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Ability of owners to identify resource guarding behaviour in the domestic dog

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ABSTRACT

Canine resource guarding (RG) describes the behaviour used by a dog to achieve or maintain control over an item of perceived value. Three distinct behavioural patterns of RG have been proposed; rapid ingestion (i.e., rapid consumption of an edible item), avoidance (i.e., positioning of the head or body to maintain item control, or location change with the item) and aggression. Research and clinical treatment has been mainly focused on aggressive forms due to the potential for harm to people and other animals. However, rapid ingestion and avoidance patterns are equally important since they may be precursors to aggression, with owner response being an important influencing factor. If this hypothesis is correct, accurate owner recognition of all patterns of RG behaviour is an important first step in preventing future aggression around items. The aim of this study was to determine if owners were able to accurately identify types of RG behaviour patterns, and if additional dog experience influences this ability. Owners (n = 1438) were recruited to watch videos, each involving different examples of RG behaviour patterns, and asked to identify each of the categories they observed. Four canine behaviour experts independently validated the videos, prior to the study, for the type of behaviour pattern(s) displayed. Data were analysed using multi-level logistic regression in Stata 13. Owners were more likely to correctly identify the presence or absence of biting aggression compared to all other RG behaviour patterns ($p < 0.001$). Owners were significantly more likely to correctly identify the absence of a behaviour pattern (i.e., rule out the pattern's existence) compared to the presence of a behaviour pattern ($p < 0.001$). Owners that reported having an advanced knowledge of dog behaviour ($p < 0.01$) or had participated in professional dog training classes ($p < 0.01$) were significantly better at correctly identifying RG behaviour patterns. The results suggest owners are good at identifying obvious RG aggression but could improve their ability to recognize other patterns of RG. Future research is needed to examine whether identification can be improved through alternative methods of training. Future efforts could aim to educate owners on appropriate methods to prevent escalation of RG behaviour when it is observed.

1. Introduction

Canine aggression is a serious problem; dog bite injuries to humans are common and often occur around an item of potential value to the dog, such as food or a toy (Guy et al., 2001; Overall, 2013). Recognizing early warning signs and situations that trigger aggressive behaviour that may lead to a bite is an important skill to minimize the risk of aggression around resources (De Keuster and Jung, 2009). Further, expert opinion suggests that other patterns of behaviour exist for the same functional purpose, such as avoidance (e.g., blocking access to an item through head or body movements, or grabbing an item and running away with it), and rapid ingestion of an edible item (Jacobs, 2016). Identification of and proper response to these non-aggressive patterns of behaviour may decrease the potential for future aggressive responses, as hypothesized by Landsberg et al. (2013).

Canine body language is the most important tool for interpreting a dog's reaction in any given situation (Beaver, 1999). Dogs use visual signals, such as changes in body posture and facial expression, to instantaneously communicate their responses to changes in their social environment (Simpson, 1997). It has been suggested that a person's inability to correctly read warning signals emitted by a dog is a critical factor in the occurrence of severe aggression towards that person (Mertens, 2002). Therefore, in certain circumstances, aggression around resources might be preventable

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provided proper recognition and reaction to precursory behaviour are exercised. There are relatively few scientific papers describing the abilities of general lay people to correctly identify dog behaviour. Bahlig-Pieren and Turner (1999) reported that people interpreted facial expressions of fear and curiosity in dogs with over 80% agreement. Tami and Gallagher (2009) report that their participants were successful at identifying and agreeing on fear, friendliness and play solicitation, but had difficulty identifying and agreeing on the classification of aggression, confidence and play sequences. These results are concerning given that aggression is the most dangerous behavioural issue facing owners.

The aim of this study was to determine if owners were able to correctly identify four different categories of resource guarding behaviour from a sample of video recordings of dogs' responses to standardised tests for aggression. To fully test the accuracy to which owners can identify among these behavioural categories, we tested the correct identification of both the presence (i.e., the existence of a particular behaviour category within the video) and absence (i.e., the lack of existence of a particular behaviour category within the video) of each behaviour category. For the purpose of this study, two of the four categories of resource guarding behaviour investigated involved different displays of aggression: 1) threats involving growling, freezing, body tension and teeth-baring, and 2) aggression involving biting and snapping. The two additional resource guarding categories investigated were avoidance and rapid ingestion. We hypothesized that owners would be less likely to correctly identify the more subtle forms of resource guarding, such as avoidance, rapid ingestion and threatening behaviour compared to biting and snapping aggression.

2. Materials and methods

All procedures were submitted and approved by the University of Guelph Research Ethics Board (#13JL006) and Animal Care Committee (Animal Utilization Protocol #2566) prior to the start of this study.

2.1. Collection of videos

During initial questionnaire development, forty-four videos of dogs being tested for behaviour around food and rawhides were made using protocols from the Safety Assessment For Evaluating Re-homing (SAFER). All testing was conducted by the same assessor who was trained and certified by the American Society for the Prevention of Cruelty to Animals (ASPCA) for SAFER testing, and who had five years experience conducting SAFER testing. Videos were collected at two locations: a shelter and a teaching veterinary hospital. Rooms within both facilities were empty aside from the individuals participating in the test and the testing equipment. The shelter room was approximately 3 m × 3 m, whereas the room within the teaching hospital was approximately 9 m × 12 m. Camera locations and angles were standardised within each facility, selected to obtain the best view of the dog's entire body.

The following standardised protocols for behaviour testing were used during video collection for this study:

1) Food test- The food type and brand was standardized between dogs. Only the bowl size and amount of food differed and was dependent on the size of the dog such that smaller dogs received less food than larger dogs. To begin the test, the dog was offered a mix of canned and dry food and allowed to start eating. After three bites, the evaluator then asked for the food saying "can I have this?; while pulling the bowl away from the dog using a fake hand, then allowing the dog to eat again. The evaluator then pushed the dog's head away from the bowl twice each time saying 'my bowl', then stroked the dog's head and neck using the fake hand before removing the bowl.
2) Rawhide test- The rawhide brand was standardized between dogs. The size of the rawhide differed slightly depending on the size of the dog (three sizes were available, with the smallest rawhide size offered to dogs less than 25 pounds, and the largest reserved for dogs more than 65 pounds). To begin the test, the evaluator showed the dog the unbasted rawhide, offered it to the dog and allowed the dog to engage with the rawhide. The evaluator then reached with the fake hand to take the rawhide. If the dog did not surrender the rawhide, the evaluator reached for it a second time. If the dog readily gave the rawhide back to the evaluator, she returned it to the dog one final time before removal.

Following collection of the videos, video clips were edited to begin when the evaluator began walking toward the dog with either the food bowl or rawhide in hand, and edited to conclude after removal of the bowl or rawhide. Video clips were edited to remove sound to ensure that comments from the evaluator could not be heard by the participants, with the exception of instances of vocalization such as growling, which remained in the video clip.

2.2. Validation of behaviour categories by experts

Following video collection, four veterinarians with expertise in companion animal behaviour (identified as Diplomates from the American College of Veterinary Behaviourists (DACVB)) were recruited to watch the videos. Videos were hosted on the online survey website Fluidsurveys™. Video presentation order was randomized among participants. Experts independently watched each video and grouped the video into one of five behavioural categories. In the presence of multiple categories, experts had the option of indicating more than one category was present. An ethogram describing each behavioural category was provided to the experts (Table 1). Additionally, a long-text box was provided following the presentation of each video for experts to make additional, open comments about the behaviour of the dog in any particular video. Videos that received 100% consensus between experts in all categories were used in the final dog owner questionnaire (n = 16 videos). All categories of resource guarding were represented by a minimum of three videos, with several videos including more than one category (Table 2).

2.3. Questionnaire development and participant recruitment

Participant inclusion criteria included individuals over the age of 18 with the daily responsibilities of ownership, such as feeding and exercising the dog. Initial advertisements for the study were posted to Facebook, Kijiji, Craigslist, and Ontario Veterinary College listservs. Snowballing techniques were used to advertise the survey to owners through the use of social media. This method relies on referrals of participants and is utilized to reach groups of people that might not be easily accessible through more traditional means (Atkinson and Flint, 2001; Biernacki and Waldorf, 1981). Therefore, recruited individuals were encouraged to share the survey with acquaintances.

Owners were given a brief tutorial prior to the start of the survey, which included video examples of each behaviour and written descriptions of each behavioural category (Table 1). None of the example videos for the tutorial were included in the 16 experimental videos. Participants were able to return to the tutorial page at any point during the survey.

Fifteen versions of the survey were created in order to achieve a semi-random order of distribution of the videos to each participant, such that not all participants watched all videos to decrease

Table 1
Ethogram given to experts and dog owners providing a description of each resource guarding behaviour category.

Behaviour Category	Description
Avoidance	The dog holds on to the item in their mouth and actively avoids the item's removal by moving his head or body away from the person who is trying to take the item, OR the dog grabs the item and runs away with it.
Rapid Ingestion	Compared to the dog's normal (initial) speed of eating, the dog's speed of eating is increased with larger bites; often there are no gaps or pauses between bites. The dog's head is lowered and sometimes appears pressed into the food bowl.
Threats	The dog appears stiff and tense overall. The dog may show a hard stare, growl (low, guttural noise), bare teeth (lifts lips to reveal incisors and canine teeth), or freeze (sudden cease of all movement with a stiff and rigid body).
Aggression	The dog snaps or bites (rapid opening and closing of jaws in the air or on skin) at a person, animal, or other object (e.g., a fake hand).
No Resource Guarding	The dog's body is relaxed and appears loose and potentially wiggly. Tail may wag at times and remains in a neutral position. The dog does not show any rapid ingestion, avoidance, threatening or aggressive behaviours.

the amount of time required to complete the survey. Each version of the survey included seven videos from the following three groups: 1) five randomly selected videos, each displaying at least one of the five different expert-confirmed categories of resource guarding (n = 5), 2) an additional video, randomly selected from one of the categories, was included to assess test-retest reliability (n = 1), and 3) one video displaying a three-category combination was included to assess the effect of multiple occurrences within the same video (n = 1). Upon initial survey access, a random number generator assigned each participant to one of the fifteen versions of the survey. Within each survey version, video order was randomized for each participant. A single video was displayed on each page of the survey, and participants were asked to identify which of the five behaviour categories of interest were being displayed by the dog in the video. The same five behavioural categories provided to the experts were also provided to the dog-owner participants. Participants were informed that more than one behavioural category may exist within a video and were requested to select all applicable categories for each video observed.

Owners were coded correct for the behaviour category when they properly identified the presence of a behaviour or the absence of a behaviour in the given video. For example, if the video contained three categories: aggression, rapid ingestion, and threatening behaviour, a participant would be considered correct for each of the three respective behaviour categories occurring in the video by indicating their presence in the video. Participants were also considered correct for each of the two remaining categories (i.e., avoidance and no resource guarding), by not indicating their presence in the video.

Table 2
Description of videos included in owner questionnaire.

Video ID.	Categories Identified by Experts	Breed of dog in video[a]
1	Aggression, Rapid Ingestion, Threat	Border Collie
2	Aggression, Threat	Chihuahua
3	Aggression, Threat	Wheaton Terrier
4	Aggression, Threat	German Shepherd
5	Threat	Golden Retriever
6	Rapid Ingestion, Threat	German Shepherd mix
7	Threat	Black Labrador mix
8	Threat	Border Collie
9	Avoidance, Threat	Jack Russell Terrier
10	Avoidance	Yellow Labrador mix
11	Avoidance	Chihuahua mix
12	Rapid Ingestion	Pug
13	Rapid Ingestion	Puggle (Pug x Beagle)
14	No Resource Guarding	Corgi Mix
15	No Resource Guarding	German Shepherd
16	No Resource Guarding	Jack Russell Terrier

"Mix" after primary breed indicates the dog is not a purebred but the researchers cannot clearly identify other breeds. Multiple representations of the same breed is a coincidence, each video represents a unique dog.

[a] As best identified by researchers.

2.4. Analysis

Average intra-observer percent agreement was calculated for each behaviour category to assess test-retest reliability. Cohen's kappa is influenced by prevalence and becomes invalid when the prevalence of the outcome measure is low (Feinstein and Cicchetti, 1990); the prevalence of "incorrect" agreement responses for each behaviour category for the current data was less than 20%, therefore the kappa statistic was deemed to be inappropriate for calculating test-retest reliability for the current data set.

Data collection was non-hierarchical, involving semi-random selection of videos for each participant. To account for this data collection method, we used a multi-level logistic regression (Stata 13) (StatCorp, College Station, TX) to determine the association between various independent variables and the participant's ability to correctly identify the presence and absence of the five behavioural categories in each video. The following independent variables were examined: behavioural category type (aggression, rapid ingestion, avoidance, threats, and no resource guarding), category presence or absence (i.e., for each video, each behavioural category was either present or absent according to experts), number of categories within a video (i.e., for each video, either multiple behavioural categories were present or a single behavioural category was present), self-reported advanced knowledge of dog behaviour, past dog-related employment experience, attendance at professional dog training classes, and experience consulting with a companion animal behaviour expert.

The multi-level logistic regression included random intercepts for participant and video with a cross-classified correlation structure. A manual forward selection procedure was used to identify a main effects model with a requirement of a p-value less than 0.05 for a variable to remain in the model. Potential confounders (i.e., an extraneous variable that has an association with the independent variable(s) and the dependent variable) were assessed by measuring the change in the coefficients (in log odds scale) with removal of each potential confounder. A twenty percent change or more in the coefficients was used to identify a confounding variable (Dohoo et al., 2003). When the selected main effects were finalized, all biologically plausible 2-way interactions were tested for significance, which included: 1) potential interactions between the presence or absence of each behaviour category, 2) attendance at a professional dog training class and the ability to correctly identify each behaviour category, and 3) self-identified advanced knowledge and the ability to correctly identify each behaviour category. Where significant interactions were noted amongst the categorical variables, contrast statements were used to describe the relation-

Table 3
Average proportions for the correctly identified presence and absence of each behavioural category.

Behaviour Category	Presence Proportion Correct	Absence Proportion Correct
Aggression	0.85	0.96
Avoidance	0.80	0.91
Rapid Ingestion (RI)	0.64	0.92
Threats	0.74	0.82
No Resource Guarding[a]	0.87	–

[a] Removed from subsequent analyses as "No resource guarding" absent is the same as indicating an alternate category's presence.

Table 4
Average intra-observer percent agreement for participant reliability of correct identification within each behavioural category.

Behaviour Category	Percent Agreement
Aggression	65.6%
Avoidance	84.7%
Rapid Ingestion	84.6%
Threats	43.5%
No Resource Guarding	70.5%

ships between groups with different combinations of the model's significant interaction. To assess the fit of the model, we assessed the normality and homogeneity of variance of best linear unbiased predictors (BLUPS) using a normal quantile plot and by plotting the predicted outcome against the BLUPS, respectively. Pearson residuals were also assessed visually to identify any potential outliers.

2.5. Interpretation of odds ratios

Logistic regression uses a logit transform of the probability of the outcome (in this case, the probability of correctly identifying the presence or absence of a behaviour category). The coefficient value is the log of the odds of the outcome, which can be converted into an odds ratio (by exponentiating the coefficient) for easier interpretation. An odds ratio greater than 1 indicates a positive association between the independent variable and the outcome. An odds ratio equal to 1 indicates no effect, while an odds ratio of less than 1 indicates a negative association or sparing effect between the independent variable and the outcome. For a dichotomous independent variable, the odds ratio represents the odds of the outcomes increase (or decrease) when the independent variable is present. Independent variables with multiple categories are converted into a series of indicator variables minus one category. Each indicator variable represents the effect of that level compared to the category not included in the model (i.e. the "baseline" category, or "referent" category) (Dohoo et al., 2003).

3. Results

3.1. Demographics

A total of 1438 individuals completed the survey. The majority of participants indicated residence in Canada or the United States (U.S.) (n = 1025), with 667 residing in Canada and 358 in the U.S. Ten individuals resided outside North America, with five residing in the United Kingdom, two in Australia, two in Italy, and one in Poland. The remaining participants (n = 403) did not supply their country of residence. Three hundred and seven individuals reported having advanced knowledge of dog behaviour and 143 reported having past or present employment experience related to dog care (dog trainer (n = 73), animal technician (n = 50), veterinarian (n = 15), dog groomer (n = 5)). Eight hundred and eight participants reported having had attended professional dog training classes, and 574 participants reported having had consulted with a companion animal behaviour expert. No information regarding participant gender or specific age was collected to minimize the length of the survey for participants.

3.2. Descriptive statistics

Descriptive statistics were used to obtain the proportion for the correct identification of the presence and absence of each overall behavioural category (Table 3). Based on average proportions, participants were able to identify the absence of a behavioural category to a relatively high degree in comparison to the presence of a behavioural category. With the exception of the presence of threatening and rapid ingestion, all categories had proportions correct equal to or higher than 80%.

Average agreement was calculated to assess test-retest reliability for the correct identification of each overall behavioural category (Table 4). Based on percentage agreement, participants were most reliable at correctly identifying rapid ingestion and avoidance behaviour, and least able to reliably identify threatening behaviour.

3.3. Final model

The final model included behaviour category type, the presence or absence of the behaviour category, attendance at a training class and self-reported advanced knowledge. Odds ratios, 95% confidence intervals and corresponding p-values for the main effects and interactions are presented in Table 5. No confounding variables were identified. There was one significant interaction found between behaviour category type and category presence or absence. For most behaviour categories (aggression, avoidance, and rapid ingestion), participants were significantly more likely to recognize the absence of the behaviour category rather than the presence of the behaviour category. However, the difference between participants correctly identifying the presence or absence of threatening behaviour was not significant. Further examining the relationships within the significant interaction, participants were more likely to correctly identify the presence of aggression than any other behaviour category in all comparisons (Table 6). Participants were also more likely to identify the presence of threat behaviour than rapid ingestion and avoidance, and the presence of avoidance behaviour than rapid ingestion. Similarly, participants were more likely to identify the absence of aggression than all other behaviour categories in all comparisons (Table 6). Participants were more likely to correctly identify the absence of rapid ingestion compared to threats and avoidance. There was no statistical difference in dog owner identification of the absence of avoidance versus threats.

4. Discussion

Overall, owners were more likely to correctly identify the presence or absence of aggression compared to all other behavioural categories. Although not statistically comparable, owners were able to correctly identify the lack of resource guarding (i.e., a dog behaving "desirably" around resources) to a similar degree. This suggests that owners can distinguish between a dog displaying resource guarding aggression and a dog that is not exhibiting any form of resource guarding relatively well. Owners were less likely to correctly identify the more subtle forms of resource guarding presented in this study (i.e., avoidance, rapid ingestion and threatening behaviours) relative to aggression.

Table 5
Final multi-level logistic regression model of factors influencing owner ability to correctly identify resource guarding behaviour categories.

Variable	Categories	OR	95% CI		P-value
Behaviour[a]	Aggression	Referent	–	–	–
	Rapid Ingestion	0.67	0.57	0.79	<0.001
	Avoidance	0.24	0.18	0.25	<0.001
	Threats	0.19	0.16	0.22	<0.001
Absence/Presence[a]	Behaviour Absent	Referent	–	–	–
	Behaviour Present	0.61	0.51	0.73	<0.001
Interaction terms[a]	Aggression*Absent	Referent	–	–	–
	Rapid Ingestion*Present	0.29	0.23	0.36	<0.001
	Avoidance*Present	1.26	0.97	1.65	0.081
	Threats*Present	1.87	1.52	2.31	<0.001
Attend training class	No	Referent	–	–	–
	Yes	1.08	1.02	1.15	0.008
Advanced knowledge	No	Referent	–	–	–
	Yes	1.13	1.04	1.22	0.003

[a] These exponentiated coefficients cannot be interpreted independently as they are part of a significant interaction.

Table 6
Interaction terms influencing owner ability to correctly identify resource guarding behaviour categories.

Contrast statements	Categories[a]	OR	95% CI		P-value
Behaviour present vs. absent	Threats, Present vs. Absent	1.15	0.99	1.32	0.07
	Avoidance, Present vs. Absent	0.78	0.65	0.93	<0.001
	Aggression, Present vs. Absent	0.61	0.51	0.73	<0.001
	RI, Present vs. Absent	0.18	0.15	0.20	<0.001
Behaviour category comparison: present	Present, Aggression vs. RI	5.15	4.49	5.90	<0.001
	Present, Aggression vs. Avoidance	3.71	3.02	4.55	<0.001
	Present, Aggression vs. Threats	2.82	2.50	3.18	<0.001
	Present, Threats vs. RI	1.82	1.64	2.03	<0.001
	Present, Avoidance vs. RI	1.39	1.14	1.68	<0.01
	Present, Threats vs. Avoidance	1.31	1.09	1.57	<0.01
Behaviour category comparison: absent	Absent, Aggression vs. Threats	5.15	4.49	5.90	<0.001
	Absent, Aggression vs. Avoidance	3.71	3.02	4.55	<0.001
	Absent, RI vs. Threats	2.82	2.50	3.18	<0.001
	Absent, RI vs. Avoidance	1.82	1.64	2.03	<0.001
	Absent, Aggression vs. RI	1.39	1.14	1.68	<0.01
	Absent, Avoidance vs. Threats	1.31	1.09	1.57	<0.01

[a] The second category is the referent in the comparison.

4.1. Owner ability to correctly identify within categories

Interestingly, owners were more reliable in correctly identifying the behaviour categories of rapid ingestion and avoidance between video clips (i.e., between different examples of the behaviour from different dogs), compared to their ability to correctly identify aggression and threatening behaviour between different video clips. The morphology of the dogs represented within each behavioural category was equally varied, suggesting this finding is not based on breed differences. However, it is possible that there is less variation between dogs for specific, minute behaviours observed during rapid ingestion and avoidance compared to aggression, making it easier to reliably identify the former two categories between dogs compared to the latter. This hypothesis would require further investigation, including a detailed analysis of RG behaviour on a vast number of dogs.

4.2. Owner ability to correctly identify between categories

In this study, the category of aggression was limited to biting and snapping behaviour. A separate category was created to include the behaviours of growling, teeth baring, freezing and body tension, labelled as 'threatening' behaviours. Dividing threats and aggression into two separate categories allowed for a more specific investigation on the ability of owners to identify these behaviours compared to previous research (e.g., Tami and Gallagher, 2009). Our results suggest that owners are good at identifying biting and snapping behaviour, but might have more difficulty identifying subtle aggressive behaviours such as growling, teeth baring, freezing and body tension. Threatening behaviours are important for owners to identify because they are generally observed immediately prior to biting and snapping (Archer, 1988). Proper identification and response to threatening behaviour by the dog owner could help decrease the risk of being bitten (De Keuster and Jung, 2009).

Interestingly, owners were able to identify the presence of threatening behaviour better than the presence of rapid ingestion and avoidance, but identifying the absence of threatening behaviour (i.e., correctly observing a lack of threat behaviours in the video example) was more challenging than identifying the absence of the other two categories. Owners may be more sensitive to the presence of behaviours that indicate a potential threat of harm than behaviours that are relatively benign towards people, such as rapid ingestion and avoidance. The threat behaviour category consisted of four behaviour examples with instructions to participants that if any one of the behaviours were observed within the video they should select this category as being present. It may have been more difficult for participants to definitively rule out the existence of one or more of the subtle behaviour patterns that collectively make up the threatening behaviour category, thus resulting in difficulty identifying the absence of the threatening category compared to rapid ingestion and avoidance, which are both defined by only one behaviour type.

4.3. Owner ability to identify the absence or presence of each category

Owners were able to better identify the absence of a behaviour category rather than the presence of that behaviour category for

rapid ingestion, aggression and avoidance categories. Although no significant difference was identified, there was a numerically higher odds of owners identifying the presence rather than the absence of threat behaviours. A particularly large difference was observed between identifying the absence of rapid ingestion compared to the presence of that behaviour. This suggests it is easier for owners to correctly identify when a dog is eating at a normal speed compared to when the speed of eating increases. Similarly, owners were better at correctly identifying the absence of aggression rather than the presence of aggression (although both were identified with relative consistency overall). As mentioned previously, this study limited the behaviour category of aggression to only include biting and snapping, which may be more obvious behaviours to owners in both presence and particularly absence. Identifying the absence of avoidance was less difficult for owners compared to identifying the presence of that behaviour. Avoidance is generally identified through movement of a dog (either through locomotion or body position) to avoid an object's removal. Dogs that remain completely stationary are not exhibiting avoidance, and this may have been a relatively easy cue for owners to acknowledge.

In four videos, threatening behaviour was observed in combination with aggressive behaviour (biting or snapping). It is possible that participants may have been better able to identify aggression when it was preceded by threatening behaviour, essentially using threatening behaviour as a cue for an upcoming aggressive response. Further, it is also possible that participants found threatening behaviour to be more clearly identifiable when it was paired with a more obvious behaviour, such as biting, thus elevating the number of correct identifications. In contrast, ruling out the existence of all of the behaviours that collectively make up the category of 'threats' may have been more difficult. These results suggest educational efforts for owner identification of aggressive behaviour could focus on behaviours indicative of threats (i.e., behaviours generally occurring prior to a bite).

4.4. Effect of owner expertise

It has been suggested that hands-on experience with dogs may help people to correctly interpret dog behaviour (Bahlig-Pieren and Turner, 1999). One of the requirements for participation in this study was ownership, thus all participants should have had a baseline level of hands-on experience with dogs. However, some participants had additional experience that surpassed general ownership, which had a positive effect on their ability to correctly identify behaviour categories. This is similar to results reported by Diesel et al. (2008), who suggest that people with formal training or more than eight years of experience with dogs are more consistent in agreement of their assessment of dog behaviour. In the current study, individuals that reported attending professional training classes or had self-identified advanced knowledge of dog behaviour were more likely to correctly identify the behaviour categories than those that did not report these additional experiences with dogs. While having 'self-identified advanced knowledge' was not further explained or defined, the data suggest those identifying with this question have extended knowledge beyond employment experience as this factor was not significant in our model.

In a study by Tami and Gallagher (2009), no differences were found between veterinarians, dog trainers, owners and non-owners in their description of dog behaviour. That study required participants to score the behaviour of a dog on a video using a list of eight adjectives (indifferent, fearful, confident, friendly, submissive, defensive, playful, and aggressive). These adjectives were presented to the participants without definition or description, and the authors acknowledge a potential issue in the overlap of interpretation for some of the adjectives. The descriptions and examples we provided to participants left no room for external interpretation of the behavioural categories of interest, which may have resulted in a better representation of the differences between individuals with and without additional dog experience. However, the small degree (i.e., the small, albeit significant, odds ratio) to which additional experience had an effect on behaviour identification was surprising. It is possible that the significance was driven from our large sample size, or that our tutorial served to balance the differences between experience levels to a lesser degree than exists in reality. It has been demonstrated that educational programs do improve dog owner ability to correctly interpret risk scenarios involving aggression (Wilson et al., 2003). Although our tutorial may have served to improve our participants' ability to correctly identify the behaviour categories overall, we still found significant differences between groups having different levels of experience. This suggests there is room for improvement in identifying dog behaviour by gaining additional experience or knowledge.

4.5. Ability of participants to correctly identify videos with multiple categories

We included several videos containing more than one behavioural category in order to assess owner ability to identify behaviour when there were compound behavioural responses. In a univariable model this variable was significant, although it was not significant when other factors were considered and thus was not retained in our final model for further exploration. This suggests that videos containing multiple categories did not influence performance as much as the other factors that were ultimately included in the model.

4.6. Limitations

Due to safety concerns it was necessary to use an artificial hand during behaviour assessments. It is possible that some of the dogs may have been reacting to the artificial hand, rather than the removal of the food or rawhide. It is unknown if dogs perceive an artificial hand in the same way they would a real hand and are responding to the threat of loss of a resource (i.e., resource guarding), or are fearful of the hand. However, the objective of this research was not to determine the underlying motivation for the dog's behavioural reaction but to assess the ability of owners to identify behaviour, including behaviours related to fear (e.g., "stiffness", "freezing"). Therefore, the concern for using an artificial versus a real hand should not have affected the validity of our research findings.

It is possible that the behaviour of the SAFER tester influenced respondents' category choices, inadvertently cueing into the presence of an unwanted response. However, the tester was experienced in controlling reactions to attempt to provide a standardised procedure between dogs, and sound was edited from the videos in case there was a verbal cue from the tester regarding an observed behaviour. Therefore, this effect should have been minimized.

It was not possible to standardise video length and timing between behavioural events for videos that included multiple behaviour categories. Variability in video timing (e.g., behaviours occurring simultaneously versus following a delay) may have influenced participants' ability to resolve and recognize particular behaviour categories.

Furthermore, the breeds of dogs represented in the video examples varied considerably, but lacked a large enough sample size to allow meaningful statistical analysis. Potential differences between videos (i.e., between dogs) were controlled for during analysis by including a random effect for video. However, it is possible that variation in coat colour, coat length and breed of dog may have influenced some participants' interpretation of behaviour for certain videos. It has been suggested that people view large, dark

coloured dogs to be more threatening than pale coloured or small dogs even though the context in which the person viewing the dog is the same (Blecker et al., 2013). Furthermore, pit bull breeds are more likely to incite fear and avoidance in people relative to dogs of small, medium and large size without features "related to dangerousness" (Gazzano et al., 2013). While this study did not have any examples of pit bull breeds, there were three German Shepherd dogs which are frequently considered to be a breed of increased risk for aggression and thus may be perceived as being more threatening compared to the other breeds represented in this study (Gershman et al., 1994). These underlying biases may have evolved partially from differences in breed characteristics that obscure critical visual signals, such as docked tails and cropped ears. This effect may have influenced the participants in this study to some degree. However, German Shepherd dogs were represented in three different categories, and thus, potential effects should be minimized. Future research should investigate breed characteristics that might influence owner interpretation of these behaviour categories.

Furthermore, the ability of owners to identify specific resource guarding categories may be over-estimated in this study relative to reality, in which it is not possible to pause and replay a behavioural reaction. The videos chosen for this study demonstrated clear examples of each behavioural category of interest, whereas in reality, conflicting behavioural reactions can be displayed which may make identification more challenging. However, the rigor to which each video was selected increases the internal validity and is one of the major strengths of this study. Four canine behaviour experts independently identified the presence of the behaviour categories expressed by each dog, and only those videos which achieved 100% consensus on each category were included in this study. While some owners may have had greater difficulty correctly interpreting the behaviour of certain breeds (or breed characteristics), the videos did provide validated representations of the behaviour categories of interest.

5. Conclusion

Resource guarding is one of the most common behaviour problems reported by owners to canine professionals (Landsberg et al., 2013). Owners are most concerned with resource guarding aggression, which involves the potential for harmful actions towards a person or other animal when attempting to maintain control over an item (Overall, 2013). However, avoidance and rapid ingestion are additional types of behaviour patterns that dogs may use to maintain control of an item. These types of resource guarding may be precursors or indicators of potential future aggression depending on a variety of intervening factors, including owner behaviour, therefore identifying these types of resource guarding is important. Our study indicates that owners are very good at identifying dogs without RG behaviour, and dogs with biting and snapping behaviour, but are relatively less effective at identifying avoidance, rapid ingestion and threats (e.g., growling, freezing, body tension, and baring teeth). Future emphasis should be placed on education programs to help owners identify early warning signals and reduce the risk of harmful behaviour through appropriate owner response.

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