RESEARCH ARTICLE

Linking social identity, risk perception, and behavioral psychology to understand predator management by livestock producers

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Human behaviors can determine the success of efforts to restore predators to ecosystems. While behaviors such as lethal predator control may impede predator restoration, other land management practices can facilitate coexistence between predators and humans. Socio-psychological theories provide useful tools for understanding and improving these human behaviors. We explore three frameworks to understand what shapes Australian livestock graziers' behaviors with regards to management of the threat that dingoes pose to livestock. These frameworks are the theory of reasoned action (incorporating values and beliefs about dingoes), the social identity approach, and perception of risk. We distributed a survey to Australian graziers by mail and online ($n = 138$) which allowed recording of information on these three frameworks and their engagement in lethal dingo control. Among the respondents, we found that all three frameworks were linked with lethal dingo control when assessed individually, but when combined in a hierarchical regression, only social identity (specifically, identifying as an "environmentalist" or "pest controller") was significant in predicting behavior. This result reveals the strength of social norms and normative beliefs over perceived risk in shaping behavior. As such, social identity is a useful metric for predicting and understanding environmental management behavior. Determining what these social identities mean in a given context is important for identifying how to implement behavior change to promote evidence-based management that facilitates restoration of wildlife such as predators to landscapes where conflict with humans occurs.

Key words: human–wildlife conflict, predator management, social identity approach, theory of reasoned action, wild dogs

Implications for Practice

- Predator restoration can only be successful where human behaviors facilitate coexistence, so understanding these behaviors and what shapes them is essential.
- Social identity can be a useful predictor of wildlife or pest management behaviors by land managers like farmers.
- Understanding what different social identities mean for different communities in the context of environmental management may be useful for influencing management behaviors, e.g. to facilitate restoration of controversial wildlife like predators.

Introduction

In recent decades, there has been a push by conservationists to restore predators to areas from which they have been removed (Ritchie et al. 2012; Newsome et al. 2015). This is because predators perform important roles in regulating trophic systems (Estes et al. 2011; Ritchie et al. 2012), but their populations have been reduced globally such that many are now threatened (Ripple et al. 2014). Diminishing predator populations have occurred in large part due to conflict between predators and humans. Predators can threaten both human safety and economic interests such

as livestock production; humans often respond to this threat by killing predators. As such, restoring predators to ecosystems cannot be successfully achieved without addressing conflict with humans.

Successful ecological restoration efforts must be supported by local communities (Higgs 2005), so understanding and managing human behaviors that hinder or facilitate coexistence with problematic wildlife like predators is essential (Dickman et al. 2006; Schultz 2011; Marchini 2014; Nilsson et al. 2020). When wildlife return to an area after extirpation, community attitudes and behaviors that might hinder successful restoration can be predicted by social and cognitive factors (Bruskotter et al. 2009). Considering conflict between livestock producers and

predators specifically, the impact of predators on livestock is not the only predictor of human management behaviors. Fear for personal safety and social motivations are key factors predicting ranchers' intention to kill jaguars (*Panthera onca*) in Brazil (Marchini & Macdonald 2012). Social group also has been identified as a predictor of attitudes toward and intention to kill large predators like gray wolves (*Canis lupus*) in North America (Naughton-Treves et al. 2003; Lute et al. 2014). In Europe killing wolves is sometimes considered an act of political protest against perceived challenges to rural lifestyle and values (von Essen et al. 2015; Pohja-Mykrä 2016). In recognition of this human-to-human aspect of human–wildlife conflict, several socio-psychological theories and conceptual frameworks have been developed to explain what shapes wildlife management attitudes and behaviors. Understanding which of these is most applicable to a given conservation issue is important for identifying and implementing solutions using evidence-based social and psychological theories to shape behavior (Baynham-Herd et al. 2018).

In this study, we applied three theoretical frameworks and tested their effectiveness in predicting wildlife management behaviors. We tested these frameworks separately, as well as in combination, to determine whether one had more predictive power than the others.

The theory of reasoned action (TRA) and its extension, the theory of planned behavior (TPB) (Fishbein & Ajzen 1975; Ajzen 1991) have been applied to environmental psychology and include socio-psychological components such as values, norms, and attitudes to understand human behaviors (Klöckner 2013). According to these theories, a person's behavioral intention (a strong predictor of actual behavior) is a function of (1) the person's individual attitude toward the behavior (i.e. whether they consider the action to be good or bad) and (2) the influence of the person's environment, including social influences and their perception of control over the situation (Ajzen & Fishbein 1980). The latter includes social or subjective norms within the person's social environment. Norms are socially agreed rules that define what is right and appropriate (Webster 1975), and subjective norms describe a person's perception of whether others think they should perform a specific behavior to align with these norms, termed normative beliefs (Ajzen & Fishbein 1980).

In extending the influence of the person's environment, the TPB, which updates the TRA, adds perceived control to the theoretical framework (Fishbein & Ajzen 2010). This includes the capability and control of the individual to perform the action. This addition to the model extends actual behavioral control, which may inhibit the link between intentions and behavior, but it is not included in the psychological modeling of the behavior of interest. TPB and TRA have been used for predicting behavior for decades, but are not without criticism. Their predictive ability varies, largely because behavioral intention and actual behavior may differ (Sutton 1998; Webb & Sheeran 2006) due to contextual variation in control over performing behaviors. Here, we focus on individuals with greater volitional control over whether or not they perform the behaviors of interest (i.e. predator control methods). This alleviates some of the

limitations for these models of predicting behavior and renders them more useful in this context.

Social norms and normative beliefs are not uniform within societies, but rather distinct within different social identity groups (e.g. environmentalists, animal rights activists). According to the social identity approach (SIA) (Abrams & Hogg 1990), values link people within a social identity group, defining what is desirable and acceptable and thus giving direction to normative beliefs or behavioral rules that group members must abide by (Manfredo et al. 2016). As such, the SIA links with aspects of the cognitive theories described above (Terry & Hogg 1996) that have been identified as useful predictors of environmental (and other) behaviors, and is important in understanding attitudes toward wildlife management (Bruskotter et al. 2009; Lute et al. 2014; van Eeden et al. 2019c) and environmental behaviors (Gatersleben et al. 2014; Fielding & Hornsey 2016). Self-identification with a particular group is considered to serve as a "moderator" of the relationship between perceived norm and behavioral intention, but can also directly influence behavioral intentions, attitudes and norms (Fishbein & Ajzen 2010).

Some conservation researchers advocate further exploration of the combined effect of social identity and risk perception to understand conflict over wildlife (e.g. Lute & Gore 2019). Perception of the risk posed by wildlife interacts with attitudes toward wildlife and wildlife management (Vaske et al. 2004; Gore et al. 2006; Sponarski et al. 2018), and the broader literature has identified risk perception as useful for predicting behavior (Lobb et al. 2007; Dohmen et al. 2011). Risk perception is shaped by social norms (Lute & Gore 2014; Lute & Gore 2019) and specific beliefs and values (Oltedal et al. 2004), and there is a feedback loop in that risk perceptions are considered a background factor in shaping behavioral and normative beliefs that predict behavioral intention (Fishbein & Ajzen 2010). Most risk studies focus on the perceived likelihood of occurrence of an event or threat (cognitive or probability dimension), but the perceived severity of this threat (affective or consequential dimension) may be of greater importance in shaping outcomes and behavior (Sjöberg 1998; Sponarski et al. 2018; Wilson et al. 2019). While a broader affective measure of worry is distinct from the perceived severity of the threat, it assesses a person's quick but overarching feeling about the risk, and shares a consistent and critical relationship with risk perceptions (Finucane et al. 2000). Cognitive (likelihood) and affective (severity) measures of risk perception are weakly linked, but considering both is recommended as each can result in a different picture of risk perception (Sjöberg 1998).

In this study we consider TRA (incorporating values and beliefs), the SIA, and perception of risk to predict and understand wildlife management behaviors related to the Australian dingo (variously described as *Canis lupus dingo*, *C. dingo*, and *C. familiaris;* Smith et al. 2019). Extensive lethal dingo control has occurred across large areas of Australia since European settlement two centuries ago, in large part due to the real and perceived threat that dingoes pose to livestock, particularly sheep. While there are no nationwide estimates of current nor historic dingo population size, dingoes have been removed from large areas of their former range below the 5,500 km "dingo fence"

that has been erected and maintained to keep dingoes out of areas with sheep grazing (Newsome et al. 2015). Restoration of dingoes to these areas is promoted because of their purported benefits in suppressing populations of large herbivores like kangaroos (*Macropus* and *Osphranter* species) and introduced meso-predators like feral cats (*Felis catus*) and red foxes (*Vulpes vulpes*) (Newsome et al. 2015).

The dingo is an ideal case study in understanding how human behaviors shape wildlife restoration and management because the species is steeped in controversy. For example, there is scientific debate about the dingo's trophic role in Australian ecosystems (Letnic et al. 2012; Allen et al. 2013). The dingo does not fit neatly into the categorizations we usually assign wild animals (Hytten 2009; van Eeden et al. 2019b) because it was brought to Australia around 5,000 years ago, and thus viewed as either a native or introduced species by different stakeholders. Because hybridization between dingoes and domestic dogs has occurred, they are inconsistently labeled as "dingoes" or "wild dogs" by those who support their conservation and those who propose their control, respectively (Kreplins et al. 2018). Some research has been conducted by Australian government and industry groups on how best to engage communities in controlling dingoes, mostly with the goal of protecting livestock production industries (Binks et al. 2015; Ecker et al. 2015; Howard et al. 2018). There is virtually no government or nongovernmental organization (NGO) support for livestock producers wishing to adopt nonlethal methods that are used successfully elsewhere (e.g. livestock guardian animals, improved livestock husbandry; van Eeden et al. 2018). These disagreements and ambiguities are reflected in conflicting policy across Australia that both protects and persecutes dingoes (Smith & Appleby 2015; Ritchie et al. 2018).

Little research has focused on understanding the human dimensions of dingo conservation and management outside of promoting community-led lethal control, but there seems to be limited support for nonlethal management methods among the livestock-producing community. One study found that Australian farmers were willing to engage in a range of voluntary conservation actions on their properties—all *except* reducing lethal control of dingoes, even if they were paid to do so (Addison & Pavey 2017). Rather than seeing dingoes as an important part of Australian ecosystems, many landowners see culling dingoes as their duty as stewards of their land, although this attitude may be shifting among some farming communities, particularly cattle producers, who may not see dingoes as a threat or even perceive benefits to maintaining dingoes such as via the suppression of large herbivores that compete with livestock for feed (Clark et al. 2018; van Eeden et al. 2019a). Given our current limited understanding of the human dimensions of dingo management and the bias toward dimensions that encourage lethal control, we herein investigate what socio-psychological factors shape Australian livestock graziers' behaviors in protecting their livestock from dingo predation. We use the results to consider how management behaviors might be influenced to promote evidence-based management that facilitates dingo restoration in Australia.

Methods

Survey Design and Distribution

We developed a survey that measured respondents' (1) social identity, (2) perception of the risk dingoes pose to their livestock, and (3) values, beliefs, and behaviors regarding dingo management. We asked respondents to what extent ("not at all," "somewhat," or "strongly") they identified with four identity groups: pest controllers, environmentalists, animal welfare advocates, and farmers. We omitted the latter group from the analysis because all but three respondents identified as farmers. We chose the other three identities because we considered them particularly relevant to wildlife management in Australia. "Environmentalists" and "animal welfare advocates" have been widely studied with regards to environmental and wildlife management globally (Kellert 1984; Lute & Gore 2014; Lute et al. 2016). We considered "pest controllers" relevant in an Australian context because Australia's wildlife management is heavily focused on controlling introduced species and species considered pests in comparison to other countries where lethal wildlife management may be focused on managing game for recreational or subsistence hunting purposes (Franklin 1996). Many Australian land managers consider control of invasive and pest species as a stewardship duty (Addison & Pavey 2017). The total number of respondents who indicated the extent to which they identified as pest controllers, environmentalists, and animal welfare advocates was $n = 101, 100$, and 102, respectively. Not all respondents indicated to what extent they identified as each identity group, so these were omitted from analyses of each identity group. Two respondents who did not indicate identification with any of these groups were excluded.

We measured risk in two categories: cognitive risk and affective risk. Cognitive risk was measured by asking respondents how likely they considered attacks on their livestock to be, from "not likely," "somewhat likely," to "very likely." Affective risk was measured by asking respondents how worried they were about attacks on their livestock, from "not at all," "somewhat," to "very" worried. We measured values as how respondents regarded the intrinsic value of wildlife using a 5-point scale (anchoring: strongly disagree to strongly agree, Table 1) derived from a study by Bruskotter et al. (2015). We averaged response scores to these statements (reversing those with opposing meanings; Table 1) to derive an overall value score, with negative scores indicating that respondents consider wildlife to hold intrinsic value. We measured beliefs about dingoes and dingo management from responses to the statements "Dingoes play a valuable role in Australian ecosystems" and "Dingoes should be eradicated wherever possible." We reversed the score of responses to the latter statement and averaged the responses to this and the first statement to derive an overall belief score (i.e. positive belief score indicates generally positive attitudes toward dingoes).

To record behaviors, we asked respondents to indicate which management methods they used to prevent predation on livestock by dingoes: any or all of aerial baiting (with poison, usually 1080), ground baiting, shooting, trapping, employing professional dog trappers ("doggers"), fencing, livestock

Table 1. Percentage use of lethal and nonlethal management methods to prevent predation on livestock by dingoes. The table compares results of the current survey with those collected by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) in 2014 (Binks et al. 2015).

Method	ABARES (%)	Current Survey (%)
Aerial baiting	26	26
Ground baiting	81	67
Shooting	87	65
Trapping	31	53
Professional doggers	NA	42
Fencing	12	35
Animal husbandry	NA	19
Livestock guardian animals	5	14
Do nothing	NA	11
Any lethal control	NA	84

guardian animals, and animal husbandry. Animal husbandry was defined as management that minimizes opportunities for predation on livestock such as strip grazing (intensive grazing over small areas) or moving livestock away from forested areas during calving/lambing. We also asked respondents to indicate whether they did not use any management and created a new category that recorded whether respondents used any lethal control method (aerial or ground baiting, shooting, trapping, doggers). This latter category serves as the focus of our analysis of behavior because combining several related behaviors into one metric can more accurately capture behavioral tendency (Fishbein & Ajzen 1974; Weigel & Newman 1976).

Before distributing the survey, we asked colleagues working in agricultural sciences for feedback, and conducted a pilot study by distributing the survey to one of The University of Sydney's residential colleges that has many students from rural areas. Adjustments were made to the questions to address concerns raised or where responses returned for a question were not useful. The questions used in this survey are provided in Supplement S1.

The survey was distributed both online and by mail. A publicly available version of the survey was hosted online by The University of Sydney using the REDCap electronic data capture

tool (Harris et al. 2009). We shared a link to this survey and a short description about its background and aims with a range of relevant networks including (but not limited to) pest management agencies, meat and wool production groups, farmers' federations, and rural newspapers. The link to the survey was then shared on Facebook and Twitter and by email by other persons not known to us. This kind of web-based survey distribution is becoming increasingly common; although it can result in biased sample composition (i.e. recruiting respondents interested in the topic, excluding those without internet access) and does not allow for examining nonresponses, it is an accepted approach to social research focused on understanding stakeholder perspectives on a specific issue (Couper 2001; Chang & Krosnick 2009). One of us (L.M.V.) also conducted two interviews on rural radio stations (Australian Broadcasting Corporation) describing the study and inviting listeners to contact her or the radio station if they were interested in participating in the survey. Our mixed approach to recruitment functions as a snowball sample using modern techniques, as used in the social sciences to access difficult to reach groups (Handcock & Gile 2011).

Printed surveys were mailed to five people who contacted the authors to request a hard copy as well as 79 properties where a previous study was completed in the 1950s (van Eeden et al. 2019a). The latter were sent a letter outlining the purpose of the survey and offering to send respondents who completed the current survey a copy of the survey that was completed on their property in the 1950s.

Due to the small sample size and potential biases in the recruitment of survey participants, we did not consider our sample to be representative of all Australian farmers and their dingo management behaviors. Nonetheless, useful insights can still be gained in understanding what factors shape dingo management among those engaged in discussion about dingo control. We also compared rates of use of different management methods with a national survey conducted by the Australian Bureau of Agricultural and Research Economics and Sciences (Table 1, Binks et al. 2015).

We distributed the survey and received responses between February and August 2018. This research was conducted with approval from The University of Sydney's Human Research Ethics Committee (protocol number 2017/721).

Data Analysis

We first tested relationships between social identity, risk perception, values, beliefs, and behavior (lethal dingo control) using Spearman's correlations and compared demographic variables (gender, age, level of education) with social identity. Because there appeared to be stronger relationships between two of the identity groups (pest controllers and environmentalists), the other predictor variables, and behaviors, we focused the remaining analysis on these two identities (Table 2).

We then conducted a four-step hierarchical logistic regression (Wong & Mason 1985) in SPSS version 24 (IBM Corp 2016) treating (1) social identity, (2) perception of the risk, and (3) values and attitudes as predictor variables and behavior (whether a respondent engaged in lethal control) as the response

Table 2. Items measuring respondents' intrinsic values. Cronbach's alpha is 0.742.

Item	Mean	SD
Wildlife are on earth primarily for people to use	−0.81	1.249
Humans should manage wildlife populations so that humans benefit	0.12	1.394
The needs of humans should take priority over wildlife protection	−0.17	1.208
Wildlife are only valuable if people get to use them in some way	−1.08	1.149
Animals should have rights similar to the rights of humans*	−0.46	1.268
Wildlife have inherent value, above and beyond their use to people*	1.29	0.948

*Indicates scores reversed for inclusion in analysis.

variable. The first three steps tested the relationship between behavior and each of these three sets of predictor variables separately. The fourth step combined all predictor variables to identify which was the most useful predictor of the use of lethal control in dingo management. We then explored the relationship between the most important predictor variable and the use of all dingo management methods separately using bivariate correlations.

Results

We received 138 responses, comprising 106 online and 32 by mail (mail response rate: 38.1%). Most (76.5%) of the respondents were male and the average age was 53.44 ± 13.15 (SD) years. The majority (84%) of respondents used some kind of lethal control. Among our respondents, the most commonly used dingo and wild dog management methods were all lethal: ground baiting, shooting, trapping, and professional doggers (Table 1). The most commonly used nonlethal methods were fencing, animal husbandry, and livestock guardian animals (Table 1).

Sixty-four (50.4%) strongly and 48 (37.8%) somewhat identified as pest controllers, 44 (34.6%) strongly and 62 (48.8%) somewhat identified as environmentalists, and 20 (16.0%) strongly and 59 (47.2%) somewhat identified as animal welfare advocates. The only significant relationship between social identities and demographics of interest (gender, age, level of education) was that those who somewhat or strongly identified as environmentalists were more likely to be university-educated than those who did not identify as environmentalists ($\chi^2 = 11.846$, $df = 2$, $p = 0.003$; Table S1). Lethal control was used by 95.3% of strongly identifying pest controllers, 67.4% of strongly identifying environmentalists, and 57.1% of strongly identifying animal welfare advocates (Table S2).

On a scale of -2 (high intrinsic value) to 2 (low intrinsic value), the respondents on average held weak attitudes/beliefs regarding the intrinsic value of wildlife (mean = -0.47 ± 0.80 SD) and beliefs about dingoes (0.20 ± 1.29). The high variance suggests some lack of consensus among respondents. Around half somewhat (24.5%) or strongly agreed (25.2%) that dingoes played a valuable role in Australian environments (compared with 19.4% and 12.2% who somewhat or strongly disagreed, respectively) and half somewhat (19.4%) or strongly (28.1%) disagreed that dingoes should be eradicated wherever possible (compared with 17.3% and 21.6% who somewhat or strongly agreed, respectively). Based on bivariate correlations, there was a strong and significant relationship between two identity groups (pest controllers and environmentalists) and perception of risk and the value-attitude framework. Specifically, environmentalists were less likely than nonenvironmentalists to consider dingoes to pose a risk to their livestock (affective risk $r = -0.276$), more likely to consider wildlife to hold intrinsic values ($r = -0.344$), and more likely to consider dingoes to play a valuable role in Australian ecosystems ($r = 0.391$), while the opposite trends were observed for the pest controller identity (affective risk $r = 0.428$, values $r = 0.268$, beliefs about role $r = -0.251$) See full results of correlations in Table S3.

Logistic regression analysis including the three categories of predictor variables identified that both social identities (pest controller $\beta = 2.331$, $p < 0.001$, and environmentalists $\beta = -2.484$, $p < 0.001$), affective risk ($\beta = 2.72$, $p < 0.001$), values ($\beta = 1.207$, $p = 0.015$), and beliefs about dingoes ($\beta = -0.976$, $p = 0.003$) were related to behavior (engaging in any lethal control) (Table S4). When all three levels were included in the analysis, only the social identities were significant at $p \leq 0.05$ (pest controller $\beta = 2.463$, $p = 0.045$, and environmentalists $\beta = -3.124$, $p = 0.016$) in predicting lethal control behavior. The all-inclusive model (Step 4) represented the best fit (akaike information criterion = 36.291).

Among the respondents, we identified that environmentalists were more likely to engage in nonlethal management like improved animal husbandry or taking no action, and less likely to engage in shooting, ground baiting, and shooting. Pest controllers, by contrast, were more likely to engage in aerial baiting, ground baiting, shooting, trapping, fencing, and employing professional doggers, and less likely to take no action (Fig. 1, Table S5).

Discussion

We identified significant relationships between social identity, perception of risk, values, beliefs about dingoes, and behavior (lethal dingo control) among the stakeholders. These findings support existing behavioral psychology theories (e.g. TRA), which posit that background factors, behavioral beliefs, and social norms can be important influences on behavior (Fishbein & Ajzen 2010). Further, that these various components are linked is supported by theory that these components inform each other. For example, social identity groups share values, norms, and beliefs, while social identity groups in turn help to establish social norms and shape behavior (Terry & Hogg 1996; Terry et al. 1999; Fishbein & Ajzen 2010).

Social identities were the only significant predictors of whether participants engaged in lethal dingo control after accounting for the other two frameworks. Social identity can therefore serve as a useful metric for predicting behaviors relating to human-dingo conflict. This finding accords with previous social research on predator management which has found identity and social group to be important in predicting tolerance of, or intention to kill, predators (Naughton-Treves et al. 2003; Marchini & Macdonald 2012; Lute & Gore 2014). The identities that these studies considered were primarily linked with occupation (e.g. livestock producer), recreation (e.g. hunter), or organization affiliation. While other research has linked a range of social identities to attitudes toward lethal wildlife control (e.g. Bruskotter et al. 2009; Lute et al. 2016), to our knowledge, our study is the first to specifically link an ideological identity like "environmentalist" to self-reported use of lethal control of predators.

Social identity was also useful for predicting whether respondents used common methods like poison baiting, shooting, and trapping or took any management action at all. The lack of a significant link between identities and less commonly used management methods might be a result of small sample size, but
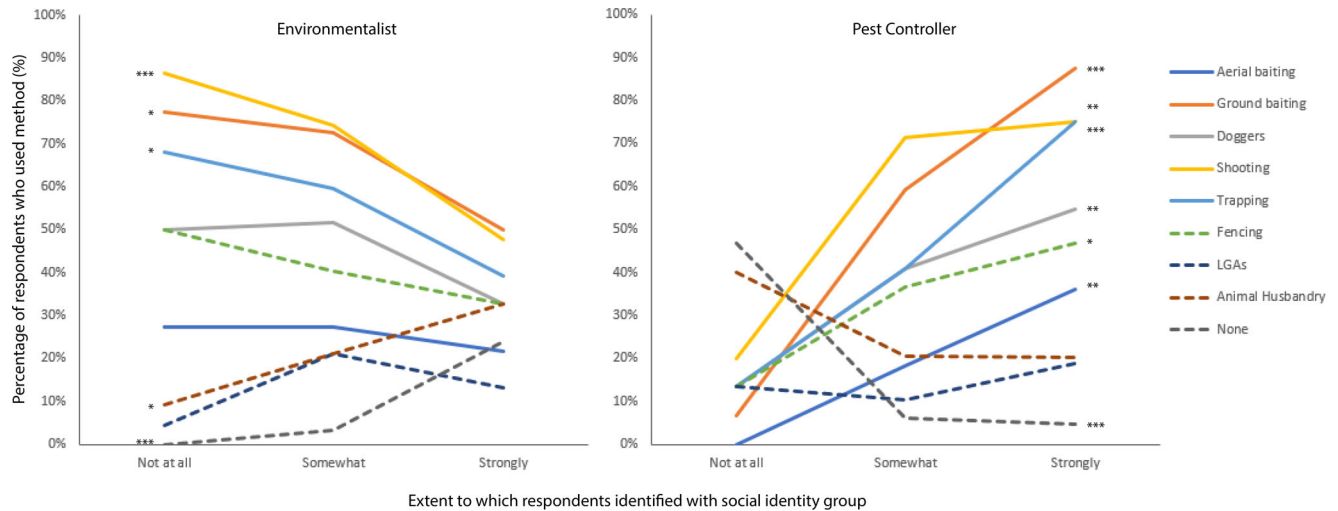
Figure 1. Relationship between the extent to which a respondent identified as an environmentalist or pest controller with their use of different lethal and nonlethal methods for preventing dingo predation on livestock. Nonlethal methods are represented by a dashed line. Significance (indicated by ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$) based on bivariate correlations between social identity and the use of each management method (see Table S5).

also limited access to such methods. A previous exploration of changes in dingo management in Australia suggests that there may be increasing interest in nonlethal management among some graziers (particularly cattle graziers; van Eeden et al. 2019a), which may be linked to an increase in prevalence or change in understanding of environmental identity. While education about an issue is not necessarily linked with changes in behavior (McKenzie-Mohr et al. 2012), the fact that environmentalists were more likely to be university-educated and less likely to use lethal methods may mean that we will continue to see changes in dingo management as Australian farmers increasingly attain university education (Productivity Commission 2005).

Identity can be thought of as a process—while some aspects of personality and context provide stability to how people identify, each situation provides an opportunity for individuals to determine the fit and relevance of a given identity (Oakes 2002; Huddy 2015). Identity provides a means of defining the self within each situation, and as context shifts (e.g. with more university-educated farmers or governmental support for nonlethal methods) this may result in a redefining of grazier identities, and greater opportunity for dingo restoration efforts. People understandably adapt and react to the context in which they find themselves, and in this way, identity is no different from any other adaptive behavior. However, only the "pest controller" and "environmentalist" identities were important in terms of predicting dingo control behavior as well as linking with values, beliefs, and risk perception. Australian attitudes toward wildlife are considered to strongly favor native species, whereas conservation management is heavily focused on lethal control of introduced species (Smith 1999), but stakeholders differ in their regard for the dingo's status in Australia, with those who promote dingo control typically labeling the species an invasive pest (Hytten 2009). The "animal welfare advocate" identity was not linked with dingo control behavior, perhaps suggesting

that species like dingoes that are perceived to be pests or introduced may not be granted the same rights and respect as valued (native or commercially valuable) species (Trigger et al. 2008).

Among the assessments of the three frameworks separately, perception of risk provided the best fit. Considering the influence of risk perception on behavior, affective risk was a significant predictor, but cognitive risk was not. This aligns with previous studies suggesting that affective dimensions typically dominate probabilistic dimensions in predicting behavior (Wilson et al. 2019). However, when these dimensions of risk were included in the final stage of the regression, social identity appeared to account for the variation in worry, but it did not appear to fully explain cognitive risk perceptions, thus emphasizing an opportunity for outreach addressing risk perceptions to impact downstream behavior. Cognitive risk can also depend on perceived benefits, and outreach materials focused on benefits and improved control over risky outcomes has increased capacity for predator populations in previous work (Slagle et al. 2013).

Policy and Management Implications

Ecological restoration, including conservation of problematic wildlife, requires understanding and addressing human behaviors. Exploring what factors influence behavior and how they function in specific management contexts allows us to develop more effective programs that promote evidence-based management by influencing behaviors (Baynham-Herd et al. 2018). In this case, risk perceptions were linked with behavior, so emphasizing the benefits of nonlethal management in reducing costs and predation on livestock could improve grazier uptake of these practices. In communicating about risk, it may help to put livestock losses attributed to dingoes in perspective with other causes of loss. Many studies have found the proportion of lamb deaths in Australia attributed to direct predation (by dingoes,

eagles, red foxes, feral dogs, etc.) to be very low (less than 10% for most studies), with major causes of death being starvation or mismothering (average 44% in review by Szantar-Coddington 1995). Lamb survival rates are similar in areas with and without common predators in Australia (see Hinch & Brien 2014). Similarly for cattle production, some studies have attributed a greater proportion of calf deaths to poor animal husbandry than to predation (Wallach et al. 2017).

However, communication that addresses only risk perception (e.g. reducing the likelihood of predation by predators on livestock) may have limited effect in influencing wildlife management behaviors if it fails to incorporate emotional and psychological factors (Lute & Gore 2019). In our case, behaviors may be entrenched in perception of self-identity and thus be difficult to change, but appealing to norms associated with different social identity groups could more likely influence behaviors than focusing only on risk reduction. Future management and communication of policy would benefit from studies that seek to define what moral judgments and norms identifying as a "pest controller" or "environmentalist" in Australian land management and livestock production contexts entail. Anyone seeking to encourage lethal wildlife control might promote values and moral judgments associated with removing species considered pests. Alternatively, if seeking dingo-friendly land management and livestock production practices, policy makers might appeal to values and norms associated with an environmental identity, perhaps promoting the environmental benefits of maintaining top predators in the landscape. Some online predator-friendly farming platforms have been established in Australia (Johnson & Wallach 2016) which may be effective in promoting nonlethal practices by creating a visible in-group that normalizes and guides such behavior.

An important barrier to shaping dingo management behavior is that the values, attitudes, and social norms surrounding appropriate management objectives differ not just between livestock producers who implement management, but between top-down forces that regulate and provide support for different management approaches (e.g. policy-makers, government agencies). At present, there is limited support for nonlethal management among influential government and industry stakeholders, but some researchers argue that reducing lethal dingo control could benefit biodiversity (Letnic et al. 2012) and livestock production (Johnson & Wallach 2016). Different stakeholders may use different constructions of the dingo's image (i.e. invasive pests versus native predators) to appeal to different social identities. This aligns with our findings around social identity, with the beliefs held by pest controllers (those who likely see dingoes as invasive and believe they should be controlled) and environmentalists (those who may see dingoes as valuable and belonging in Australian landscapes) reflected in their engagement in dingo management behavior. Providing government (or NGO) support for graziers who use nonlethal methods is an important first step and has effectively changed livestock producer behavior elsewhere (Stone et al. 2017) as long as the support is comprehensive rather than financial only (Naughton-Treves et al. 2003).

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Supporting Information

The following information may be found in the online version of this article:

Supplement S1. The survey distributed to respondents.
Table S1. Demographic information for those who somewhat or strongly identified as each of the three identity groups.
Table S2. Percentage (and number) of respondents using some kind of lethal control among groups not at all, somewhat, or strongly identifying with each identity group.
Table S3. Respondent demographics, comparing between identity groups.
Table S4. Logistic regression results testing relationships between social identity, perception of risk, and the value-attitude cognitive hierarchy with behavior (the use of lethal dingo control).
Table S5. Bivariate correlations (Spearman's rank order coefficient) between predictor variables and all management methods used for preventing dingo attacks on livestock.