat	27	0.9
Cat massage brush		
Yes, he/she does and always uses	348	11.3
Yes, he/she does, but barely uses or never uses	330	10.7
No, he/she does not use	2405	78.0
Cat water fountain		
Yes, he/she does and always uses	1064	34.5
Yes, he/she does, but barely uses or never uses	358	11.6
No, he/she does not have	1661	53.9
Cat grass		
Yes, I always offer	897	29.1
Yes, but I barely offer	823	26.7
No, I never offer	651	21.1
I don't need it because he/she does have access to garden/lawn	712	23.1
Cat walk outside (on a leash)		
Yes, I do. I always take he/she with a leash or cat bag	201	6.5
Yes, I do. But I barely take he/she to a cat walk	326	10.6
No, I do not. I never take he/she to a cat walk	2556	82,9
Access to balcony with cat net		
Yes, he/she does and always observes outside	2241	72.7
Yes, he/she does, but barely observes outside	483	15.7
No, he/she does not have access	359	11.6
Access to the top of walls and gates		
Yes, he/she does and always observes outside	1261	40.9
Yes, he/she does, but barely observes outside	417	13.5
No, he/she does not have	1405	45.6
Use of catnip		
I always offer Catnip to my cat	563	18.3
I did offer to my cat once, but he/she did not like	1345	43.6
I never offer Catnip to my cat or I do not know what is it	1175	38.1
Play with other animals		
Yes, he/she plays with both dogs and cats	556	18.0
Yes, but he/she only plays with the cats	603	19.6
Yes, but he/she only plays with the dogs	170	5.5
No, he/she does not play with other animals	1256	40.7
I only have one cat	498	16.2
Food puzzle		
Yes, I always offer	108	3.5
Yes, but I barely offer	300	9.7
No, I never offer	2675	86.8

Table 2. Principal component analyses (PCA) for personality for the four significant independent personality dimensions (PC1, PC2, PC3, and PC4). Measures loading significantly on each dimension are noted in gray. The eighteen traits are listed down the page, and the significant factors (dimensions) appear across the table. Each factor is a combination of the variables with a score > 0.50 or < -0.50 , i.e., the scores in gray. The bottom row is the percent of the total variance in the modeled traits explained by that factor, with the total percentage explained by all four factors at the end of the row.

	PCA1 Friendly	PCA2 Explorer	PCA3 Fearful with people	PCA4 Voracious
Active	-0.49	0.53	-0.07	-0.16
Aggressive	-0.38	0.37	-0.23	0.33
Agile	-0.39	0.56	-0.06	-0.31
Curious	-0.53	0.50	-0.16	-0.05
Calm with cats	-0.54	-0.29	0.48	0.13
Excitable	0.16	0.46	0.23	0.09
Fearful with cats	0.36	0.30	0.24	-0.11
Fearful of people	0.38	0.32	0.63	-0.29
Hostile with cats	0.49	0.37	-0.42	-0.04
Hostile with people	0.38	0.33	0.08	0.29
Playful	-0.65	0.32	0.17	0.03
Sociable with cats	-0.61	-0.10	0.45	0.28
Sociable with people	-0.53	-0.11	-0.42	0.36
Solitary	0.58	0.02	0.17	0.16
Tense	0.44	0.23	0.21	0.33
Vocal	-0.18	0.26	-0.00	0.38
Voracious	-0.07	0.17	0.07	0.63
Attentive	-0.23	0.57	0.03	-0.05
Percent Variance	19%	13%	8%	7%

$p \leq 0.001$), and playing with other animals ($r = 0.27$, $p \leq 0.001$). Cats considered by their guardians as more “friendly” (higher PC1 scores) tended to access these types of enrichment more frequently. In turn, PC2 (explorer) showed a low and positive correlation with toys ($r = 0.14$, $p \leq 0.001$) and play interaction ($r = 0.15$, $p \leq 0.001$). Cats perceived by their guardians as more “exploratory” (higher scores in PC2) were provided with toys more frequently and their guardians reported engaging more in play interactions with them. PC3 (“fearful of people”) had a low and positive correlation only with playing with other animals ($r = 0.16$, $p \leq 0.001$), with animals characterized as “fearful of people” mentioned as more playful with other animals. Finally, PC4 was not related to the use of any environmental enrichment items.

Association between house factors and the use of environmental enrichment

According to the chi-square tests, the apartment type of residence was related to higher frequency for the following environmental enrichment items: scratching post, hiding places, cat self-groomer, water fountain, cat grass, outdoor walks on a leash, access to a balcony and/or window with net, catnip, and food puzzles; and lower frequency of access to the top of walls and gates. We found a higher frequency of animals living in apartments without any conspecifics, which prevents them from engaging in play with other animals. In apartments with more than one cat, they were reported as playing with other cats, but not with dogs (Table 3).

The indoor or outdoor housing was also associated with the types of environmental enrichment provided. For indoor cats, there were higher frequencies for the following environmental enrichments: scratching posts, hiding places, cat-self groomers, water fountains, cat grass, outdoor walks on a leash, access to balconies and/or windows with net, catnips, and food puzzles. Lower frequencies of environmental enrichment provision were found for outdoor cats, except for the access to the top of walls and gates which was higher for outdoor than indoor cats. A high frequency of play with other cats and dogs was observed in outdoor cats (Table 4).

Table 3. Association between type of residence and the use of environmental enrichment.

Enrichment item		Apartment (%) n = 1249	House (%) n = 1764	Farm (%) n = 55	χ^2
Scratching post	Always	48.9	28.1	29.1	204.89**
	Barely	31.9	30.3	25.5	
	Never	19.2	41.7	45.5	
Hiding Places	Always	57.9	52.1	50.9	12.74*
	Barely	22.9	24.7	20.0	
	Never	19.2	23.2	29.1	
Cat massage brush	Always	12.8	10.5	3.6	25.43**
	Barely	13.1	8.7	16.4	
	Never	74.1	80.7	80.0	
Cat water fountain	Always	41.0	30.0	27.3	60.20**
	Barely	13.5	10.4	10.9	
	Never	45.5	59.6	61.8	
Cat grass	Always	33.2	26.6	21.8	476.28**
	Barely	36.8	19.8	9.1	
	Never	25.9	18.4	3.6	
Walk on a leash	No, he/she has access to garden or yards	4.1	35.2	65.5	16.55**
	Always	7.5	5.9	3.6	
	Barely	12.7	9.4	3.6	
Access to balcony with cat net	Always	79.8	84.8	92.7	93.32**
	Barely	79.3	68.1	69.1	
	Never	15.7	15.5	18.2	
Access to the top of walls and gates	Always	5.0	16.4	12.7	154.74**
	Barely	31.5	46.8	61.8	
	Never	9.9	15.8	23.6	
Catnip	Always	58.6	37.4	14.5	156.55**
	Barely	24.8	14.0	5.5	
	Never	49.3	39.7	32.7	
Play with other animals	No, I have only one cat	25.9	46.3	61.8	241.76**
	No, he/she does not play with other animals	28.4	11.2	5.5	
	Yes, play with dogs	14.7	23.0	18.2	
	Yes, play with cats	2.8	7.2	12.7	
	Yes, play with dogs and cats	44.0	39.0	29.1	
Food puzzle	Always	10.1	19.6	34.5	23.26**
	Barely	5.0	2.6	1.8	
	Never	11.7	8.5	7.3	
	Never	83.3	88.9	90.9	

We used * $p < 0.05$ and ** $p < 0.01$.

Discussion

The results of the present study supported our first hypothesis that cat guardians use different types of environmental enrichment items for their cats. The types of environmental enrichment with the highest reported frequency of use (*i.e.* guardians answered *yes, he/she does have and always uses it*) were play interaction (77.4%), access to a balcony and/or window with net (72.7%), hiding places (54.5), and toys (46.0%). Guardians reported that they always play with their cats, which has the potential to strengthen the dyad bond, being beneficial for both cats and guardians (Grigg & Kogan, 2019). In addition, it is a strategy to promote physical and mental stimulation essential to enhance the welfare of companion animals, especially those kept confined (Ellis, 2009; Houser & Vitale, 2022).

In our study, quiet and private hiding places were among the most commonly reported resources provided for cats, as also noted by Grigg and Kogan (2019). Hiding places are valuable alternatives for felines, as they need a safe place to rest, especially in multi-cathouseholds or for cats that are considered anxious or fearful (Ellis et al., 2017). Many guardians (46.0%) mentioned that their cats had toys and always played with them. However, some guardians reported that, despite having access to toys, the cats rarely engaged in play (40.6%). This lack of interest in toys may be attributed to the

Table 4. Association between type of management (indoor vs outdoor) and the use of environmental enrichment.

Enrichment item	Frequency of use	Indoor (%) n = 2127	Outdoor (%) n = 956	χ^2
Scratching post	Always	44.7	18.7	324.73**
	Barely	32.3	27.1	
	Never	22.9	54.2%	
Access to high places	Always	44.1	36.4%	17.81*
	Barely	21.8	26.7	
	Never	34.1	36.9	
Hiding Places	Always	58.3	46.1	48.48**
	Barely	23.2	25.5	
	Never	18.6	28.3	
Toys	Always	52.5	31.4	247.03**
	Barely	40.1	41.9	
	Never	7.4	26.7	
Owner play with the cat	Always	78.7	74.3	12.98**
	Barely	20.7	24.2	
	Never	0.6	1.6	
Cat massage brush	Always	12.8	7.8	29.30**
	Barely	11.8	8.2	
	Never	75.3	84.0	
Cat water fountain	Always	38.9	24.8	85.26**
	Barely	12.8	9.0	
	Never	48.3	66.2	
Cat grass	Always	33.2	20.0	645.84**
	Barely	32.6	13.5	
	Never	23.9	14.9	
Walk on a leash	No, he/she has access to garden or yards	10.2	51.7	65.55**
	Always	8.5	2.2	
	Barely	12.1	7.1	
Access to balcony with cat net	Always	79.4	90.7	32.46**
	Barely	74.2	69.2	
	Never	16.3	14.2	
Access to the top of walls and gates	Always	9.4	16.5	560.83**
	Barely	29.9	65.5	
	Never	10.3	20.6	
Catnip	Always	59.8	13.9	183.68**
	Barely	22.0	9.9	
	Never	47.6	34.8	
Play with other animals	No, I have only one cat	30.4	55.2	102.63**
	No, he/she does not play with other animals	21.1	11.2	
	Yes, play with dogs	17.2	24.8	
	Yes, play with cats	4.3	8.2	
Food puzzle	Yes, play with cats	43.3	35.0	43.38**
	Yes, play with dogs and cats	14.1	20.8	
	Always	4.4	1.5	
	Barely	11.5	5.9	
	Never	84.1	92.7	

We used * $p < 0.05$ and ** $p < 0.01$.

guardians' failure to provide sufficient stimulation, as most seem to offer toys for solitary play rather than those that require interaction (Grigg & Kogan, 2019). Another explanation could be that cats tend to habituate to toys after a few sessions, losing interest in a specific object, especially when they are not encouraged or sufficiently stimulated (Hall et al., 2002).

The least provided enrichment items were cat self-groomer(11.3%), outdoor walks on a leash (6.5%), and food puzzles (3.5%). We believe that these types of enrichment are still not widespread in Brazil. Cat self-groomers were less frequently reported in our study, possibly because guardians neglected the positive effects of tactile stimulation provided by this device. They possibly related brushing only with hair care and most sampled cats were short-haired. Most guardians answered that they never take their cats for outdoor walks on a leash. Supervised walks can be regarded as a tool of environmental enrichment. However, there are still few studies on this topic. We believe

that there is a lack of knowledge about its benefits, in addition to the importance of training the cats and respecting their individual preferences during this practice. Some cats may be scared and refuse to walk outside, requiring guardians to consider the cat's personality before taking it outdoors and pay attention to cats' behaviors during the walk.

The food puzzle is a cognitive enrichment tool and had the lowest frequency of provision in our sample. Many guardians seem unaware of the diversity of feeding strategies available (Alho et al., 2016). A recent study by Delgado et al. (2021) explores "contrafreeloading," a methodology in which an individual, given the choice, selects the option that requires (or does not) effort to obtain food. The cats, unlike other animal species, preferred readily available food rather than making the effort to obtain it. However, these results should be interpreted with caution due to the small sample size (only 17 cats) (Delgado et al., 2021). Therefore, further research is needed to confirm whether diversifying and increasing the challenge of food delivery through environmental enrichment could be beneficial, particularly for indoor cats.

Our second hypothesis was that the guardians took into account the personality of their animals when choosing the types of environmental enrichment since the cats' personality could influence the adaptation and effectiveness of the enrichment (Ellis, 2009). In general, we found low correlation coefficients (most lower than 0.30) between the personality dimensions obtained (expressed by the PCA scores) with the provision of environmental enrichment. So, it is possible to suppose that guardians do not seem to take into account the personality of their cats when choosing a certain item of environmental enrichment.

We found four personality dimensions that were regarded as "friendly," "explorer," "fearful of people," and "voracious." In our study, cats that obtained lower values in PC1 ("friendly") were those considered by the guardians as more curious, calm with other cats, playful, sociable with cats and with people, and obtained higher values for the term solitary. Cats with "friendly" personalities were the most reported. This dimension depicts the actions of cats toward conspecifics or humans (Turner et al., 1986). In this dimension, also called "friendliness" (Arañori et al., 2016, 2017; Turner et al., 1986), we find the terms sociable, calm, friendly, gentle, sociable with people, fearful of people, and tense (Arañori et al., 2016, 2017; Feaver et al., 1986; Travník et al., 2022). The dimension "agreeableness" (Evans et al., 2019; Gosling & Bonnenburg, 2021; Litchfield et al., 2017), also are comparable to our PC1. This dimension refers to the emotional stability and valence of emotional responses toward a human or cat, ranging from the most positive emotional state (agreeableness) to the most negative (avoidable). In the present study, guardians of cats characterized as "friendly" tended to provide more some types of environmental enrichment items, such as hiding places, high places, scratching posts, toys, play interaction, and mentioned that their cats played with other animals. In Litchfield et al. (2017) the terms used to describe the dimension "agreeableness" were affectionate, friendly to people, gentle, playful, cooperative, trusting, and inquisitive. It could explain the fact that cats perceived as more playful have received more of these types of enrichment.

In our study, cats that scored higher on PC2 were perceived by guardians as more active, agile, curious, and attentive. In Travník & Sant'Anna (2021), the PC2 expressed high emotional arousal, through the terms agitated and active. The dimension "extraversion" (Evans et al., 2019; Gosling & Bonnenburg, 2021; Litchfield et al., 2017), is also like our PC2. The "extraversion" dimension is defined by the reaction responses to people, as well as the energy and activity level of the behaviors (Salonen et al., 2019). Guardians of cats scoring higher on PC2, *i.e.* identified as more exploratory, reported providing toys more often and engaging more frequently in play interactions with their cats. Interactive play between guardian and pet can be beneficial for both, as it can strengthen bonds and relax the cat (Bouma et al., 2021; Evans et al., 2019; Grigg & Kogan, 2019).

Cats that obtained higher values in PC3 were considered more fearful of people by the guardians. Usually in other studies, this characteristic appears together with other terms that represent the behaviors of animals linked to humans, such as our PC1 (Feaver et al., 1986). This separation may have occurred due to a different perception of what would be fearful and what would be solitary, described in the negative side of PC1. The fearful cats were associated with playing with other

animals, but not with people. It can be a result of cats not being properly introduced to people in early life, which could lead to poor socialization. The results from a study conducted by McCune (1995) showed that kittens who were socialized between the second and the 12th week of age were more friendly to familiar and unfamiliar people compared to unsocialized kittens.

Cats that obtained higher values in PC4 were considered by their guardians as animals that ingest more food than usual for their weight. Few studies with personality included the term voracious and none of them presented a specific personality dimension for it. For example, in the study by Feaver et al. (1986) the term voracious did not present correlation coefficients greater than 0.78 with the personality items, to be included in the next phases of the analysis. The PC4 “voracious” was not associated with any type of environmental enrichment. Higher body condition scores (obesity) are more frequent in cats kept indoors (Buffington, 2002; Rowe et al., 2015; Wall et al., 2019) and the availability of some types of environmental enrichment could benefit these individuals by increasing body activity (Ellis, 2009). Also, the guardian’s personality could play a role in these subjects. Results from a study by Finka et al. (2019) that shows parallels with the Parent-Child Relationship demonstrated that neurotic guardians generally kept their cats indoors, and these animals are more likely to develop obesity and anxiety, compared to agreeable guardians, which is a similar finding to what happens to humans. However, the magnitude of these associations was considered low, being reasonable to speculate that the guardians do not seem to take into account the personality of their animal when choosing a certain item of environmental enrichment.

We also evaluated whether there was an association between house factors and the use of different types of environmental enrichment. The apartment type of residence and indoor housing were associated with higher frequencies of provision of most environmental enrichment items, such as scratching posts, hiding places, cat self-groomers, cat water fountains, cat grass, outdoor walks on a leash, access to a balcony and/or window with net, catnip, and food puzzles. Outdoor access and houses were associated with allowing the cat access to the top of walls and gates. These results are in line with those obtained by Windschnurer et al. (2022), who reported that guardians of indoor-only cats or cats with less frequent outdoor access compensate for environmental restriction by initiating more tactile and non-tactile human-cat interactions and offering more toys to their cats and particularly more frequent access to classical and instrumental toys as well as auditory stimuli.

The relationship between the low frequency of use of environmental enrichment and outdoor access may suggest that guardians perceive the external environment itself as a stress relief mechanism and entertainment for their cats. These findings corroborate the results of Machado, et al. (2020) who reported a relationship between the type of management (indoor vs. outdoor) and the cat care practices, with indoor cats being more likely to have a closer relationship with their guardians. In addition, guardians who kept their cats outdoors were also those who usually provided less environmental enrichment and less health care (e.g., routine visits to the vet) (Machado, et al., 2020).

Some guardians might not believe that it is possible to adapt to the indoor environment so that their cats can exhibit their natural behavioral repertoire indoors without exposing themselves to risks (Foreman-Worsley et al., 2021). However, our study suggests that most guardians are aware of several types of environmental enrichment and, to some extent, make these resources available to their cats.

This study has limitations that could serve as a starting point for future studies. Our sample was collected through an online form spread via social media, reaching only respondents with internet access. This resulted in a homogeneous and non-representative sample. In fact, most respondents were between 18 and 35 years old (60.3% vs. around 30% in Brazil) and had higher education (77.2%) more frequently than the general Brazilian population (19.2%), according to data from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística [IBGE], 2022).

Additionally, in Brazil, 51.5% of the population is female (IBGE, 2022), while in our sample 92% were female-identifying respondents. This discrepancy has already been reported in previous similar studies conducted in Brazil (Franck et al., 2022; Machado, et al., 2020, 2020b) and other countries (Adamelli et al.,

2005; Lue et al., 2022; Ramón et al., 2010). Emotional closeness levels seem to be higher in females, who tend to interact with and be more concerned about their cats (Adamelli et al., 2005; Mertens, 1991). Mertens (1991) also reported that young women are often preferred by cats as companions. It is plausible that due to these factors, women engaged in social media groups about pets and had a higher likelihood of answering online questionnaires about their cats.

Finally, most of the cats lived exclusively indoors and their guardians provided routine health care, which possibly did not represent the Brazilian reality. It probably impacted the results, overestimating the provision of certain types of environmental enrichment items. So, the results should be interpreted with caution, always considering the type of recruitment and sampling method used (online survey). Achieving a representative sample of Brazilian respondents would require collection in person across all Brazilian regions, reaching communities with varying socioeconomic levels, which is an enormous methodological challenge for a country with continental dimensions.

We concluded that guardians reported offering environmental enrichment items to their cats, with some types of enrichment being provided more frequently than others. Enrichment was more commonly reported for indoor cats and those living in apartments than for outdoor cats and those living in houses. Weak associations were found between the provision of environmental enrichment and cats' personalities, as rated by their guardians. Future studies should consider additional variables that could help explain the enrichment choices made by cat guardians, such as income and socioeconomic status. Additionally, the relationships between the availability and use of enrichment and cat personality may be influenced by factors such as the cat's age, health status, and occurrences of behavioral problems. These variables should be included in future studies exploring the individual responses of cats to environmental enrichment.

Acknowledgments

The authors are grateful to all the anonymous participants who gently answered the questionnaire, providing valorous data about their cats.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The authors reported there is no funding associated with the study related to this article. Aline Cristina Sant'Anna received a Productivity Grant from the Brazilian National Research Council CNPq.

Informed consent statement

Informed consent was obtained from the anonymous participants who answered the online questionnaire.

ORCID

Luana da Silva Gonçalves  <http://orcid.org/0000-0002-5635-8728>
Daiana de Souza Machado  <http://orcid.org/0000-0002-5063-3696>
Isadora de Castro Travnik  <http://orcid.org/0000-0002-5558-0028>
Aline Cristina Sant'Anna  <http://orcid.org/0000-0002-5431-7199>

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