This paper is firstly dedicated to Tammy Windfelder, who has fostered my interest in and love for animal behavior.

I would also like to dedicate this paper to the cats of Tabby's Place and St. Hubert's; specifically Chicken Salad, Elliot, Faye, Magda, Thurman, Olive, Jeannie, Mullet, Cassie, Weldon, Moon, Hickory, Walley, Benny Boy, Chocolate Chip, Mr. Jingles, Cuddles, Beep-Beep, Little Legs, and Fuzzy.

I would like to thank Joe Pagani, Tara Sannucci, St. Hubert's Animal Welfare Center staff, Danielle Rice, Carolyn Schultz, and Tabby's Place staff and volunteers for their assistance, participation, and other contributions to this study.

Drew University

College of Liberal Arts

The effects of housing style and individual history on the behavior of domestic cats (*Felis catus*) in animal shelters

A Thesis in Biology

by

Charlotte Mary Clements

Submitted in Partial Fulfillment

of the Requirements

for the Degree of

Bachelor of Arts

With Specialized Honors in Biology

May 2023

Abstract

3.2 million cats enter animal shelters across the United States every year, where they experience extremely high stress levels. Much of the research in the area of improving cat welfare in the shelter has focused on altering the microenvironment of the cat's cage (e.g., providing a box for the cat to hide in). However, many shelters are shifting their focus to changing the macroenvironment, and have begun integrating a communal housing style, in which individuals are able to freely roam around a room and interact with each other. Anecdotally, this is understood to reduce stress, however the small amount of research that has been done does not provide a clear picture of what the impacts on stress are, and why it impacts stress levels in some cats but not others. In this study, I followed 31 cats in their journey through the shelter, starting when they arrived and were housed in individual cages for a quarantine period, and continuing as they were transitioned to community room housing. I assessed their stress levels through the behaviors and posture indicators used by cats to communicate fear, contentment, affiliation, and defensive aggression. In doing this, I sought to investigate whether changes behavior can be observed as individuals are transitioned between these two housing styles. Specifically, I studied whether individual improvement or further deterioration in a community room was associated with certain factors, such as sex and whether the individual was admitted to the shelter as a stray/feral cat or as an owner-surrendered cat. I performed a series of behavior observations on individuals while they were housed in a cage, continuing as the individual was moved into a community room. Feral/stray cats showed significantly more affiliative behavior, on average, than owner-surrendered cats in community room housing, whereas owner-surrendered cats showed significant deterioration and became more fearful, on average. There were no significant differences based on sex. Additionally, behavior of community rooms as a whole was analyzed in 20-minute scan sampling periods in which I recorded every instance of an individual having a nearest neighbor, as in another cat within a 0.3-meter radius. In Suite B at Tabby's Place, stray/feral

individuals accounted for most of the nearest-neighbor interactions; they were most often nearest-neighbors with other formerly stray/feral individuals or owner surrendered individuals. Owner surrendered individuals were rarely nearest neighbors with other owner surrenders. In the Tower Room at St. Hubert's, stray/feral individuals were more often nearest-neighbors with owner surrendered individuals, or individuals who were seized from hoarding homes. At both facilities, owner-surrendered individuals were most often nearest-neighbors with formerly stray/feral individuals, indicating that stray/ferals may be initiating these interactions. This research is important in furthering our understanding of what predisposes a cat to thrive in a certain type of housing; specifically, it suggests that stray/feral individuals should take priority in community room placement, and in the instance that an owner-surrender is placed in a community room, they should be closely monitored for signs of increasing stress.

Table of Contents

Introduction

Interest in understanding the complex nature of cat behavior has grown significantly since the 1980s, in both cat owners and the academic community alike. The application of this understanding has been notably important for advances made in the welfare of the 3.2 million cats who find themselves in animal shelters across the United States every year (The American Society for the Prevention of Cruelty to Animals, 2023). Living in a shelter is often a highly stressful experience for a cat, as cats are highly sensitive to the novel, constantly changing sights and sounds that are typical within a shelter environment. Simple changes to living conditions, such as the addition of enrichment items, have shown to improve the welfare of shelter cats by means of reducing stress, as well as through a reduction in the frequency in abnormal behavior, increasing behavioral diversity, and increasing positive utilization of their environment (Ellis, 2009).

Traditionally, cats in the shelter are housed individually in cages, occasionally with another individual if they were surrendered to the shelter together. Cages are often the default housing style, due to their advantages in disease management and social stress reduction for the caged individual (Suchak & Lamica, 2018). Cages are frequently made of material such as stainless steel and are set up in a way that makes them easy to sterilize. Additionally, confinement to a cage facilitates easier monitoring of the caged individual's health and behavior. However, being housed in a cage is understood to be among the main sources of the stress experienced by shelter cats (Ellis, 2009). Much of the research done on cage stress has focused on specific aspects of the cage, such as available floor space and enrichment, but the consensus seems to be that singly housed individuals experience higher stress than communally housed individuals. Research in this area has utilized both ethological approaches and biological approaches to investigate the role of cage housing in stress experienced by shelter cats. Gourkow & Fraser (2006), for example, used the Cat-Stress-Score system, originally developed by Kessler & Turner (1996), to assess

stress levels and found that singly housed individuals had higher mean stress scores over a ten-day period, compared to communally housed individuals. On the other hand, Foster & Ijichi (2017) used Infrared Thermal Imaging (IRT) of core eye temperature and Feline Temperament Profile (FTP) scores to assess stress and found that eye temperature, and thus stress, was higher in singly-housed cats compared to communally housed cats.

These findings have indicated that communal housing may provide an advantage in managing the stress of shelter cats, as it eliminates the cage overall and should thus eliminate the confinement stress facilitated by cage housing. Thus, many shelters have begun incorporating communal housing options into their husbandry practices. However, it is important to note that there are few studies investigating the effects of communal housing versus single/cage housing, and among these few, there is little consensus in their results (Finka et al. 2014). Additionally, many studies did not report statistically significant findings. This implicates the growth in communal housing use by shelters, as there is conflicting and insignificant data to support its purported benefits in stress management and improvement of welfare. Anecdotal evidence is likely a driving force in the expansion of communal housing use; this kind of evidence is important, however formal research into this area involving statistical analyses can be highly valuable in reinforcing or contradicting these anecdotal findings.

Many of the current studies available on communal housing in animal shelters focus on a variety of factors related to housing, such as availability of enrichment and hiding spaces in communal housing versus cage housing. However, the Association of Shelter Veterinarians (2022) specify the provision of resting perches, hiding spaces, and toys in group housing spaces in the Guidelines for Standards of Care in Animal Shelters (p. 16). Thus, assuming shelters are following these guidelines, it is not likely that cats would be without these environmental enrichment factors while in communal housing. The guidelines for selection of individuals to be placed in communal housing are vaguer, stating that behavior needs to be assessed prior to cohousing unrelated or unfamiliar individuals (Association of Shelter Veterinarians,

2022, p. 17). As previously mentioned, the existing bodies of research on communal housing of cats in animal shelters have produced highly variable results, emphasizing the variability of cat behavior overall. There is little to no research within this area that focuses specifically on individual characteristics of the cats themselves, and whether individuals can be grouped together based on how well they adapt to communal housing and whether or not they share a certain characteristic such as age, sex, or intake circumstance. In my research, I focused specifically on intake circumstance, or rather whether an individual was surrendered by their owner or admitted to the shelter as a stray or feral cat. Life history has previously been correlated to amount of stress experienced in the shelter, as Dybdall et al. (2007) found that owner surrendered individuals showed the greatest behavioral measures of stress and arousal compared to stray cats. Dybdall et al. (2007) used exclusively cats who were housed singly in cages. This study aims to determine whether or not these findings can be replicated in communal housing, as well as investigate potential differences in behavioral stress between owner surrendered individuals and stray/feral individuals between both cage and communal style housing.

Before understanding cat behavior in animal shelters, though, it is important to first understand why cats are in animal shelters to begin with; the simple answer can be traced back thousands of years, to the earliest days of the human-cat relationship.

Domestic Cats as Companion Animals

Wildcats (*Felis silvestris)*, specifically the Near Eastern wildcat subspecies *Felis silvestris lybica*, have domesticated their way into the lives of humans over the last 9,000 years, beginning in the early Neolithic period (Ottoni et al., 2017). The advent of agriculture catalyzed the transition from humans living as nomadic hunter gatherers to living in sedentary communities (Nilson et al., 2022). With this, humans began to store grains and other food, which in turn attracted mice (Nilson et al., 2022). In a

process often referred to as “self-domestication”, domestic cat ancestors (*Felis silvestris lybica*) took advantage of this abundant and easily accessible prey supply; humans, in turn, tolerated their presence, as they benefited from the cats serving as a form of cost-effective and low-maintenance pest control in their homes and businesses (Crowley et al., 2020; Nilson et al., 2022).

Though the cat-human relationship from this perspective can be described as both mutualistic and symbiotic, the relationship in modern nature has proven to be much more dynamic. This was best described by Crowley et al. (2020), “cats exist on a spectrum of human responsibility and control over their movement, feeding and reproduction.” (pp. 478). The cat-human relationship, specifically in the Western world, exists on a spectrum. On one end, cats are the beloved companions that can be found in over 35% of American households (Humane Society of the United States, 2022). On the other hand, there is an almost equal amount of cats living outside (30-40 million) as there are living in homes (45.4 million) in the United States (Humane Society of the United States, 2022).

Community Cats

While there are over 45.4 million cats living in households across the United States, the number of cats living outside is comparable, at an estimated population of 30 to 40 million (Humane Society of the United States, 2022). These cats generally can be categorized as either stray or feral. The major factor differentiating these groups is the degree to which they are socialized to humans. Stray cats can be defined as homeless cats that are socialized and friendly with humans, often being previously owned cats who become lost or wander away from home. Alternatively, feral cats are characterized by their lack of socialization and subsequent evasive, antisocial nature. Many feral cats are born in the wild, as less than 3% of outdoor cats are sterilized despite increasing trap-neuter-return efforts over the last 30 years (Chu et al., 2009). There is a brief window in the kitten development timeline, between 2 and 8 weeks of age,

during which feral kittens may be socialized if they are removed from their outdoor environment and provided consistent positive interaction with humans (Carl, 2021). As kittens grow up in the wild, however, they become deficient in the experience with humans necessary for the process of socialization, and thus grow into feral adults.

Feral cat colonies are matrilineal and structured as non-linear hierarchies, which are dictated by dominant-subordinate relationships between colony members (Crowell-Davis et al., 2003). Contrary to popular belief, cats are a social species, and thus the affiliative relationships formed between individuals are crucial to maintaining the natural social organization of the colony (Crowell-Davis et al., 2003). These relationships occur between "preferred associates"- cats who can be found close together, often within 1 meter of each other, more frequently than they are found with other members of the colony (Crowell-Davis et al., 2003, p. 20). They can be found together regardless of the context or location, and display a variety of affiliative behaviors such as nose-touching, which serves as a greeting. Crowell-Davis et al. (2003) also notes that the importance of sex in these relationships is dependent upon the sterilization status of the colony; preferred associates are disproportionately male-male pairs in intact colonies, whereas sex has no effect on pairings in sterilized colonies. Consistent with the matrilineal structure of a colony, relatedness is important in the formation and nature of relationships between members. Family members tend to be friendlier and closer to their relatives than to non-family members. With respect to non-relatives, closeness between individuals is dictated by their degree of familiarity (Crowell-Davis et al., 2003).

As with other social species, dominant-subordinate relationships exist within the colony in order to construct and maintain hierarchy. The integration of non-members into the colony is a long process that occurs if the individual is persistent enough in their attempts to join the colony, despite being met with aggression from colony members (Crowell-Davis et al., 2003). Dominance functions to allow priority access to necessary, and sometimes scarce, resources such as food, water, and simply space to exist. Note,

however, that it is not always true that the dominant individual in the group has priority access to these resources, as there are other contributing variables, such a motivation to obtain the resource (Crowell-Davis et al., 2003).

There are ritualized signals exchanged between dominant and subordinate colony members to acknowledge and maintain status. Subordinate individuals will indicate their status in the presence of a dominant individual by using certain body postures and indicators, such as lowering their ears, rolling over, looking away, leaning back, crouching, and curling their tail lateral to their thigh (Crowell-Davis et al., 2003, p. 24). Contrastingly, dominant individuals will indicate their status with a direct stare, rigid posture, stiff limbs, arched back and erect ears rotated sideways (Konecny, 1983, p. 106; Crowell-Davis et al., 2003). As previously mentioned, hierarchy is non-linear in a colony; similar to other mammalian groups, small groups may have a simple linear hierarchy, but larger groups of greater than four individuals will have ties and reversals within the group that, in turn, make the hierarchy nonlinear (Crowell-Davis et al., 2003). The dynamics within a group of cats are a unique product of the interactions, relationships, and personalities within the group.

These principles are not only true for naturally occurring cat colonies in the wild, but also for multi-cat households, in which a small group of cats, often between three or four individuals, live within an enclosed environment and share resources. These circumstances, although similar, differ from those faced by a naturally-occurring colony; in the home, there is presumably abundant resources, which should reduce the need for dominance in order to compete for access to those resources. However, there are fewer individuals in a multi-cat home; this introduces the potential for linear hierarchy, which is conducive to producing one “high-ranking” individual who displays excessive aggression towards the other “lower-ranking’ individuals. These potential issues in a multi-cat home have been identified as a risk factor for cat relinquishment to an animal shelter (Salman et al., 2000).

Cats in the Shelter

While stray and feral cats make up roughly 80% of all cat admissions to animal shelters, the remaining admissions can be described as owner surrendered cats (Miller et al., 2019). Reasons for relinquishment to the shelter vary, with the most common being too many animals, financial reasons, moving, human medical reasons, and cat behavior problems (Miller et al., 2019).

Cats make up to 50-75% of an animal shelter's population, which justifies the emphasis that has been put on increasing our understanding of cat behavior, how cat behavior is impacted by the shelter environment (Humane Society of the United States, 2022). As previously mentioned, several works of research have emerged regarding emergence of research on these factors has been followed by appropriate changes to these factors. For example, Moore & Bain (2011) found that providing toys and hiding structures in the cage reduced individual Cat Stress Score. Similarly, van der Leij et al. (2019) found that providing a hiding box to cats housed in cages was linked to a significantly faster decrease in stress levels. The importance of these findings lies is reflected in their widespread application in shelters, as the availability of hiding structures (such as hiding boxes) and toys is regarded as a requirement in the housing and animal care guidelines set forth by the Association of Shelter Veterinarians (2022, p. 16).

In comparison to cage housing, community room housing involves housing cats in a room furnished with perches, toys, food, water, and litter boxes, in which the cats are able to freely roam and interact with other cats. Anecdotally, community room housing is widely regarded as beneficial in reducing stress and decreasing length of stay in shelter cats. However, as previously discussed, previous research has been largely inconclusive on the overall impact of community room housing. For example, Ottway & Hawkins (2003) found that overall, Cat Stress Scores were higher in communally housed cats than cats housed in discrete units alone, whereas Gourkow & Fraser (2006) found that Cat Stress Scores were highest in individuals singly-housed in a cage. In contrast, Lichtsteiner & Turner (2008) found that

communal vs. single cage housing did not affect urine cortisol: creatinine ratio, and thus there were no difference in stress.

Research in this area is scarce overall, but especially in the potential factors that may predispose an individual to thrive or deteriorate in communal housing. In this study, I sought to understand the potential interactions between individual history (as in the circumstances of their admission to the shelter), sex, and whether or not the individual thrives in a community room setting. Considering previous evidence that owner surrenders tend to be more stressed upon admission to the shelter, in conjunction with the social dynamics that occur within naturally-occurring feral colonies, I expected owner surrendered individuals to become more stressed in a community room. More specifically, I expected both stray/feral and owner surrendered cats to be stressed in a cage setting, with stray/feral cats being more stressed. Upon being moved into a community room, I expected stray/feral cats to become less fearful and thus less stressed, whereas I expected owner surrendered cats to be equally as, if not more, fearful, and thus stressed, than they were in the cage setting, and in comparison, to their stray/feral counterparts. I did not expect to see a difference in stress levels between males and females in either the cage or community room setting, especially considering all cats will be fixed, which should eliminate any stress caused by sexual competition (Alger & Alger 2002).

Methods

Site Selection

All data collection took place at the two shelters where participants were housed, Tabby's Place Cat Sanctuary in Ringoes, New Jersey, and St. Hubert's Animal Welfare Center in Madison, New Jersey.

Tabby's Place

Tabby's Place is a limited admission cat sanctuary, meaning that they have agency over the cats they admit to their facility (Association of Shelter Veterinarians, 2017). They admit exclusively cats, and are a no-kill facility, meaning individuals remain permanent residents until they are adopted, or until they die of either natural causes or humane euthanasia. Tabby's Place receives the majority of their residents from animal control, TNR (trap-neuter-return) network, and overcrowded animal shelters, both locally and across the world. There are approximately 115 residents at any given time, housed in numerous community rooms of varying sizes (Fig. 1). Community rooms are the primary style of housing used and placement in a specific room is based on compatibility with respect to personality, dietary requirements, and space availability. Cats are offered appropriate portions of wet food, dry food, and water once in the morning and again at night. There is one litter box, one food bowl, and one water bowl per 1-2 residents, depending on the room size and capacity.

Figure 1. Suite B, one of the community rooms at Tabby's Place.

Cages are only utilized during an individual's initial quarantine period upon admission, or if the individual needs to be isolated for an illness. Cages are also used if the individual needs to be isolated in preparation for an upcoming medical procedure, or in select cases if the individual needs to be isolated overnight for behavioral reasons (i.e., not getting along with other cats in the room). Overnight isolation prevents conflict when staff is not present to diffuse conflicts and prevent injury. There are two rooms located in an isolated area of the building, each furnished with twelve stainless steel cages (Fig. 2). There are two cage sizes used, which will be referred to as sizes A and B. Size A cages are 56 cm x 69 cm x 56 cm, and size B cages are 85 cm x 71 cm x 71 cm. Cages within these rooms are oriented in a way in which cats are facing away from each other. To reduce stress and potential transmission of infectious disease to healthy individuals in the community rooms, human contact is limited; anyone entering the room is required to wear full PPE (gown, gloves, boot covers, and a hair net), and volunteers are prohibited from entering these rooms at all.

Figure 2. Quarantine room at Tabby's Place.

Each cage is furnished with a blanket or towel to cover the bottom, an “Kuranda” bed (an elevated cot-style bed), several enrichment items, and a litter box. Individuals are fed once in the morning and once at night before staff leaves for the day. Individuals are typically offered one portion of wet food twice daily, as well as one portion of dry food twice daily. Portion size varies greatly, based on any individual dietary requirements or restrictions set forth by the medical staff, which may be dependent upon any health conditions an individual may have, as well as body condition (i.e., emaciated vs. obese). Each cage has a water bowl, in which fresh, clean water is available to the individual at all times. Enrichment items include various toys and a small disposable scratching board that is attached to the front of the cage. The front of the cage is partially covered with a piece of fabric to reduce stress.

Upon admission, individuals receive an initial medical evaluation by the staff veterinarian and/or veterinary technicians. Medical tests and treatments are administered based on the cat’s medical history and how recently they received the required vaccines and treatments (if at all). Preventatives and tests are not always done at the same time as the intake exam, but usually over the course of a two-week period as the cat is housed in a quarantine cage. Each individual must receive the following prior to being released into a community room: a negative test for FeLV/FIV (feline immunodeficiency virus), two FVRCP (Feline Viral Rhinotracheitis-Calicivirus-Panleukopenia) vaccines, one rabies vaccine, two FeLV (feline leukemia virus) vaccines, a negative giardia test, a negative fecal float to test for intestinal parasites, two negative fungal cultures, a microchip implant, one dose of dewormer (Strongid (pyrantel pamoate) or Revolution (topical selamectin)), and one application of flea/tick preventative (Advantage Multi or Revolution). The individual also must be spayed or neutered. Other surgeries, such as enucleation or dental surgeries, are performed before or after the individual’s release into the community room, depending on the nature of the surgery itself, the individual’s condition, and any risks associated with living in a community room (i.e., increase in mobility potentially aggravating condition).

St. Hubert's

St. Hubert's is an open admission shelter which houses cats, dogs, and small animals such as rabbits and guinea pigs. Open admission differs from limited admission in that it involves a contract with local animal control agencies, and thus an obligation to accept every cat who is surrendered (Association of Shelter Veterinarians, 2017). The population of St. Hubert's varies greatly in general and especially over the course of this study, which took place from August 2022 to March 2023. About halfway through this study, St. Hubert's terminated their contract with local animal control services, which required them by law to house and care for any animals seized or otherwise taken into custody of animal control. Animal control services were a major source of cats admitted to St. Hubert's; in 2022, there were 580 cats admitted directly to the St. Hubert's Madison location through animal control, whereas only 358 cats were admitted as owner surrenders.

Less than 50% of St. Hubert's cat population is housed in community rooms. There are two large community rooms; the Tower Room, which houses between 14 and 18 cats at once, and the "Caged Cat" room, which houses around 14-16 cats at once. Tower Room consists of a 16x14' segment and a 10x7' segment, providing a total 300 square feet of floor space, which approximates to roughly 18 square feet of floor space per cat. There are also two smaller rooms; the "Sunshine" room, which houses up to 4 cats at once, and the "Americana" room, which houses 4-7 cats at once.

Determination of which cats are housed in community rooms is largely based on space, but occasionally influenced by factors such as known history of aggression towards other cats, or having a medical condition that requires daily medication. Cats housed in community rooms usually remain in their respective community room until they are adopted or need to be moved back into a cage for medical or behavioral reasons that require isolation from other cats.

St. Hubert's quarantine housing, similar to that of Tabby's Place, utilizes stainless steel cages of sizes A (56 cm x 69 cm x 56 cm) and B (85 cm x 71 cm x 71 cm), as well as an additional size, which will be referred to as size C. Size C cages measure 85 cm x 71 cm x 71 cm. Oftentimes, there is a portal between adjacent type B and C cages (Fig. 3) that can be opened and closed; space allowing, this portal is kept open, allowing the individual to move between and utilize both cages.

Figure 3. Depiction of a portal cage (University of Wisconsin-Madison, 2020).

The setup of each individual cage is identical to that of Tabby's Place, although St. Hubert's utilizes hiding boxes for cats who are especially fractious. The intake process is nearly identical to that of Tabby's Place, with the cat being medically evaluated by a team of veterinary technicians and administered the core vaccines, dewormers, and preventatives required for all cats housed within St. Hubert's. Prior to being released into a community room, each cat must have at least one recent (within the last year) FVRCP (Feline Viral Rhinotracheitis-Calicivirus-Panleukopenia) vaccine, one recent rabies vaccine, one dose of pyrantel pamoate dewormer for the treatment of intestinal worms, one dose of toltrazuril dewormer for the treatment of coccidia, and topical flea/tick preventative.

Participant Selection

Individuals chosen for behavioral analysis were adults between the ages of 1 and 12 years. All individuals were spayed/neutered prior to behavioral analysis and in good physical health at the time of behavioral analysis. Pre-existing medical conditions were taken into consideration prior to including any one individual in this study, specifically those conditions that may have an impact on the individual's stress levels and behavior towards other cats and humans. One example is an individual who was excluded due to being unilaterally blind as a result of traumatic injury requiring both eyes to be surgically enucleated (removed). Just as with any sensory deficit, complete loss of vision is often accompanied by behavioral changes, such as increased disorientation and/or non-specific fear and anxiety (Falzone and Lowrie, 2011). Thus, it would not be ethical to include this individual in a study on behavior, specifically fear and anxiety behaviors. Other diagnoses that are understood to be linked to increased aggression and other behavioral changes and thus warranted exclusion of the diagnosed individual from this study include: any neurological disorder, hyperthyroidism, hypothyroidism, and any condition or injury that predispose the individual to chronic pain (Falzone and Lowrie, 2011; Camps et al., 2019). Sex, breed, coat color, and socialization status were not factors taken into consideration.

Behavioral Data Collection

Caged Period

The period during which an individual is housed solitarily in a cage, usually immediately upon admission to the facility, will be referred to as the caged period. Behavior observations were started no earlier than three days into this period, as previous research has shown that cortisol-to-creatinine ratios in urine peak during the first three days in quarantine, then dramatically decrease and level off by the fifth

day (Moore & Bain 2011; Rochlitz et al., 1998; Broadley et al. 2014). Observations were taken in a series of phases, with the distance between myself and the cat decreasing in each subsequent phase. Each phase consisted of a two-minute continuous observation period in which I recorded every behavior and posture indicator displayed by the individual. Repeated behaviors were only counted once (i.e., hissing was only recorded once, even if the individual hissed three times within the two-minute interval). Each behavior and posture indicator correlates to a numerical value that is reflective of whether it is understood to be positive and indicative of affiliation, neutral, or associated with fear or aggression (Table 1).

Table 1. Behavior scoring system. Individual behaviors and posture indicators defined by Nicholson and O'Carroll (2021). Vocalizations defined by Tavernier et al. (2020).

Defensive /Aggressive -2	**Fearful -1**	**Neutral 0**	**Content +1**	**Affiliative +2**
Pupils oblong and dilated	Eyes wide	Sitting	Small, oval shaped pupils	Kneading
Direct stare	Dilated pupils	Does not accept treat	Eyes half open	Roll onto back or side
Ears swiveled sideways (inner pinnae visible)	Gaze to left		Ears upright and facing forward	Lean into pet
Tail lowered and rigid	Ears flattened (inner pinnae not visible)		Tail vertical/erect	Purr
Tail slapping against ground	Tail tucked under body		Laying down on stomach	Trill
Tail lashing (rapid side to side movement)	Tail wrapped around body		Laying on side	Head butt
Piloerection	Tense muscles		Stretch	Rub face
Body leaning forward with elevated rump	Crouching		Yawn	Rub body
Launching at individual	Lowered head		Sniff	Sitting at front of cage
Swat (hit or hit with paw)	Trembling		Accept treat	Eyes dilated AND ears up (arousal context)
Bite or attempt to bite	Freezing		Accept pet	Tail quivering
Growl	Hiding		Sleep	
Moan	Fleeing/avoidance		Object play	
Snarl	Sitting at the back of the cage		Meow	
Spit	Sitting in litter box		Murmur	
	Facing back of cage		Slow blink	
	Rapid breathing			
	Hiss			
	Yowl			

Phase 1 began with observing the individual's behavior while standing 1m away from the front of the cage. In phase 2, I observed the individual's response to me increasing my proximity to them by standing directly in front of the cage with my hand up to the door. In phase 3, I observed the individual's response to me opening the cage door and putting my hand inside the cage. Phase 3 was unique in that it provided the opportunity to assess the individual's tolerance for physical contact with an unfamiliar human. I began by petting the individual's head, and if they showed signs of affiliation or at least tolerance (any of the behaviors in the 0, +1, or +2 category) (Table 1), I transitioned to slowly petting down their back towards their hind end. In addition to physical contact, I offered them a treat and noted whether or not they accepted it. The treat offering was a tuna-flavored Churu purée treat on the end of a tongue depressor; this remained consistent throughout the study. Due to the potential influence of personal preference for flavor or texture, rejection of the treat offering was not counted against individuals, and was coded as a neutral behavior.

These procedures were replicated for behavioral observations taken of individuals in a community room, with the exception of a difference in the number of phases per trial; due to the absence of a cage door acting as a barrier between myself and a cat in the community room, the number of phases in each trial was reduced to two. In phase 1, I began by calling the individual and offering a treat from 1m away. In phase 2, I directly approached the cat with the treat, if they had not already approached me in phase 1. If the cat ran away, I followed them. If they continued to run away after I followed them the first time, I did not follow them again, and observed their behavior from afar.

One completion of the three quarantine and two community room phases is referred to as one trial. Observations were limited to one trial per individual per day to prevent unnecessary stress. Observations were completed between the hours of 1:00pm and 5:00pm to reduce the potential impact of stress associated with cleaning and feeding routines that occur in the morning. In situations where the

individual began to exhibit signs of extreme stress or aggression, such as lunging towards me, observations were immediately terminated, regardless of whether or not all three phases had been completed. Since time spent in the quarantine room varied greatly, trials were not taken past the individual's 14th day in quarantine.

Community Room Activity

To better understand the social dynamics between individuals of different intake circumstance within community rooms, I performed 20-minute observations of the activity of individuals in a community room at each facility. The focal community room at Tabby's Place, Suite B, houses approximately 15 to 20 cats at one time, and is considered to be one of the more active rooms in the building. I also observed Tower Room at St. Hubert's, which is similar to Suite B in both its physical size and in its usual population density, which is approximately 14-20 cats at one time.

Suite B and Tower Room are, thus, similar in the number of hiding spots, litter boxes, food bowls, water bowls, and perches they offer. Each room has at least one litter box, one water bowl, one food bowl, one perch, and at least two hiding spots per individual.

I collected data by recording each individual's nearest neighbor, which I defined as the closest individual within a 0.3m radius. I repeated this every 2 minutes for 20 minutes. To reduce the possibility of the cats' behavior being impacted by my presence, I alternated taking these 20-minute observations inside the room and outside the room looking in through the glass. Observations were taken during the afternoon (any time between 1:00pm and 5:00pm) at random over an 11-week period.

Data Analysis

Each individual included in analysis was assigned a number and an individual profile, which included the date on which the individual arrived at the facility. The first day of observations was considered quarantine day 1 (Q1). Each date after that point is labeled Q# or CR#, with the number corresponding to the number of days that individual has spent in that location. “Quarantine” and “caged period” are used interchangeably; there is no difference between them, and they refer to the same housing treatment.

As previously mentioned, behaviors and posture indicators were assigned to a numerical value on a scale ranging from -2 to +2 based on whether a display of that behavior or posture indicator is indicative of aggression, fear, or affiliation (Table 1). Scores for each individual phase were a sum of each behavior/posture indicator recorded during each 2-minute phase. If a trial was cut short due to an individual showing intense signs of fear and stress, such as lunging or attempting to bite me, the individual did not receive a score for the subsequent phases within that trial (i.e., if a trial was cut short in phase 2, the individual did not receive a score for phase 3, and only the scores received during phases 1 and 2 were counted).

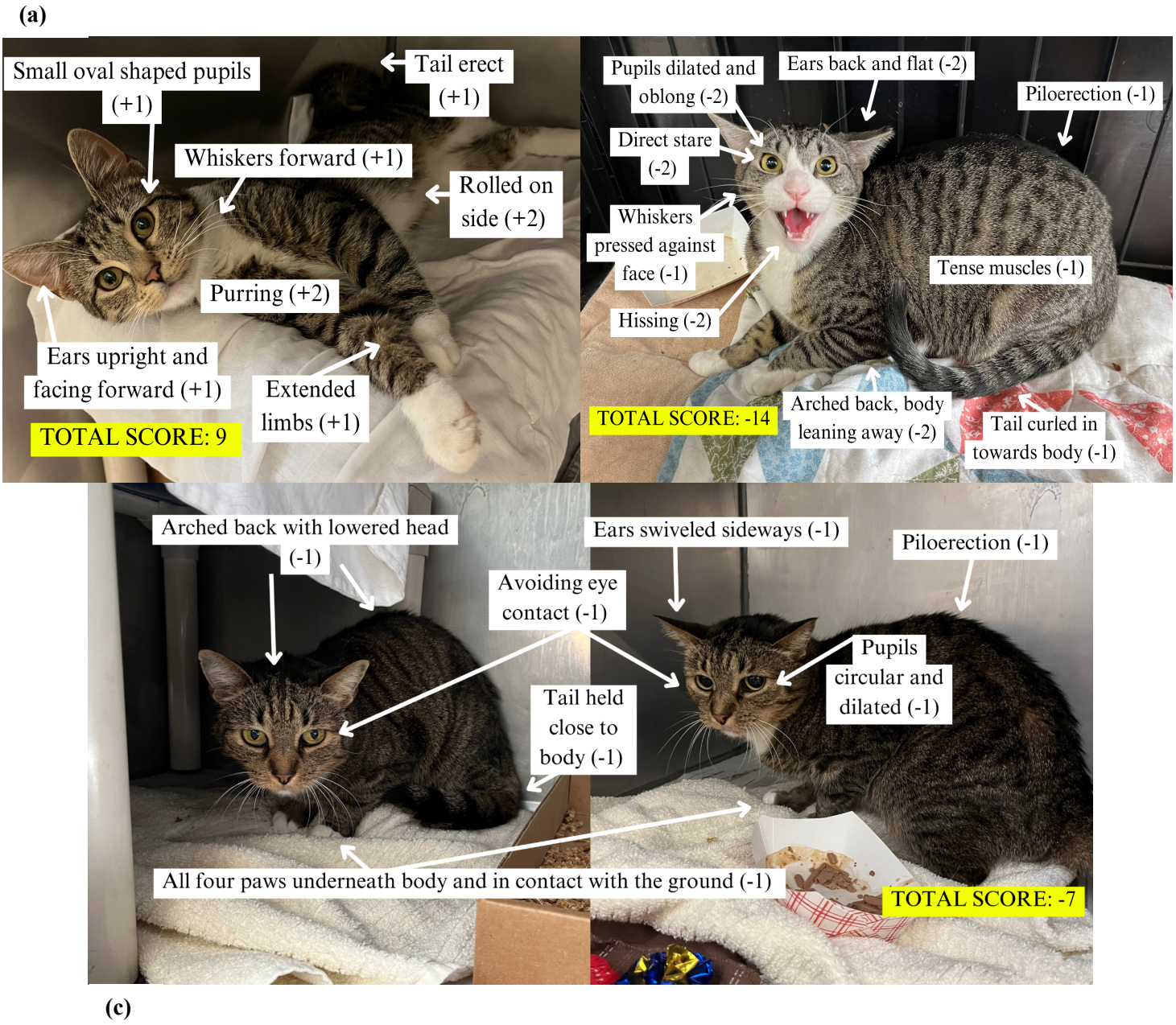

Figure 3. Application of scoring system with body posture indicators and behaviors. (a) An affiliative and non-fearful individual. **(b)** A fearful individual. **(c)** An extremely fearful/defensive aggressive individual.

Results

Of a total 31 participants, there were 14 males and 17 females, all between the ages of 1 and 12 years old. 18 individuals were (owner surrenders) and 13 were found as stray or feral cats, and most often admitted by animal control services.

To assess the effects of intake circumstance (whether the individual was an owner surrender or a stray/feral), an average caged period score was computed as an average of every behavior score that the individual received during their quarantine period. Similarly, an average community room score was computed for each individual using the individual's behavior scores from their community room period.

A mixed model ANOVA was used to investigate the relationship between average score in each housing style and intake circumstance, with average score in one housing style (average quarantine score, average community room score) as a within-subjects factor and intake circumstance (owner surrender or stray/feral) as a between subjects factor. Analysis of variance showed a main effect of intake circumstance (ANOVA; $F_{1,29}$= 14.633, p = <0.001, η_p^2 = 0.335) qualified by an interaction between intake circumstance and behavior score earned in cage vs. community room housing (ANOVA; $F_{1,29}$ = 24.214, p = <0.001, η_p^2 = 0.455). There was no statistically significant difference between the behavior scores of owner surrender and stray/feral cats in caged housing (Fig. 4; ANOVA; $F_{1,29}$ = 0.999, p = 0.326, η_p^2 = 0.033). The average owner surrender behavior score was -0.033, and the average stray/feral score was 2.065. In community room housing, there was a statistically significant difference (Fig. 4; ANOVA; $F_{1,29}$ = 52.133, p < 0.001, η_p^2 = 0.643) between the behavior scores of owner surrender and stray/feral cats; the average owner surrender behavior score was -3.765, and the average stray/feral behavior score was 6.278 (Fig. 4). Pairwise comparisons showed that the average behavior score for owner surrenders was statistically significantly lower in the community room than in the cage (p = 0.001), but the average

behavior score for stray/feral individuals was statistically significantly higher in the community room than in the cage ($p = 0.002$, $p < 0.05$).

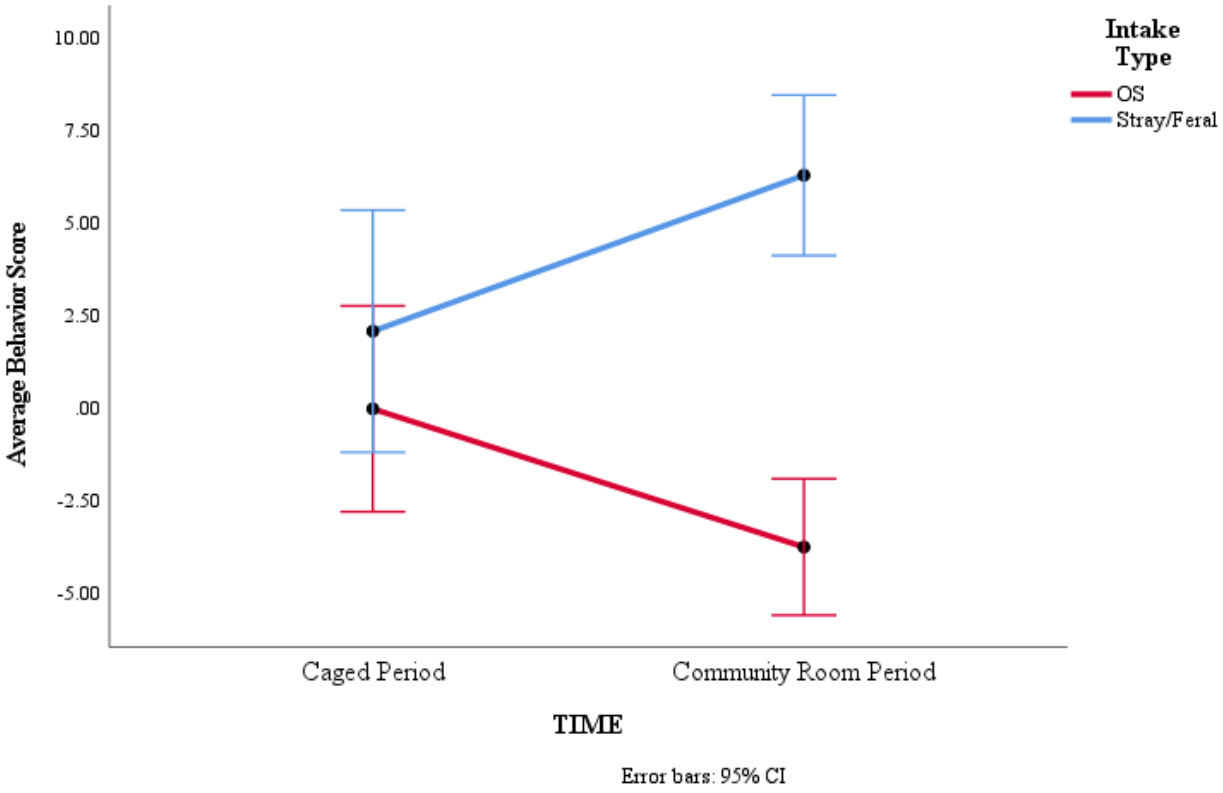

Figure 4. Line graph depicting the differences between owner surrender and feral/stray individuals in their average behavior score during the caged period vs. in community room housing.

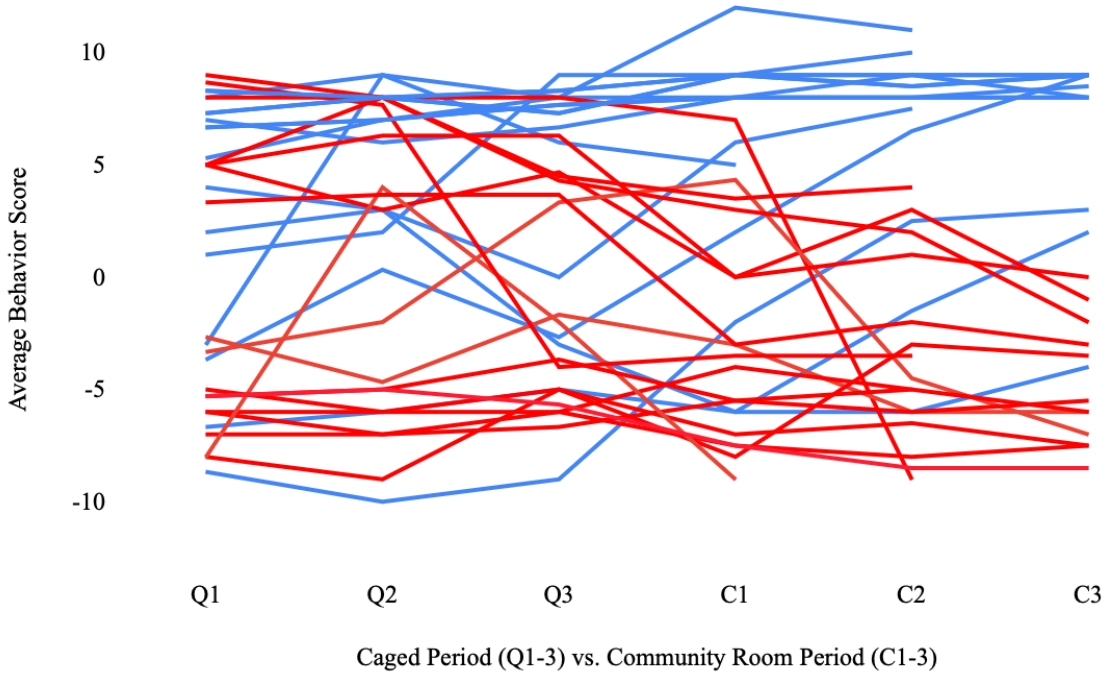

Figure 5. Line graph depicting change in behavior score between two housing styles, with each line representing an individual. Red lines represent owner surrendered individuals and blue lines represent stray/feral individuals.

A mixed-model ANOVA was also performed to assess whether or not there is an effect of sex on average behavior score in the cage vs. in the community room. There were no statistically significant relationships between these variables; in the cage, females had an average behavior score of -.79, and male cats had an average behavior score of 2.8 in the cage (Fig. 6). In the community room, males had an average behavior score of 3.1, and females had an average behavior score of -1.74.

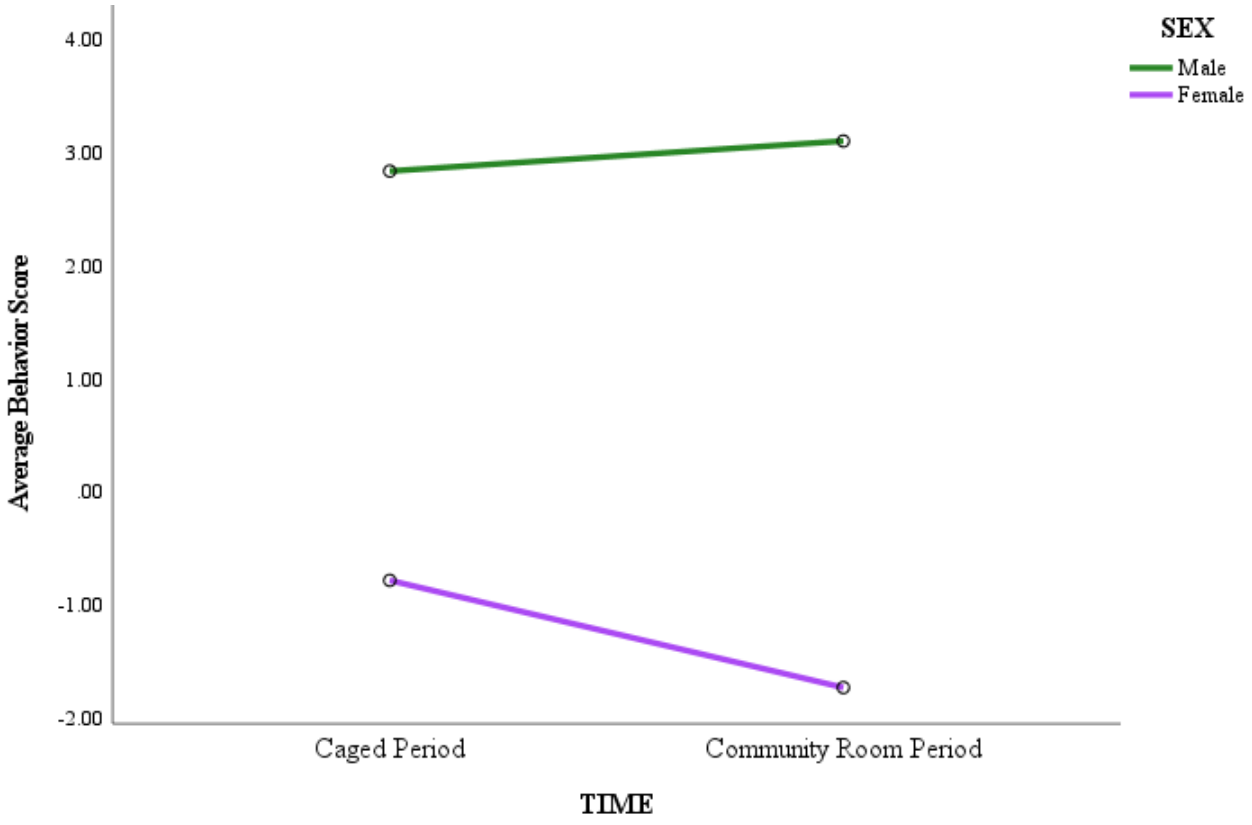

Figure 6. Line graph depicting the differences between male and female cats in average behavior score earned during the caged period vs. while in community room housing.

As for my community room nearest neighbor observations, I performed a total of twenty 20-minute observation periods on Suite B, a community room at Tabby's Place. The population within Suite B remained relatively consistent over the eleven-week period during which I performed the 20-minute observation periods at random. During this time, there were consistently at least ten owner-surrendered and eight formerly stray/feral residents in the room. Similarly, I performed a total of sixteen 20-minute observation periods on Tower room, a community room at St. Hubert's. The population of Tower room also remained relatively stable for the entirety of the 11-week period; there was a stable population of two owner surrendered individuals, five formerly feral/stray individuals, and seven individuals seized from two different cruelty cases.

Nearest neighbor instances were grouped by the intake circumstances of the two cats involved in the interaction; two owner surrendered individuals, an owner surrendered and a stray/feral individual, or two stray/feral individuals. Nearest neighbor was recorded every two minutes regardless of whether the nearest neighbor had not changed over the two-minute period (i.e., if two individuals were nearest neighbors at both the two and four-minute mark, the interaction was counted twice).

Over twenty observation periods at Tabby's Place, I recorded a total of 102 instances in which two owner surrendered individuals were nearest neighbors, 190 instances in which an owner surrendered individual was nearest neighbors with a stray/feral individual, and 276 instances in which stray individuals were nearest neighbors (Fig. 7).

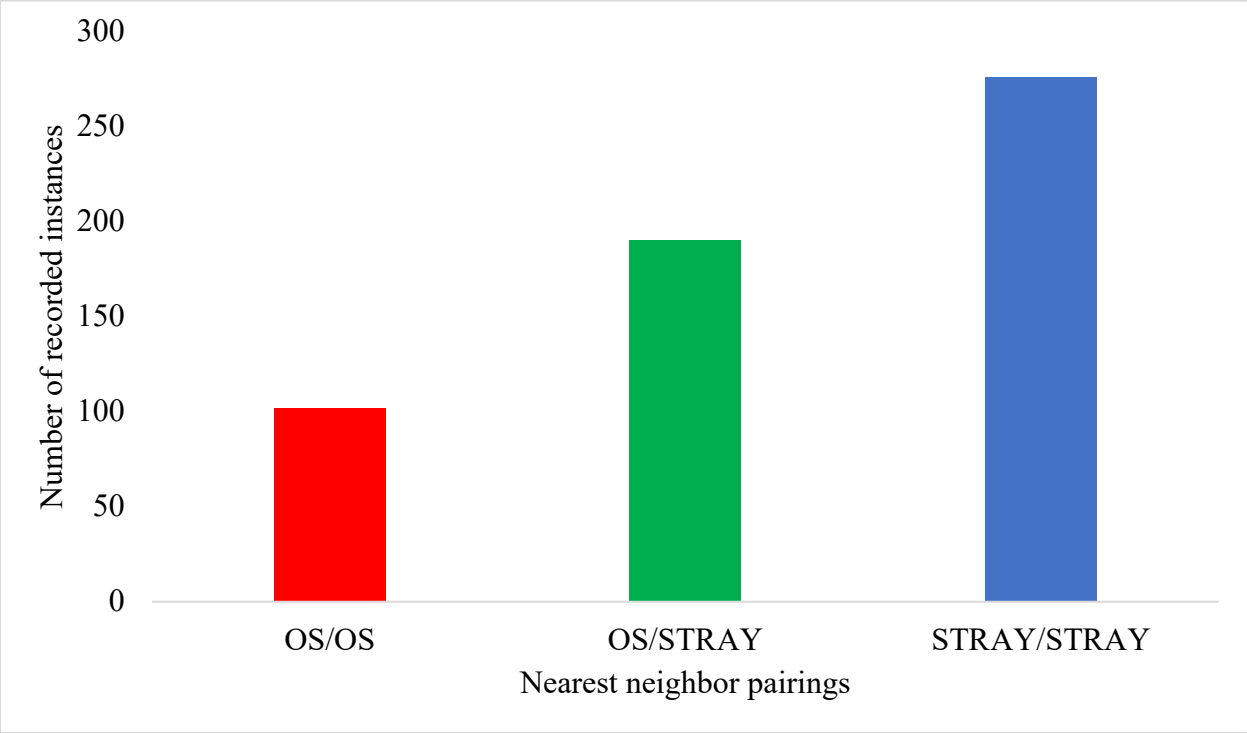

Figure 7. Bar graph depicting the total number of nearest neighbor instances recorded based on intake circumstance of the pairing. Depicts data collected from Suite B at Tabby's Place.

I collected similar data in Tower Room at St. Hubert's, in which there were not only stray/feral individuals and owner surrender individuals, but also several individuals who came from hoarding cases. I recorded a total of 8 owner surrender-owner surrender nearest neighbor instances over sixteen 20-minute observation periods. There were 134 owner surrender-stray/feral nearest neighbor instances, and 104 nearest neighbor instances between two stray/feral individuals. Individuals seized from cruelty cases were put into a separate category- there were 148 instances in which these individuals were nearest neighbors with each other, 160 instances in which one of them was nearest neighbors with a stray/feral, and 128 instances in which one of them was nearest neighbors with an owner surrendered individual (Fig. 8).

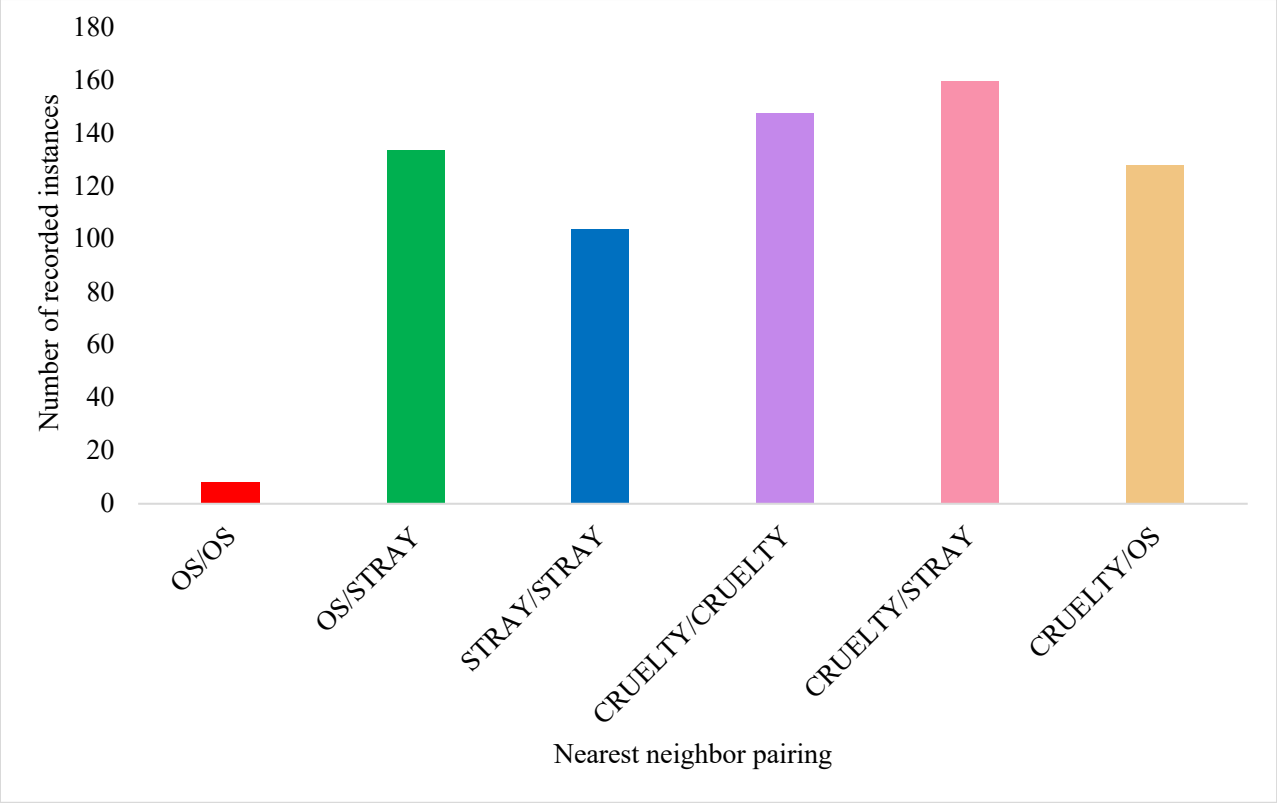

Figure 8. Bar graph depicting the total number of nearest neighbor instances recorded based on intake circumstance of the pairing. Depicts data from observations at St. Hubert's.

Discussion

The intention of this study was to investigate whether individual characteristics can be linked to whether or not an individual thrives or deteriorates in a community room as opposed to a cage setting. Based on the body of research on community room housing in animal shelters, I expected to find that owner surrendered individuals did more poorly in community room settings than did formerly stray/feral individuals. Owner surrenders had lower behavior scores upon entering the shelter and during the caged period in comparison to their stray/feral counterparts, however these differences were not significant (Fig. 4). These findings are inconsistent with those of Dybdall et al. (2007), who found that owner surrenders were significantly more stressed in a cage setting than their stray counterparts. The average of all owner surrender scores in the caged period was slightly negative (-0.033; Fig. 4), which decreased significantly during the community room period (-3.765; Fig. 4). Though I had a small sample size overall, there were more owner surrendered individuals included in my sample population (18) than there were stray/feral individuals (13). Cat behavior is highly variable, which may explain why there was no differences between owner surrenders and stray/feral behavior scores during the caged period. Despite having very similar methodology, my results may be inconsistent with those of Dybdall et al. (2007) due to differences in when observations were collected. Dybdall et al. (2007) collected observations during the first three days of the individual's stay in the shelter, whereas I waited until the third day that the individual had been in the shelter to begin taking observations. Several studies have reported similar findings that cat stress levels are the highest during the first three to six days in the shelter (Kessler & Turner, 1997; Rochlitz et al., 1998; Kessler & Turner, 1999; Broadley et al., 2014). Thus, stress scores recorded during an individual's first three days in the shelter may not be entirely reliable and may skew results, as individuals are likely to be more stressed during the first few days, whereas after that initial period, stress levels have shown to level off and remain somewhat consistent (Kessler & Turner 1997). It

would be expected, then, that scores taken after the first three days would result in greater variability amongst individual scores, regardless of intake circumstance, as individuals have had time to adjust to their surroundings, thus reducing the possibility for drastic changes in stress levels (Kessler & Turner, 1997).

In contrast, stray/feral individuals did significantly better in the community room than in a cage; the average behavior score earned by stray/feral individuals in the caged period was 2.66, and increased to an average score of 6.75 during the community room period. It was not expected that stray/feral individuals would score higher than owner surrender individuals during the caged period, regardless of these differences being insignificant on a statistical level. One explanation for this may be that there were potentially more stray individuals than feral; stray individuals are typically regarded as potentially once owned cats or cats who are "too friendly" to be outside, thus often leading to their admission to an animal shelter. Truly feral individuals are often not considered adoptable and thus not moved into community rooms. This may be done for space or financial purposes, as each cat housed in the shelter costs the shelter money. Keeping a truly feral cat can potentially be considered a welfare implication, as the stress caused by the shelter environment may be more detrimental to the individual's emotional and physical well-being than being returned to their established colony that has a caretaker.

Regardless, the highly significant increase in average stray/feral behavior score that is seen in the transition from the caged period to the community room period was expected, considering the history of this certain kind of cat. Feral cats are known to show extremely high behavioral adaptability, which allows them to survive in the wild where obtaining food and other resources requires high energy expenditure in comparison to that of a house cat who knows exactly when and where they will receive their next meal (Fisher et al., 2014). Though it is not always known as to whether an individual was a stray or feral cat, stray cats can still be characterized as adaptable, as they are able to survive on their own

out in the wild for at least some period of time. This is especially true considering strays may never return to their home and often resort to joining a feral colony (Alley Cat Allies, 2023).

Thus, I would expect the change from living outside in the wild to inside in an animal shelter to be stressful in that once they are housed in a cage, they experience a decrease in their individual freedom and free will to roam anywhere they choose. I'd expect this potential increase in stress, and subsequent fearful behavior, to be balanced out by a decrease in stress resulting from the sudden food and resource security they experience in the shelter. Since they are fed sufficient amounts of food at consistent times while staying in the shelter, they are not experiencing the stress they may experience while expending energy on hunting prey in the wild. Additionally, one's surroundings are rarely stable when living in the wild, again, because they may not know where their next meal is coming from, or where they will sleep at night, or if they may be attacked by another animal. Thus, I would also expect these individuals to be more adaptable to the constantly changing shelter environment that is often overstimulating and highly stressful for a cat.

When these individuals are released into a community room, they are once again provided with the ability to freely roam in what is essentially an artificially produced and maintained feral colony, as individuals within the "colony" are not exactly granted acceptance into the colony by natural means, but rather by shelter staff intentionally placing them in the colony. Individuals who were previously stray or feral likely have some level of experience in the process of integrating themselves into a colony, and thus may be more easily adaptable and able to do so upon being introduced to such a situation.

In contrast, owner surrendered individuals likely come very stable environment, in which they likely knew what they would be fed and when, where the litter box was, where their toys were, and who would be home. They transitioned from these very stable environments to unstable environments, where they are fed inconsistent foods and their environment is being changed every day when their cage gets cleaned. Their owner and everything they have ever known suddenly disappears, thus making the

transition to the shelter extremely stressful and difficult to adjust to, especially being a house cat who has not had to be as adaptable as their stray/feral counterparts in order to survive.

It is understandable how the stress experienced by owner surrendered individuals would worsen as they are transitioned into a community room, as it is another transition on top of the home-to-shelter transition that they may not have even recovered from yet, depending on how long their holding period in a cage was. Not only are they now coping with an additional change in routine and normalcy, but there are now other cats added into the mix. Regardless of whether or not the individual came from a multi-cat household, it is unlikely that the individual came from a home with more than three or four other cats. None of the individuals included in this study came from a multi-cat household in which there were greater than three cats. Owner surrendered individuals are likely less adaptable to living with other cats, especially unfamiliar ones, in such high densities, which may explain the further decrease in average behavior score seen in owner surrendered individuals once they are moved to a community room.

As for the trends seen in average behavior score between sexes, there is lacking research on behavior differences between male and female neutered cats in a shelter setting, specifically between different housing styles. The data was equally distributed, with fourteen females and seventeen males. There was no difference in the scores earned by males and females in either housing treatment. Previous research has shown that would need to be elaborated upon in further research to determine if females are more highly sensitive to change or the presence of other cats.

The low number of nearest neighbor interactions between owner surrendered individuals was expected, as these individuals are likely too stressed or inexperienced with unfamiliar cats to initiate relationships and closeness with other cats who are also too scared to do so. There were more frequently owner surrender and stray/feral nearest neighbor instances, and even more frequently nearest neighbor interactions between stray/feral individuals. This. This would be consistent with my hypothesis that

stray/feral individuals thrive in community room settings partially because of their presumed prior experience with large groups of unfamiliar cats.

Case Study: Hickory

Hickory is a senior male domestic shorthair “tuxedo” cat estimated to be anywhere from 8 to 10 years old. In early October 2022, he was admitted to St. Hubert’s by animal control services, who picked him up from a Good Samaritan’s house. The Good Samaritan had noticed Hickory lingering around her yard for several days, and decided that he was too friendly to be outside, so she trapped him in a dog crate and held him in her basement until animal control could pick him up.

Upon initial examination, Hickory was slightly dehydrated, underweight, and anemic. Two days prior to his release from a cage into a free roaming community room, he was evaluated again by a veterinarian and his bloodwork was rechecked. During his cage period, he gained two pounds and his anemia was resolved. Hickory did not show signs of intense fear or fear-induced aggression in a cage; his average behavior score was around a -2, which indicates that Hickory was anxious in a cage, however not completely overcome with fear.

Hickory was moved into a community room with a core group of at least 10 other cats in the room at any given time, however the typical population ranged from 14 to 16 cats in the room at one time. The “core group of 10” refers to long term residents that were present for the majority of Hickory’s stay in the room. This group of long-term residents consisted of 7 females and 3 males, all of which were fixed adults.

Despite the findings of this study regarding owner surrender vs. feral cats and their behavioral response to being housed in a community room, Hickory, who is an ex-stray cat, deteriorated in the community room. He consistently hid underneath benches and on low-level perches, often being as close

to the ground as possible, and out of sight from any humans or other cats. He rarely interacted with other cats in the room and, upon approach by myself or another unfamiliar human, hissed and cowered. In every observation I made of Hickory in the community room, his eyes were dilated and wide open. He held his tail close to his body and usually had his limbs close to his body. He never appeared to be truly relaxed, and would freeze up when he noticed me getting closer to him, and hiss when I put my hand forward. As I increased my proximity to him, he increased the frequency at which he hissed and began growling. Thus, I did not continue to attempt contact past this point, as I did not want him to experience any more stress than he was already experiencing, and did not want to risk him lunging at me.

As previously mentioned, St. Hubert's contract with animal control was terminated, starting January 1st, 2023. This resulted in a drastic decrease in the admission of cats to St. Hubert's. Few cats remained after about a month into the year, including those from the aforementioned "core group" of 10 cats who inhabited the community room alongside Hickory. By February, one of these individuals had been euthanized due to old age and poor quality of life, two individuals had been adopted, and 4 individuals had been transferred to rescue organizations. By March, Hickory and two individuals from the core group were the only individuals who remained in the community room.

The room had become much quieter, with only 3 residents taking up space that was once inhabited by an additional 10 to 13 other cats. It was with this drastic decrease in the population that both myself and the St. Hubert's behavior team observed an unprecedented change in Hickory's behavior. Hickory, who had once been incredibly fearful and unable to be approached without hissing, would now let me pet him from his head all the way down his back, and brush his matted coat. For once, his muscles were not filled with tension and his eyes were no longer filled with sheer terror at the sight of a human. Instead, now, he slowly blinked at me and accepted treats out of my hand.

I believe there may be two factors contributing to Hickory's sudden change in behavior. A decrease in the population density within the room freed up space, allowing for a greater number of

square feet per cat residing in the room. Additionally, fewer individuals may have decreased his stress levels, as the number of individuals increased subsequently increased the activity level within the room, as well as the number of individuals he may have felt like he needed to compete with for resources, or whom he saw as a threat.

This is an additional finding that, though has not been analyzed on a statistical basis, can be useful for shelters in considering population density as a factor in the success of community room style housing. Hickory's case suggests that starting individuals out in a smaller-scale room with lower population density may be advantageous in facilitating the improvement of individuals in community room style housing, and that placing individuals in highly active room with a larger population density may contribute to the deterioration of an individual's behavior. This would be useful for individuals such as Hickory, who are older, formerly stray individuals, who demonstrate shyness, but not intense fear during the cage period.

Case Study: Cats from Hoarding Homes

Animal hoarding is a uniquely sad form of animal cruelty, as it involves the suffering of many animals at once, but there is a lack of intent to cause harm behind it. Many people are unaware of how frequently animal hoarding occurs until it is taking place in their own backyard. Animals rescued from hoarding situations are frequently found in extremely unsanitary and overcrowded conditions. They are most often malnourished to some degree and suffering from disease, injury, or other medical problems (Reinisch 2009). During the course of this study, I studied the behavior of 9 cats who came from 3 different hoarding situations. None of these individuals were included in the dataset, as research on the behavior of previously hoarded cats supports that they do not fit into the "typical" profile for an owner

surrender or stray/feral cats, due to the unique nature of hoarding situations and the hoarder-cat relationship.

Four of the nine hoarded cats I studied came from the same home, and were identical solid white domestic shorthairs. They were all intact adults between the ages of four and seven years old, and were universally small in size; for example, a seven-year-old female weighed 4.66 pounds upon intake. They were referred to as the "Soup" cats, as they were all named after different kinds of soup. Three of the four Soup cats suffered from unilateral microphthalmia, a congenital abnormality in which the globe of the eyeball is underdeveloped (Large & Blacklock, 2019). The uniformity in their solid white color, which is produced as a result of a recessive gene, small size, and congenital abnormalities, as well as the fact that none of them were fixed upon intake, may be indicative of inbreeding amongst related individuals. Each of these individuals were incredibly affiliative during both the caged period and once they were transitioned into community rooms; their average caged period scores ranged from 5-7, and their average community room scores ranged from 9-11. I found that they were extremely affiliative with unfamiliar humans, even more so than the other highly affiliative individuals observed during this study; they were unique in that they wanted to be as close to the nearest human as possible; they would immediately cling to any human in the room. For example, if I was sitting down, there was a Soup cat sitting on my lap, and another Soup cat sitting in my purse, and another Soup cat sitting between my legs. If I tried to remove them, they would come right back.

These findings are consistent with those of Jacobson et al. (2022), who found that 52% of previously hoarded cats admitted to an animal shelter received "friendly" behavior scores. These individuals were also universally friendly with other cats and were rarely involved in conflict with other cats; in conflicts that I did observe involving any of the Soup cats, the Soup cat involved was not the aggressor.

I also observed seven cats from two different hoarding cases at St. Hubert's, who were all housed within the same community room. Three of these individuals, who will be referred to as the "Crystal" cats, were seized from a home with 13 other cats, after their owner was hospitalized and no one was willing to take care of them due to the unsanitary conditions in the home typical of a hoarding case. The other four individuals, who will be referred to as the "Brook" cats, were seized from a home with over 120 other cats, after a neighbor requested a welfare check due to the smell and flies emanating from the residence. Among the cats seized from the property, many were alive, however some were deceased upon discovery. These individuals arrived at St. Hubert's several months prior to when I began collecting data, and thus I was not able to observe these individuals in a cage setting.

Since individuals from cruelty cases made up such a large portion of the cats in the Tower room, where I did 20-minute scan sampling periods to observe nearest neighbors, I was able to observe how these individuals differ in their interactions with each other, other cats, and unfamiliar humans, in comparison to the Soup cats.

These individuals were universally extremely skittish and never once allowed me to touch them or get closer than two feet away from them. They would not behave aggressively if I got too close; they were genuinely fearful and would run as far away as possible. It was evident in my nearest neighbor observations that the presence of each other in the room played a large role in their ability to thrive within the room. As shown in figure 8, individuals from cruelty situations accounted for the majority of all recorded nearest-neighbor interactions; over sixteen 20-minute scan-sampling periods, I observed 148 instances in which two individuals from cruelty situations were nearest neighbors with each other, and 160 in which one of them was nearest neighbors with a formerly stray individual. Additionally, I observed 128 instances in which an individual from a cruelty situation was nearest neighbors with an owner surrendered individual; this is in comparison to the eight owner surrender-owner surrender nearest neighbor instances and 134 owner surrender-stray/feral nearest neighbor instances I observed. While this

data is limited because there were only two owner surrendered individuals in the room at once, it echoes the findings of my nearest-neighbor observations at Tabby's Place, in that owner surrendered individuals are likely not the ones seeking out interaction from other cats, and that these close interactions are likely facilitated by stray/feral individuals. In this case, cats from cruelty cases likely facilitate these interactions just as much, if not more.

I observed differences in individuals from different cases in their interactions with other cats. Individuals from the Crystal cat group were more solitary than the others; two of the individuals would consistently sit on the highest perches in the room, which were adjacent to each other, although sometimes they would sit on the same one, basically on top of each other. I never observed any of the other cats in the room on these perches, even in the rare instances in which these two individuals were elsewhere in the room. The third Crystal individual was more social than the other two, most often with the Brook individuals. The Brook individuals were more similar to the behavior of the Soup cats, but even then, exhibited differences in how they interacted with each other. Unlike the Soup cats, the Brook cats were not affiliative with humans whatsoever; however, they were extremely affiliative with each other. All four of these individuals were frequently each other's nearest neighbor, often with no regard for personal space, as seeing them piled on top of each other was not an uncommon occurrence.

The behavioral differences between these three groups of cats, despite having come from very similar situations, demonstrates the uniqueness and complexity of cat behavior, especially that of cats who have experienced the trauma associated with living in a hoarding home. All three groups were affiliative with other individuals, which is consistent with the findings of Jacobson et al. (2022), who found that cats adopted after being admitted to a shelter from a hoarding situation showed affiliative behavior with other animals in the home. Research on the behavior of hoarded cats is highly underdeveloped, and more is needed to increase our current understanding of the potential effects of this

specific type of traumatic experience on cat behavior, as well as whether this type of trauma bonds cats to humans or each other.

Limitations

There were several potential limitations to this study, one of which was the differences between Tabby's Place and St. Hubert's. Unlike Tabby's Place, which houses exclusively cats, St. Hubert's houses dogs in the same building as cats. McCobb et al. (2005) found that urine cortisol: creatinine ratio was highest among cats who were housed closely to or otherwise frequently exposed to dogs. While dogs and cats at St. Hubert's are housed in different areas of the building, the potential effect of hearing or smelling dogs cannot be ruled out as a potential confounder. Additionally, intake circumstance does not rule out the possibility of confounding factors that may impact the individual's behavior. Upon intake, shelters try to find out as much as they can about the individual's history and look for signs of abuse, regardless of where the individual comes from (outside or a home). Though I made an effort to exclude individuals who may have experienced behavior-altering trauma from this study, I was limited in my knowledge of these situations based on what was communicated with the shelter upon intake of the individual. Thus, the possibility that an individual who had sustained behavior-altering trauma was unknowingly included in this study cannot be ruled out, as there is the potential that people surrendering cats are not 100% truthful in what they communicate with the shelter about the individual. My results may also have been limited in that I did not have an alternate observer taking observations in addition to myself. The benefit of an alternate observer is that an additional person taking observations of the same individual would reinforce the validity of my observations.

Conclusion

My findings are highly valuable in that they will assist shelters in determining which individuals would benefit from being housed in a community room as opposed to a cage. Note, however, that results should not be used in a "one-size-fits-all" approach, as cat behavior is extremely variable. In deciding which cats should be considered for communal housing, this data can be used to support the prioritization of cats who were admitted as strays, as the conditions within a community room are closest to those they experienced in the wild, and thus offer an environment that they may be able to adapt to more easily. If an owner surrendered individual is to be put in communal housing, I would advise placing them in a room with a smaller group of fewer individuals; if they appear to thrive or desire more interaction than the other cats are willing to accommodate, the individual may, then, benefit from being placed in a larger communal housing group. This suggestion is supported by the evidence presented in Hickory's case study, as well as in previous research by Ottway & Hawkins (2003) which found that communal housing may be a more stressful experience when housed with a large group as opposed to a smaller group with 1-3 individuals.

Further research should focus on the impacts of sex ratio within community rooms, as well as the ratio of owner surrendered to stray/feral individuals. More research should be done, overall, on the behavior of cats from hoarding cases, as well as other cruelty situations. Individuals from these cases automatically have a unique life history that is highly individualized depending on the nature of the situation they came from. It would be interesting to further our understanding of how the nature of animal hoarding and the circumstances commonly associated with these cases may impact how an individual interacts with both familiar cats from the same case and unfamiliar cats they may encounter in the shelter or in the home, as well as how they behave towards and interact with humans.

The additional importance of this study lies in that it is among the few correlating intake circumstance to behavior outcomes. I found that owner surrenders do significantly worse in community room housing than stray/feral cats, which is not only useful for shelters in deciding which cats would be a good fit for communal housing. While cat behavior is highly variable, and intake circumstance is not the sole determinant of how an individual may behave in the shelter environment, this study demonstrates that it does play a role; one that may have been overlooked until this point, and is deserving of further exploration.

References

Alger, J.M., & Alger, S.F. (2002). *Cat culture: The social world of a cat shelter.* Temple University Press.

Alley Cat Allies. (2023). *Feral and Stray Cats: An Important Difference.* Alley Cat Allies. https://www.alleycat.org/resources/feral-and-stray-cats-an-important-difference/.

The American Society for the Prevention of Cruelty to Animals. (2023). Pet Statistics. Available online: https://www.aspca.org/helping-people-pets/shelter-intake-and-surrender/pet-statistics (accessed 10 May 2023).

The Association of Shelter Veterinarians. (2017). Shelter terminology. Available from: https://www.sheltervet.org/assets/PDFs/shelter%20terminology.pdf.

The Association of Shelter Veterinarians. (2022). The guidelines for standards of care in animal shelters: Second edition. *Journal of Shelter Medicine and Community Animal Health, 1*(2), 1-76.

Broadley, H.M., McCobb, E.C., & Slater, M.R. (2014). Effect of single-cat versus multi-cat home history on perceived behavioral stress in domestic cats (*Felis silvestrus catus*) in an animal shelter. *Journal of Feline Medicine and Surgery, 16*(2), 137-143.

Camps, T., Amat, M., & Manteca X. (2019). A review of medical conditions and behavioral problems in cats and dogs. *Animals, 9*(12), 1133.

Carl, E. (2021). A guide to socializing older (fractious) kittens. *The IAABC Foundation Journal*, *22*. Available from: https://iaabcjournal.org/a-guide-to-socializing-older-fractious-kittens/.

Chu, K., Anderson, W. M., & Rieser, M. Y. (2009). Population characteristics and neuter status of cats living in households in the United States. *Journal of the American Veterinary Medical Association*, *234*(8), 1023–1030.

Crowell-Davis, S. L., Curtis, T. M., & Knowles, R. J. (2004). Social organization in the cat: a modern understanding. *Journal of Feline Medicine and Surgery*, *6*(1), 19–28.

Crowley, S. L., Cecchetti, M., & McDonald, R. A. (2020). Our wild companions: Domestic cats in the anthropocene. *Trends in Ecology & Evolution*, *35*(6), 477–483.

Dybdall, K., Strasser, R., & Katz, T. (2007). Behavioral differences between owner surrender and stray domestic cats after entering an animal shelter. *Applied Animal Behaviour Science, 104*(1–2), 85-94.

Falzone, C., & Lowrie, M. (2011). Blindness and behavioural changes in the cat: Common neurological causes. *Journal of Feline Medicine and Surgery 13*(11), 863-873.

Finka, L.R., Ellis, S.L.H., & Stavisky, J. (2014). A critically appraised topic (CAT) to compare the effects of single and multi-cat housing on physiological and behavioural measures of stress in domestic cats in confined environments. *BioMed Central Veterinary Research, 10*(73), 1-11.

Fisher, P., Algar, D., Murphy, E., Johnston M., & Eason, C. (2014). How does cat behaviour influence the development and implementation of monitoring techniques and lethal control methods for feral cats? *Applied Animal Behaviour Science.* dx.doi.org/10.1016/j.applanim.2014.09.010.

Foster, S., & Ijichi, C. (2017). The association between infrared thermal imagery of core eye temperature, personality, age, and housing in cats. *Applied Animal Behaviour Science, 189*, 79-84.

Gourkow, N., & Fraser, D. (2006). The effect of housing and handling practices on the welfare, behaviour and selection of domestic cats (*Felis sylvestris catus*) by adopters in an animal shelter. *Animal Welfare, 15*(4), 371.

The Humane Society of the United States. (2022). Pets by the numbers. Available from: https://humanepro.org/page/pets-by-the-numbers.

Jacobson, L.S., Ellis, J.J., Janke, K.J., Giacinti J.A., & Roberson, J.V. (2022). Behavior and adoptability of hoarded cats admitted to an animal shelter. *Journal of Feline Medicine and Surgery, 24*(8), e232-3243.

Kessler, M. R., & Turner, D. C. (1997). Stress and adaptation of cats (*Felis silvestris catus*) housed singly, in pairs and in groups in boarding catteries. *Animal Welfare, 6*(3), 243–254.

Kessler, M.R., & Turner, D.C. (1999). Socialization and stress in cats (*Felis silvestris catus*) housed singly and in groups in animal shelters. *Animal Welfare, 8*(1), 15-26.

Konecny, M.J. (1983) Behavioral ecology of feral house cats in Galápagos, Ecuador (Doctoral dissertation). University of Florida, Gainesville.

Large, T.P., & Blacklock, B.T. (2019, May 23). Ophthalmological conditions in kittens and young cats. *Royal Canin Vet Focus*, (29.1). Available from: https://vetfocus.royalcanin.com/en/scientific/ophthalmological-conditions-in-kittens-and-young-cats.

Lichtsteiner, M., & Turner, D.C. (2008). Influence of indoor-cat group size and dominance rank on urinary cortisol levels. *Animal Welfare, 17*(3), 215-237.

McCobb, E.C., Patronek, G.J., Marder, A., Dinnage, J.D., & Stone, M.S. Assessment of stress levels among cats in four animal shelters. *Journal of the American Veterinary Medical Association, 226*(4), 548-555.

Miller, H., Ward, M., & Beatty, J. A. (2019). Population characteristics of cats adopted from an urban Cat shelter and the influence of physical traits and reason for surrender on length of stay. *Animals*, *9*(11), 940 (p. 1-8).

Moore, A.M., & Bain, M.J. (2013). Evaluation of the addition of in-cage hiding structures and toys and timing of administration of behavioral assessments with newly relinquished shelter cats. *Journal of Veterinary Behavior, 8*, 450-467.

Nilson, S. M., Gandolfi, B., Grahn, R. A., Kurushima, J. D., Lipinski, M. J., Randi, E., Waly, N. E., Driscoll, C., Murua Escobar, H., Schuster, R. K., Maruyama, S., Labarthe, N., Chomel, B. B., Ghosh, S. K., Ozpinar, H., Rah, H.-C., Millán, J., Mendes-de-Almeida, F., Levy, J. K., … Lyons, L. A. (2022). Genetics of randomly bred cats support the cradle of cat domestication being in the Near East. *Nature 129,* 346-355.

Ottoni, C., Van Neer, W., De Cupere, B., Daligault, J., Guimaraes, S., Peters, J., Spassov, N., Prendergast, M. E., Boivin, N., Morales-Muñiz, A., Bălăşescu, A., Becker, C., Benecke, N., Boroneant, A., Buitenhuis, H., Chahoud, J., Crowther, A., Llorente, L., Manaseryan, N., … Geigl, E.-M. (2017). The paleogenetics of cat dispersal in the ancient world. *Nature Ecology & Evolution, 1*(7), 0139.

Ottway, DS, & Hawkins, DM. (2003). Cat housing in rescue shelters: a welfare comparison between communal and discrete housing. *Animal Welfare, 12*(2), 173-189.

Reinisch, A.I. (2009). Characteristics of six recent animal hoarding cases in Manitoba. *The Canadian Veterinary Journal, 50*(10), 1069.

Rochlitz, I., Podberkscek, A.L., & Broom, D.M. (1998). Welfare of cats in a quarantine cattery. *Veterinary Record, 143*, 35-39.

Salman, M.O., Hutchinson, J., Ruch-Gallie, R., Kogan, L., New Jr., J.C., Kass, P.H., & Scarlett, J.M. (2000). Behavioral reasons for relinquishment of dogs and cats to 12 shelters. *Journal of Applied Animal Welfare Science, 3*(2), 93-106.

Suchak, M., & Lamica, J. (2018) A comparison of cats (*Felis silvestris catus*) housed in groups and single cages at a shelter: A retrospective matched cohort study. *Animals, 8*(29), 1-14.

Uetake, K., Goto, A., Koyama, R., Kikuchi, R., & Tanka, T. (2013). Effects of single caging and cage size on behavior and stress level of domestic neutered cats housed in an animal shelter. *Animal Science Journal, 84*(3), 272-274.

University of Wisconsin-Madison. (2020). Cat portals: Order information and instruction for installation. Available from: https://www.uwsheltermedicine.com/library/resources/cat-portals-order-information-and-instruction-for-installation.

van der Leij, W.J.R., Selman, L.D.A.M., Vernooij, J.C.M., & Vinke, C.M. (2019). The effect of a hiding box on stress levels and body weight in Dutch shelter cats; a randomized controlled trial. *PloS One, 14*(10), e0223492.