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Single vs multiple cat adoptions: A trade-off between longer adoption times and social bonding in shelter cats

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Abstract

*Timely adoption is essential for shelters to prevent unnecessary illness or euthanasia in cats (*Felis catus*). Many studies have examined the role of individual cat characteristics and environmental factors in facilitating cat adoptions, but none have looked at the role the number of cats being adopted plays. In this study, we examined whether or not adopting cats in pairs influences adoption times, in addition to commonly studied factors. We then collected video data on a small subset of cats to determine whether pairs that were adopted together differed behaviourally from pairs who were not. Our results demonstrate that cats who are adopted as part of a multi-cat outcome spent three days (42%) longer on the adoption floor than those adopted individually, independently of other factors such as age and coat colour. This difference increased to 13 days (185%) longer if the cat had a notification indicating they must be adopted together with another cat. While behavioural data show that these pairs of cats engage in significantly more affiliative behaviour with each other than cats who were adopted singly, there was a large discrepancy between which pairs the shelter classified as multi-outcome and those who would be classified that way based on behaviour alone. We suggest that decisions to place cats together should be made carefully given the potential adverse impacts of keeping cats in the shelter longer. Further, we suggest that guidance should be developed to help shelters accurately and consistently identify which cats merit a multi-outcome adoption.*

Keywords: *adoption, animal shelter, animal welfare, cat,* Felis catus*, social behaviour*

Introduction

Around 3.2 million cats (*Felis catus*) are surrendered to shelters each year, with approximately half of them being adopted out to new homes (ASPCA undated). Over time, adoptions have increased, reducing the need for euthanasia (Weiss *et al* 2013). Given that shelters have finite space and resources for caring for animals, a desire to increase adoption rates has led to a large emphasis on decreasing the time surrendered animals spend at the shelter (Janke *et al* 2017; Wagner *et al* 2018). A shorter stay not only benefits the population as a whole, but also individual animals; cats who are in the shelter longer are more likely to display behavioural or health issues (Dinnage *et al* 2009; Gouveia *et al* 2011).

There have been a number of studies examining factors that impact time to adoption. Janke *et al* (2017) ranked different factors and found that a preference for a younger age was the most important factor (Zito *et al* 2015), followed by a preference for non-black/brown coat colours (Lepper *et al* 2002), and then by a preference for exotic breeds (Brown & Morgan 2015). Weiss *et al* (2012) found that in addition to the cat's appearance, the adopters' reasons for selection were impacted by their social interaction with the cat, as well as the personality traits of the cat. Incorporating toys and other enrichment, including socialisation, can reduce fear behaviours and increase activity, which also increases adoption success (Gourkow & Fraser 2006; Fantuzzi *et al* 2010). Some studies (eg Brown & Morgan 2015; Janke *et al* 2017) have been able to directly tie adopter preferences to a decrease in length of stay for certain cats, particularly based on physical characteristics like breed or coat colour. Other studies have relied on adopter surveys to infer that cats that align with adopter preferences would have a shorter length of stay (eg Gourkow & Fraser 2006; Weiss *et al* 2012).

The academic literature available is comprehensive in examining how the features and behaviour of the cat impact time to adoption, but there has been little research into how shelter management procedures, such as housing choices, impact adoption rates. In our previous research, we found that cats in single versus group housing had an overall similar live release rate and length of stay at the shelter, but group-housed cats spent more time available for adoption (Suchak & Lamica 2018). This occurred because singly housed cats were more often moved to housing off of the adoption floor out of public view. Thus, all things being equal, it appeared that singly housed cats are adopted faster, if given the same opportunity for public viewing. Although there are a number of reasons why singly housed cats may be easier to adopt than cats in group housing, one key issue may be that people

may prefer to adopt single, individual cats rather than multiple cats at one time. Although there are numerous cats in group housing that can be adopted individually, there are also a higher proportion of 'bonded pairs' who need to be adopted together. 'Bonded pairs' are cats that the shelter deems must be adopted as a multi-outcome. Adopters are informed of this constraint either through written descriptions of the cat (such as those seen on kennel cards or online profiles like Petfinder) or by volunteers and staff while engaging in the adoption process. Online, there are frequent references to the idea that bonded pairs take longer to adopt but, to date, there are no scientific studies evaluating this claim (Burzhardt undated; 'Bonded pairs' undated; 'Bonded Pairs: why you might want to adopt two instead of one' undated; Romanow 2020). These websites typically discuss pros and cons to keeping 'bonded pairs' of cats together, and their popularity suggests this to be an important topic for shelters and rescues. Indeed, a Google search reveals 1.64 million results when searching for 'bonded pair of cats.'

If it does take longer for cats that are 'bonded pairs' to be adopted together, it is imperative to accurately assess whether or not these cats are, in fact, socially bonded. The domestic cat evolved from a solitary ancestor, but matrilineal social groups can form in spaces where there is an abundance of resources (Crowell Davis *et al* 2004; Bradshaw 2016). Affiliative social relationships between cats can be characterised by behaviours such as allogrooming, allorubbing, nose touches, approaching with tail-up, playing together, and lying together. Littermates have more affiliative interactions with other littermates than with unrelated cats (Bradshaw & Hall 1999); however, unrelated cats developed more positive interactions and decreased aggression the longer that they stayed together (Barry & Crowell Davis 1999). This presents an interesting challenge for shelters, where information about the individual histories of the cats is often lacking and there is limited opportunity to observe the cats' behaviour together, yet important decisions still need to be made about whether cats are socially bonded and need to stay together.

The primary goal of the present study is to evaluate whether adoption as a single cat (hereafter: single outcome) or as part of a pair (hereafter: multi-outcome) impacted the amount of time adult cats spent available for adoption. We hypothesised that if adopting two cats is a deterrent to adoption, as popular knowledge would suggest, then cats who are part of a multi-outcome will spend a significantly longer time available for adoption than those adopted singly. Our secondary goal was to examine the behaviour of pairs of cats who are classified as bonded pairs in comparison to those who are not. We hypothesised that if these dyads are truly socially bonded, then we should see significantly more affiliative behaviour from these pairs than between dyads where the cats were adopted into different homes.

Materials and methods

Study animals and setting

Overall, 3,242 adult cats (over one year of age) housed at a large, managed-intake shelter in the Northeastern United States were included in this study. The analysis of multi-outcomes on adoption times included 3,105 cats (1,721 females, 1,384 males), representing all of the adult cats identified in the PetPoint database as being adopted in the years 2014–2016. Petpoint is an online database used by shelters to manage animals under their care. Animals are logged using a unique ID number and their reports include information about their location in the shelter, availability for adoption, health, behavioural issues, and any adoption/return history. The behavioural portion of the study examined 137 adult cats who were placed in a colony room from 2017–2018. All cats used in this study were housed in one of two housing conditions: single caging (0.38–0.85 m^2 of floor space) or colony housing (3.06–5.41 m^2 of floor space). Single cages typically had a bed or box, food dish, toys (ie, toy mouse or spring) and litter-box and many had a porthole with two compartments. Colony housing consisted of a large room with 2–9 cats that had benches, shelves, crates or boxes, beds, towels, toys, and multiple food and water dishes. Dry food and water were given *ad libitum*. Housing was cleaned once per day with additional spot cleaning as needed and cats were given wet food twice per day.

Database mining

To examine the impact of multi-outcome on adoption times, the PetPoint database was used to identify all adult cats who were available for adoption for the period starting 1 January 2014 and ending 31 December 2016. If a cat was present in the dataset multiple times (eg the cat was adopted and then returned), we only used their first entry into the shelter during the data-collection period. Once the cats were identified, the following information was collected: date of birth, breed, primary colour, sex, whether or not the cat was part of a multi-outcome, whether or not there was a notification specifying that the cat must be adopted with another cat, and the number of days the cat was located on the adoption floor. There were originally 63 breeds or mixes identified, many with one or few cats; these were collapsed into four breed groups: domestic shorthair, domestic longhair, mix and other. 'Other' consisted of purebred cats such as Balinese, Persian, Japanese Bobtail, etc. For the purposes of analysis, domestic shorthair was used as the reference category. Similarly, 20 primary colour categories were collapsed into eight: Orange, Tan, Black, Blue, Brown, Grey, Cream, and White. Orange cats were used as the reference category. Our dependent variable was time spent on the adoption floor. The adoption floor was defined as a location where the public could access the cat for adoption. As our previous research demonstrated that singly housed cats were more likely to be moved off the adoption floor,

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where they would not be able to be adopted, we felt this would provide a more accurate measure of the impact of multi-outcomes than their overall length of stay at the shelter (which is defined as the time between their admission date and adoption date). In previous studies (eg Janke *et al* 2017; Suchak & Lamica 2018), using the full length of stay has obscured features that delay time to adoption since certain cats are likely to spend more time unavailable and out of public view than others. We chose to specifically focus on time on the adoption floor, rather than length of stay, as our question of interest was regarding the public's choice to adopt the cat and if the cat is not available for adoption due to shelter management, illness, or for various other reasons, they cannot be chosen. If the cat was adopted as part of a multi-outcome, we noted the name and identification number of the other cat.

All data were analysed using R version 3.6.0 (R Core Team 2019). The impact of multi-outcomes on adoption time, relative to other factors was analysed using a Generalised Linear Mixed Model and the package *glmmTMB* (Brooks *et al* 2017). The dependent variable was days listed on the adoption floor. The main independent variable of interest was a binary categorical variable identifying whether or not the cat was adopted with other cats. Sex, breed, age and primary colour were also entered as fixed effects. To control for the fact that cats who were adopted together were not independent, that is, if two cats in our sample were adopted together, they by definition had the same adoption date and frequently the same number of days available, we entered the identification number of the partner cat as a random effect. The *dHARMA* package (Hartig 2019) was used to assess the distribution of the error terms. If there was significant heteroscedascity, a median cut-point was used to create a categorical dependent variable, cats above or below the median days to adoption. The fixed and random effects remained the same. This resolved the issue with heteroscedascity. The performance package (Lüdecke *et al* 2019) was used to check for multi-collinearity between the fixed effects. All of the VIFs were at or around 1 and no correlation between the fixed effects were detected.

Behavioural data

From 2017–2018, we had access to a Fortinet FCM-MD20 Internet Protocol (IP) camera in a colony room. During this time, 132 adult cats (75F, 57M) passed through the room as part of 24 different groups of cats. There were 413 dyadic combinations of cats in this portion of the study. Some cats placed in the room came into the shelter together, others were introduced while at the shelter. Cats were placed in the room at the purview of shelter staff and left the room as they were adopted or moved to a new location by shelter staff. Each day, 2 h of data were collected, one while the shelter was open to the public and another while the shelter was closed, with the exception of Sunday when both data collection periods occurred while the shelter was closed. The recording times were selected to cover as many hours of the day as possible but could not be completely random due to the shelter having variable opening hours depending on the day of the week. An infra-red sensor allowed for recording data at night. Altogether, we coded 481 h of data, with a mean observation time per dyad of 8.68 h. As this study was strictly observational, the Canisius College IACUC does not review or require approval for observational studies. The video camera and PetPoint database were used with permission from the shelter. Although humans occasionally came into view on the camera during observations, we did not collect any data on people and therefore this study was exempt from Institutional Review Board review.

An ethogram was developed to identify affiliative behaviour based on behaviours described in Crowell-Davis *et al* (2004) and Bradshaw (2016) (see Table 1). We used the BORIS software programme (Friard & Gamba, 2016) to code all occurrences of dyadic affiliative behaviour that occurred in the group. Inter-rater reliability was excellent (state behaviours: $r = 0.99$, event behaviours: $K = 1.0$). Since affiliative behaviours included both point and state behaviours, we used the Composite Sociality Index (CSI) developed by Silk *et al* (2013), to aggregate the data. In addition to being able to combine values across different types of behaviour, the CSI also accounts for the amount of behaviour between a dyad relative to the overall behaviour of the group.

The CSI of dyad *xy* is calculated as follows:

$$CSI_{xy} = \frac{\sum_{i=1}^{d}\left(\frac{f_{ixy}}{\bar{f}_i}\right)}{d}$$

In this equation, f_{ixy} is the rate or proportion of time that dyad *xy* engages in behaviour *i*, and divided by the mean proportion or rate of behaviour in the group. (This is summed across all of the behaviours contributing to the index, which are listed in Table 1, and *d* represents the number of behaviours contributing to the index.)

We again used a GLMM to test whether there was a significant difference in CSI values for cats who were multi-outcomes versus single outcomes. This analysis was dyadic, that is, the CSI represents the overall affiliation of each pair of cats. The dependent variable was the affiliative CSI, the fixed effect was whether the cat was part of a multi-outcome, and the random effect was the group number. This is to control for the fact that the overall group dynamic or size might influence dyadic behaviour. Since this analysis was dyadic, and all dyads were unique, there was no need to control for the identities of the cats adopted in pairs. The dHARMA package (Hartig 2019) was again used to assess the distribution of the errors, these were found to be normally distributed. As there was only one fixed effect, there was no need to test for multicollinearity between fixed effects.

Table 1 Social behaviour ethogram.

Name	Definition	Type
Approach with a tail up	Cat moves into proximity of another cat with the tail held erect	Point
Touch noses	Cat touches/sniffs their nose to the nose of another cat, often performed while standing and facing one another	Point
Social sniff	A cat approaches another's side or back and makes a sniffing motion. If they approach face-to-face and sniff the nose, mark as touch noses	Point
Sit/rest in proximity	Cat is within approximately 1 adult cat body length (measured from nose to base of tail) from another cat and is stationary. No barriers are present between the cats	State
Sit/rest in contact	Cat is physically touching another cat. No space can be seen between the two cats	State
Social play	Cats engage in mutual play behaviour: chasing, wrestling, or playing with the same item. Not agonistic	State
Allogroom	Cat uses its tongue to groom another cat	State
Allorub	Cat rubs or flanks on another cat	State
Cofeed	Cats are eating out of the same dish at the same time (not taking turns)	State

Table 2 Factors influencing time spent on the adoption floor.

	Estimate	Standard error	*Z*-value	*P*-value
Intercept	**–0.49**	**0.13**	**–3.90**	**< 0.0001**
Sex: M	–0.08	0.08	–1.12	0.26
Domestic longhair	**–0.23**	**0.11**	**–2.14**	**0.03**
Mixed breed	**–0.40**	**0.13**	**–2.96**	**0.003**
Other breed	**–1.10**	**0.33**	**–3.38**	**0.007**
Tan	–0.28	0.24	–1.19	0.24
Black	**0.48**	**0.12**	**3.96**	**< 0.0001**
Blue	0.07	0.18	0.38	0.71
Brown	**0.28**	**0.13**	**2.16**	**0.03**
Grey	0.01	0.15	0.07	0.94
Cream	–0.80	0.42	–1.92	0.06
White	0.12	0.16	0.78	0.43
Age	**0.05**	**0.01**	**4.03**	**< 0.001**
Multi-outcome	**0.51**	**0.12**	**5.26**	**< 0.001**

Significant factors at $P < 0.05$ level are indicated by bold.

As a final step, we compared the selection of dyads who were adopted in multi-outcome to those who would be predicted to be adopted together based on social behaviour alone. We used a Cohen's Kappa, calculated using the vcd package in R (Meyer *et al* 2020) to score agreement between the real-world outcome and the outcome predicted by the computer on two different measures: those predicted based on their CSI and those predicted based on their affiliative state behaviours (excluding point behaviours), as state behaviours like sleeping in contact and allogrooming might be more salient to shelter staff.

Results

Database study

Altogether, 330 cats were adopted as part of a multi-outcome from 2014–2016. This represents between 9.6 and 11.6% of adult cats adopted from the shelter each year. Cats adopted singly spent a median of seven days on the adoption floor, versus ten days for cats adopted as part of a multi-outcome. The initial model showed evidence of heteroscedasticity, so a median cut-point was used to create

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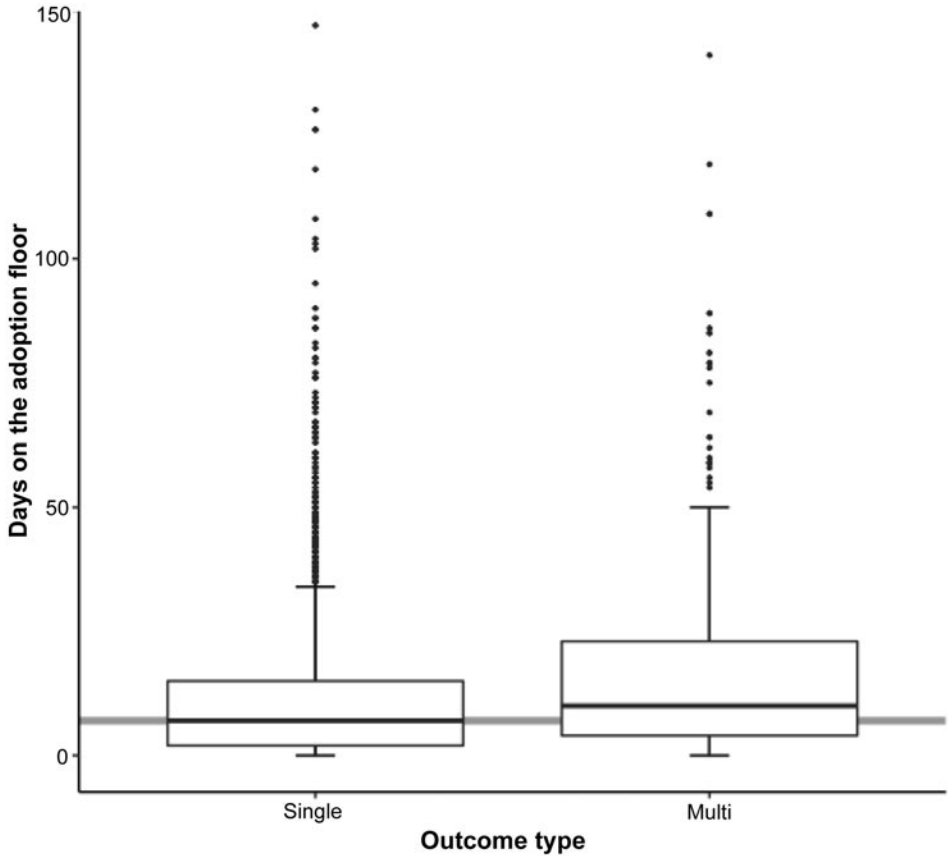
Figure 1



Days on the adoption floor by outcome type. The boxes represent the days individual cats spent on the adoption floor for cats adopted singly (single; n = 2,775 cats) and cats adopted in pairs (multi; n = 330). The grey line represents the median cut-point used in the analysis, the whiskers represent 1.5 times the interquartile interval.

a dichotomous dependent variable of cats scoring above or below the median time to adoption. There was no evidence of multicollinearity. The revised model revealed that the intercept, breed, colour, age and multi-outcome all contributed significantly to whether cats spent more time on the adoption floor (*AIC*: 4,192.30; Table 2).

Specifically, relative to domestic shorthairs, all other breeds spent less time on the adoption floor (domestic longhair: $\beta = -0.23$, SE = 0.11, $Z = -2.14$; $P = 0.03$; mixed breed: $\beta = -0.40$, SE = 0.13, $Z = -2.96$; $P = 0.003$; other: $\beta = -1.10$, SE = 0.33, $Z = -3.18$; $P = 0.007$); relative to orange cats, black and brown cats spent more time on the adoption floor (black: $\beta = 0.48$, SE = 0.12, $Z = 3.96$; $P < 0.0001$; brown: $\beta = 0.28$, SE = 0.13, $Z = 2.16$; $P = 0.03$); and older cats also spent more time on the adoption floor ($\beta = 0.05$, SE = 0.01, $Z = 4.03$; $P < 0.001$). However, the factor which had the highest predictive value for a length of stay above the median, even more so than being a black cat, was whether or not the cat was part of a multi-outcome ($\beta = 0.51$, SE = 0.12, $Z = 5.26$; $P < 0.001$, Figure 1).

Only 146 out of 330 multi-outcome cats had formal notifications entered into the PetPoint database notifying shelter staff that they had to be adopted together. The remaining cats were adopted together either based on an informal recommendation from the shelter staff or at the discretion of the adopter. The median time to adoption was the same for cats adopted singly and without a formal notification (seven days); however, those with a notification spent a median of 17 days on the adoption floor. Given that notifications may be playing a role in delaying adoptions, we re-ran the models above with notification instead of multi-outcome as an independent variable. The initial model again showed heteroscedasticity, so a median cut-point was used to create a dichotomous variable. There was no multicollinearity. The pattern was largely the same as above: breed, colour, and age all significantly predicted time spent on the adoption floor (*AIC*: 4,172.0; Table 3). The presence of a notification was by far the strongest predictor of increased time spent on the adoption floor ($\beta = 1.18$, SE = 0.20, $Z = 5.97$; $P < 0.0001$; Figure 2); cats who had notifications were significantly more likely to be above the median time on the adoption floor.

Behavioural study

From 2017–2018, 33 out of 132 cats (25.0%) were adopted as part of a multi-outcome. Thirty out of the 33 cats had a notification in the PetPoint database indicating that they must be adopted together. There are an odd number of cats

Table 3 Factors influencing time spent on the adoption floor, including notifications for multi-outcomes.

	Estimate	Standard error	*Z*-value	*P*-value
Intercept	**–0.45**	**0.13**	**–3.55**	**0.0003**
Sex: M	–0.09	0.08	–1.14	0.25
Domestic longhair	**–0.45**	**0.11**	**–2.32**	**0.02**
Mixed breed	**–0.39**	**0.14**	**–2.87**	**0.004**
Other breed	**–1.09**	**0.33**	**3.32**	**0.009**
Tan	0.29	0.24	–1.21	0.22
Black	**0.47**	**0.12**	**3.83**	**0.0001**
Blue	0.04	0.18	0.25	0.80
Brown	**0.26**	**0.13**	**2.02**	**0.04**
Grey	0.0006	0.15	0.004	1.00
Cream	**–0.85**	**0.42**	**–2.02**	**0.04**
White	0.11	0.15	0.72	0.47
Age	**0.04**	**0.01**	**3.39**	**0.0007**
Multi-outcome: no note	0.11	0.15	0.73	0.47
Multi-outcome: with note	**1.18**	**0.20**	**5.97**	**< 0.0001**

Significant factors at $P < 0.05$ level are indicated by bold.

because three of the cats (the ones without notifications) were actually adopted with cats that were not in the colony room at the time of the study. On occasion, cats were moved between colony rooms and these three cats appear to have been adopted with cats they were housed with at other times during their stay. Thus, all of the dyads where we had observations of both individuals had notifications indicating that they must be adopted together.

In this smaller dataset, cats adopted singly spent a median of nine days available for adoption, whereas cats in multi-outcomes were available for a median of 20 days. Similar to the database analysis above, we ran a model to see which factors influenced time spent on the adoption floor. All assumptions were met with the initial model. The results revealed that the intercept and multi-outcome were significant contributors to increased time spent on the adoption floor (*AIC*: 992.6, multi-outcome $\beta = 0.55$, SE = 0.18, $Z = 3.02$; $P = 0.003$; Table 4).

We then tested whether dyads who were adopted together engaged in more affiliative behaviour than those who were not. The initial model had significant heteroscedascity, so a median cut-point was used. The results revealed that dyads who were part of a multi-outcome were more likely to score above the median in their affiliative behaviour (Multi-outcome: *AIC*: 530.6, $\beta = 1.65$, SE = 0.70, $Z = 2.34$; $P = 0.02$; intercept: $\beta = –0.02$, SE = 0.26, $Z = –0.86$; $P = 0.39$; Figure 3).

Although, generally, the cats who were adopted together were more affiliative, it is clear from Figure 3 that there is a lot of variability among the singly adopted cats, with a large number of outliers exceeding the affiliative CSI of the multi-outcome cats. Therefore, we compared the real-life selection of cats for a multi-outcome with how a computer would select dyads if selecting simply based on affiliative behaviour. Using the CSI values, the agreement between the computer and shelter selections was extremely low ($K = 0.03$), which is generally interpreted as 'none to slight' agreement (McHugh 2012). When restricted to just the rate of state behaviours, agreement was slightly better ($K = 0.24$), which is on the lower end of 'fair' agreement. In general, there was limited agreement between the selection based on observed affiliative behaviour vs those actually selected to be adopted together by the shelter.

Discussion

In this study we found that cats who were adopted as part of a multi-outcome spent more time on the adoption floor than cats who were adopted singly, supporting our hypothesis. While a relatively small proportion of cats were adopted together, these data confirm numerous anecdotal concerns that 'socially bonded' cats take longer to adopt (Buzhardt undated; 'Bonded pairs' undated; 'Bonded Pairs: why you

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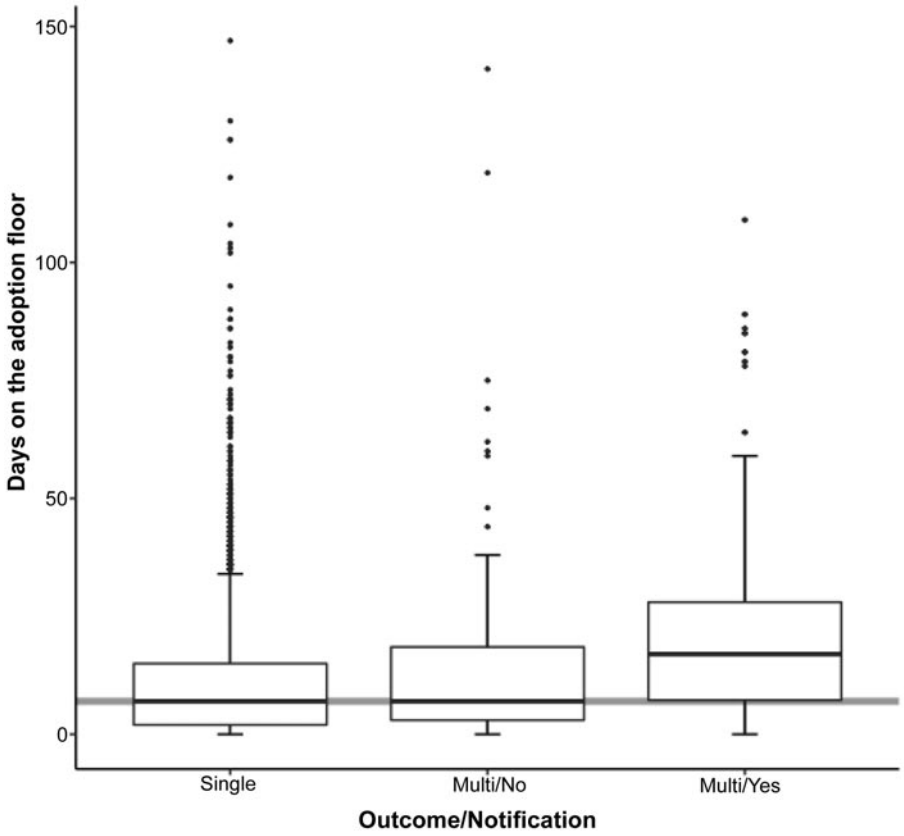
Figure 2



Days spent on the adoption floor by outcome and notification. The boxes represent days spent on the adoption floor for cats adopted singly (single; n = 2,775), cats adopted in pairs without a formal notification (multi/no; n = 184), and cats adopted in pairs with a notification entered into the database (multi/yes; n = 146). The grey line represents the median cut-point used in the analysis, the whiskers represent 1.5× the interquartile interval.

might want to adopt two instead of one' undated; Romanow 2020) and represent the first scientific analysis of such data. It is unclear how widespread this practice is, and whether these patterns are consistent across shelters. But given how commonly this concern is articulated in popular literature, this seems to be a well-known, if anecdotal, phenomenon. It is noteworthy that multi-outcome represented a larger proportion of the variance than any other factor, including factors commonly reported to increase adoption time such as coat colour (Lepper *et al* 2002). In general, most of the literature has focused on features of the cat, which cannot be changed (Janke *et al* 2017), rather than management practices, which can be altered to decrease adoption time.

This effect seems particularly strong when multi-cat adoptions were linked to a notification requiring the cats to be adopted together, which nearly tripled the time spent on the adoption floor. It was intriguing that in the database study, only 44% of cats adopted together had a formal notification. It is possible some adopters come into the shelter looking to adopt pairs and may not be concerned with whether there is a notification requiring cats be adopted together. It is also possible that there was word-of-mouth encouragement to adopt the cats without notifications in pairs from volunteers or shelter staff, or some sort of informal signal, like a hand-written note on a kennel card. Since our study relied upon information entered into the database, we are unable to rule this possibility out. However, it is noteworthy that even if there were informal notifications or suggestions to adopt in pairs, it did not have any noticeable impact on length of stay, unlike the notifications formally entered into the database. Given this distinction, if volunteers or staff are encouraging multiple adoptions by word of mouth or by some informal mechanism, they may want to encourage adopters interested in two cats to focus on pairs formally labelled as bonded since encouraging adopters to adopt pairs of cats who need not go together may inadvertently increase time at the shelter for pairs that must go together.

The behavioural portion of the study allowed us to assess whether cats adopted together engage in more affiliative behaviour than those who are adopted singly. Interestingly, in this sample, 30/33 cats had a notification, a much higher percentage than in the general shelter population. This is likely due to the fact that our camera was located in a colony housing room and cats who are socially bonded are more likely to go into a larger group setting as they may be

Table 4 Factors influencing time spent on the adoption floor in the behavioural study.

	Estimate	Standard error	*Z*-value	*P*-value
Intercept	**2.35**	**0.22**	**11.89**	**< 0.0001**
Sex: M	–0.16	0.16	–1.00	0.30
Domestic longhair	0.22	0.22	0.96	0.34
Mixed breed	–0.54	0.62	–0.87	0.38
Black	0.24	0.21	1.15	0.25
Blue	–0.60	0.39	–1.53	0.13
Brown	–0.39	0.22	–1.79	0.07
Grey	0.12	0.26	0.46	0.65
White	0.47	0.38	0.12	0.90
Age	0.00002	0.03	0.001	1.00
Multi-outcome	**0.55**	**0.18**	**3.02**	**0.003**

Significant factors at $P < 0.05$ level are indicated by bold.

perceived as comfortable being housed with other cats. Overall, the dyads that were adopted together did display significantly more affiliative behaviour than those who did not, as measured by the Composite Sociality Index (Silk *et al* 2013). It is possible that this could result from the increased length of stay of multi-outcome cats, which gave them more time to habituate to the shelter and display more affiliative behaviour. However, Bradshaw and Hall (1999) found significant differences between pairs of cats within the first five days of being relocated to a cattery. Furthermore, in our study, both single- and multi-outcome pairs displayed a great deal of variability, with some single-outcome cats having extremely high indices, and three pairs of multi-outcome cats engaged in no affiliative behaviour at all. This discrepancy led us to investigate the agreement between which dyads were selected for multi-outcomes by the shelter staff vs which would be selected solely on the basis of their affiliation rates. These two metrics did not agree well at all. Indeed, of the 15 dyads with the highest CSI, only one pair was selected by shelter staff to be a multi-outcome. Agreement was slightly better when behaviour was just limited to state behaviours, but only four of the top 15 pairs with the highest rate of affiliative behaviour were selected by shelter staff to be adopted together. It is possible that in the course of their daily interactions, shelter staff saw some sort of signal that suggested other pairs merited a multi-outcome that were not detectable in our observations. However, for the 15 dyads that were actually adopted together, we had an average of 24.75 h of video observation time per dyad, using a comprehensive ethogram of social behaviour. Given the constraints of staffing and the fact that shelter staff have numerous obligations beyond monitoring the animals, it seems unlikely that there was a systematic pattern of behaviour that we missed that could explain this difference.

While we recognise that shelters will likely not have the capacity to carry out detailed behavioural observations, we recommend that shelters develop clear procedure based on behavioural criteria, such as observing the cats sleeping in contact, grooming, or playing together, before labelling cats as needing a multi-outcome. This need not be time consuming and could entail shelter volunteers or staff simply checking a box every time they notice a pair of cats engaging in these behaviours. We noted that all of the cats labelled as needing a multi-outcome came into the shelter together, whereas the ranking based on the CSI actually included four dyads who were introduced at the shelter. This raises an important question about whether affiliative cats without a long-term relationship are truly bonded and need to be adopted together, as the literature would suggest that true social bonding between cats takes time (Barry & Crowell-Davis 1999). Based on our data, we would recommend labelling cats as needing a multi-outcome based on behaviour. This could be observed while at the shelter, or shelters could ask owners surrendering multiple cats questions regarding affiliative behaviour on the intake survey. Better characterising which behaviours illustrate 'social bonding' in cats is an ongoing area of research that could significantly impact the ability of shelters to manage their populations.

Of more concern, however, are the pairs of cats marked as needing to go together who showed little or no affiliative behaviour and thus no clear behavioural evidence of a social bond. We suspect that there may be a tendency to over-emphasise the affiliation between cats who were surrendered together, particularly if there is an indication on the

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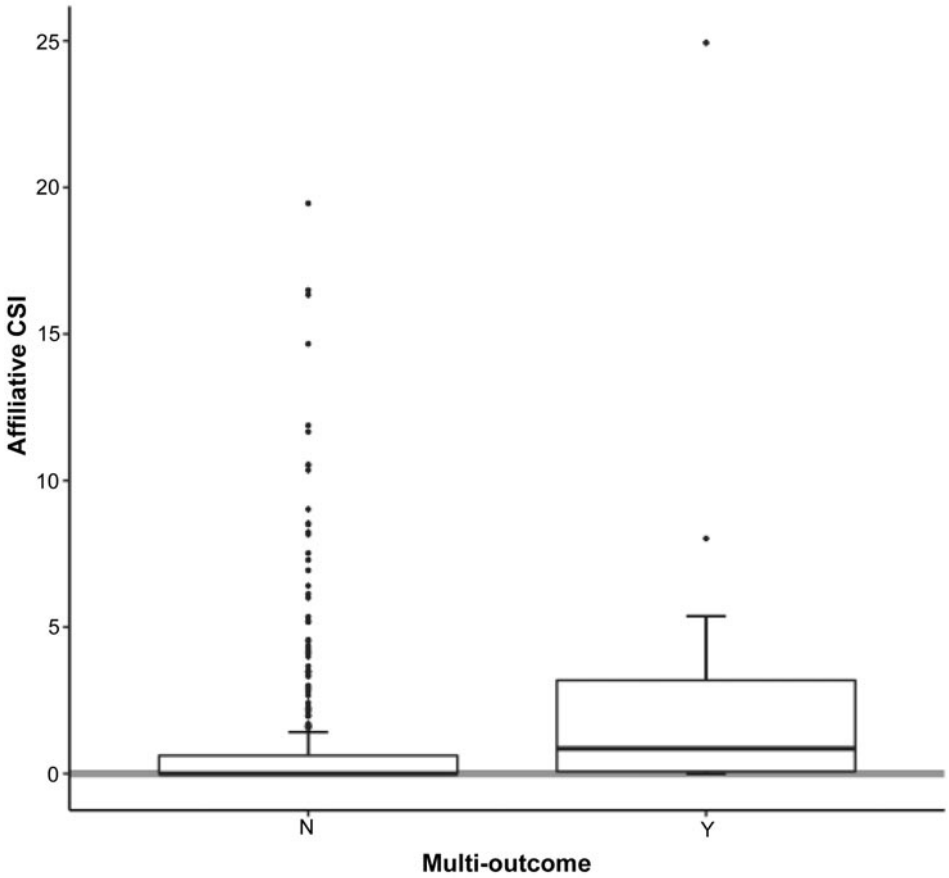
Figure 3



Composite Sociality Index for dyads of cats not adopted together (single; n = 397 dyadic combinations) vs those adopted in pairs (multi-outcome; n = 15). The grey line represents the median cut-point used in the analysis, the whiskers represent 1.5× the interquartile interval.

intake form that they have been together in the household for a long time. While it is likely that such cats will get along if placed in the same household, our previous research has shown that simply being surrendered together is not a good predictor of social behaviour (Suchak *et al* 2016). Given that cats who are labelled as needing to be adopted together are spending significantly longer time on the adoption floor, and the possibility of adverse impacts like developing upper respiratory symptoms the longer at the shelter (Dinnage *et al* 2009), any inference solely based on cats being from the same household should be approached with caution. For example, Dinnage *et al* (2009) found that adult cats had a 26% chance of developing upper respiratory infection systems at seven days, and an 80% chance by day 14. Given that our multi-outcome cats with notifications were on the adoption floor for 17–20 days, that would suggest they are in the range for increased risk of developing upper respiratory symptoms.

Although 132 individuals is an extremely large sample size for a behavioural study, the fact that the percent of individuals who are adopted in multi-outcomes is so small overall makes it difficult to observe large numbers of cats in 'bonded pairs.' However, it is important to realise that even 30 cats, comprising 15 different dyads, observed for an average of nearly 25 h each across different hours of the day and shelter conditions, represents a substantial and systematic dataset. Future studies should investigate whether these patterns hold across other samples of cats, particularly among shelters of varying size and with different management procedures.

In addition to confirming whether the behaviour patterns observed in this study are reflective of the shelter population, examining length of stay in single- and multi-outcome individuals at a variety of shelters would elucidate whether the extended length of stay we found is an absolute, or relative increase. At our shelter, being labelled as a multi-outcome increased the time to adoption by ten days, which was approximately 125–150%. The median length of stay at our shelter is relatively low compared to reports from other shelters (eg Janke *et al* 2017 reported a median of 33 days and Brown *et al* 2015 reported an average of 61.2 days). A relative increase, that is, one where other shelters might see a similar percentage increase, would have significant implications for both cat welfare and capacity for care at shelters that typically average higher lengths of stay.

The question of how humans are assigning cats to multi-outcomes would also be interesting to explore. A human-focused study was beyond the purview of the current study, which was focused on the impact on the cats, but it represents

an important aspect of this question that has yet to be explored. For example, in our database sample, numerous cats were adopted together without a clear indication as to why. Furthermore, those multi-outcome events appeared not to have impacted their overall time to adoption, but formal notifications entered by shelter staff did. Future studies could examine the dynamic around the adoption event, perhaps surveying adopters who voluntarily choose to take two cats, even when not specified by shelter staff. It would also be useful to survey staff at a variety of shelters to find out what, if any, standard operating procedures are used to designate cats as needing to be adopted together. For example, in the *Guidelines for Standards of Care in Animal Shelters*, there is information about selecting individuals to go into group housing together, but no information on selecting individuals for multi-outcome adoptions (Newbury *et al* 2010).

Animal welfare implications

Anything that results in an increased time to adoption should be carefully considered and employed only when necessary. While numerous studies have focused on how the features of cats (such as age, breed, and coat colour; Janke *et al* 2017) influence adoption times, few have looked at how shelter procedures and the social needs of the cat impact adopters' choices. In the case of a truly bonded pair of cats, it may be distressing to be separated. However, as our data show, this designation comes at a cost, added time at the shelter, which can contribute to capacity issues and health issues for the cat. Being able to accurately identify which cats need to be adopted in pairs seems paramount for both the welfare of the cat as well as managing the flow of cats through the shelter.

Declaration of interest

None.

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