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THINKING COWS:

A REVIEW OF COGNITION, EMOTION, AND THE SOCIAL LIVES OF DOMESTIC COWS

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I. WHO MOOS? RE-INTRODUCING THE DOMESTIC COW

Before she was called Cincinnati Freedom, people referred to her as the product she was to become: beef. In February 2002, this determined, all-white cow showed the world the force of her personality when she leapt a six-foot fence to escape the slaughterhouse that confined her. For 11 days, Cinci Freedom evaded her pursuers in the streets of Cincinnati, OH. Following her recapture, Cinci was eventually moved by a set of caring humans to farm animal paradise Farm Sanctuary in Watkins Glen, NY. As inspiring as it was, Cinci's flight from slaughter comprises only one part of her story.

Cincinnati Freedom
Photo by Derek Goodwin

At Farm Sanctuary, Cinci revealed herself as not only an inspiring individual, but also an essential contributor to the well-being of her cow companions. Fellow slaughterhouse escapees Queenie, Maxine, and Annie Dodge bonded with Cinci, and the four ladies became inseparable, always travel-

ling and grazing in each other's company. The deep emotional connection between Cinci and the herd was heartbreakingly evident when veterinarians diagnosed Cinci with untreatable spinal cancer. During her final day, the herd gathered around Cinci — some licking her face and back to provide tactile reassurance — with each individual member approaching to say goodbye. Cows depend on each other for emotional support, and the powerful friendships that Cinci made testify to social depth and caring.

Most of the 43.5 million cows used for food in the United States are not nearly as lucky as Cinci to have escaped a life of use and slaughter.[1] Almost all of these cows live and die — often without the social support from friends and family members they need — as tools of the meat and dairy industries. We hope that Cinci's story, as well as an exploration of the emotional, cognitive, and social capacities of domestic cows just like her, provide more opportunities for cows to experience the comfort and pleasure of friendship as well as freedom from use as mere things. We want to understand cows as the someones they actually are.

II. AIMS AND SCOPE

How do stories of cows' care for their friends and families correspond to measured assessments of their capacities? Do they really think and feel in ways that can be compared to other cognitively and emotionally complex nonhuman animals, such as dogs? Scientific research can help us answer these questions and learn more about who cows are. We examined all of the currently available peer-reviewed, scientific studies on cow cognition, emotion, and sociality. Our review focused on complex capacities such as time perception, self-awareness, emotion, and personality. Our goal was to develop the most informed idea of how cows demonstrate intelligence and socioemotional complexity in ways we humans can recognize. This white paper summarizes our findings from the scientific literature.

The capacities explored in this paper also emphasize the need for additional research in cow behavior, cognition, emotionality, social complexity, and

personality. At present, the available research on cows overwhelmingly focuses on how these animals can be used to maximize the profits of farming industries. Consequently, most studies on cows explore questions such as: How can we make cows grow bigger bodies in smaller spaces? And: How quickly after her calf is taken away can a mother cow be reimpregnated to maximize her efficiency? We want to encourage future research to shift away from a focus on how to use cows. Instead, we hope our review inspires much-needed, non-invasive studies on who cows are. We want both the scientific community and the public to understand cows not as commodities for human use and exploitation, but as individuals with complex emotions, personalities, and families.

III. SENSORY CAPACITIES

Even though they were domesticated for human use in the early Neolithic period (as early as 10,500 B.C.), domestic cows still demonstrate a range of sensory capacities passed down from their wild auroch ancestors. Animals' sensory capacities determine the kind of basic information they can use

Cows display complex emotions and personalities.
Photo from Farm Sanctuary

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to experience their environment; by extension, understanding their basic sensory capacities can help us understand and evaluate their intelligence and overall psychology.

When lunchtime arrives, cows love salty and sweet foods, and they make use of their approximately 20,000 taste buds (about double the number that humans possess) to savor every mouthful. Cows require salty and sweet foods to get the calories and electrolyte balance they need to stay healthy. Cows enjoy salty snacks so much that they often use their sense of smell to sniff out foods with higher levels of sodium.[2]

Residents at Farm Sanctuary's New York Shelter grab a bite to eat.
Photo from Farm Sanctuary

Cows also use smell to navigate social relationships, and they can detect the scent of stress hormones present in the urine of fellow cows.[3]

Cows also use smell to navigate social relationships, and they can detect the scent of stress hormones present in the urine of fellow cows.[3] With eyes on both sides of their heads, cows have a field of vision of at least 330 degrees (a human's field of vision is roughly half of a cow's). Sudden movements often spook cows, and, as prey animals, they pay better attention to moving objects than to objects that remain still.

Even though cows primarily rely on vision to navigate their environments, they are also highly sensitive to touch.[4] Their well-developed tactile sense

enables them to enjoy getting a scratch behind the ears from a friendly human.[5] Studies also indicate that dairy-cow herd members spend more time licking cows who are injured or sick, possibly to soothe their discomfort.[6]

Cows' acute sense of touch also means that the factory farming conditions in which many of them live cause them considerable pain. Their highly developed tactile sense means that they suffer greatly when they are routinely branded and castrated without pain relief or forced to live in overcrowded feedlots in which they must stand in manure and have no access to pasture or shelter.[7] The widespread industry practice of de-horning, or the process of removing the fully-grown horns of adult animals or the horn buds from young animals, also causes profound suffering.[8]

Object discrimination provides an important basis for several other forms of cognition, including an animal's ability to mentally group objects into categories.

IV. LEARNING AND MEMORY

Often associated with slow movement and, by extension, dull minds, cows are actually quick learners with great memories. The rapidity of an animal's ability to learn is one measure of her intelligence, and cows can respond appropriately to the sound of an alarm after only seven trials.[9] Further, cows remember what they learn, another indication of their cognitive abilities. They can recall the location of food for at least six weeks.[10] Cows also remember one another as individuals, an important social capacity discussed below. The highly suggestive current findings about cow cognition suggest that future studies have much to uncover about their ability to learn and remember.

Object Discrimination

The term "object discrimination" describes a cow's ability to tell the difference between a blade of grass and a flower, to provide a simple example. Cows have the ability to discriminate between a wide variety of similar objects and even pictures of objects and individuals. Object discrimination provides an important basis for several other forms of cognition, including an animal's ability to mentally group objects into categories. For example, dogs can categorize color photographs according to whether or not those photographs depict nature scenes (like landscapes) or other dogs.[11] Many

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other animals, including other farm animals such as pigs, also categorize and differentiate among various kinds of objects.[12] These kinds of abilities show that the animal has mental concepts and is representing these concepts "in their head" and not just responding to stimuli.

Cows, too, have mental concepts, and can distinguish between objects according to geometric shape, size, color, and brightness.[13] Their ability to tell one object from another is not limited to just shapes, however: Interestingly, cows can also tell the difference between individual humans. Both calves and adult cows can learn to fear humans who have previously handled them roughly.[14] Cows can even differentiate between two humans wearing the same clothes, an indication of their ability to use a range of sensory cues to tell items apart. In one study, researchers taught cows to press their noses to the right wrist of a handler to receive a tasty snack. Then, only one of the two handlers in the study provided the cows with the food prize they expected to receive. Even though the two handlers (the one who gave food and the one who did not) wore the same clothes, the cows learned to approach the snack-providing handler more often than the handler who provided no food.[15] In this instance, cows demonstrated associative learning — their understanding of the relationship between a behavior

Interestingly, cows can also tell the difference between individual humans.

Stella the cow with a Farm Sanctuary visitor.
Photo by Jo-Anne McArthur

and an outcome — which forms the basis of the even more complex capacities described next.

Discrimination Among Individuals

A cow's ability to tell the difference between her friends Bessie, Abigail, and Penelope — what scientists call individual discrimination — forms the basis of social relationships and hierarchies, as well as responses to familiar versus unfamiliar individuals. Like cows, a range of animals can tell the difference between individual members of their species, including dogs,[16] elephants,[17] and pigs.[18] Importantly, individual discrimination underlies an animal's ability to recognize family members and familiar individuals, as well as make fine distinctions among the individuals who comprise her social circles. Cows demonstrate ample ability to differentiate between individuals of their own species. In just a few trials, heifers can learn to discriminate familiar cows, and they can retain that information for at least 12 days.[19] Heifers can also differentiate between individual cows who, at the outset of a test, are not all equally familiar to them.[20]

In just a few testing sessions, cows discriminated between photographs of various kinds of cow faces from the faces of members of other species.[21]

Not only can cows tell the difference between other cows, they also demonstrate a concept of species. That is, they can organize "cows" into a conceptual group distinct from other kinds of animals, and they can accomplish this mental organization even with the visual differences in individual cows' appearances. In just a few testing sessions, cows discriminated between photographs of various kinds of cow faces from the faces of members of other species.[21] In another study, heifers differentiated between two-dimensional images of familiar and unfamiliar cow faces.[22] This finding is particularly striking: It suggests that the cows could mentally sort the images of cow faces into the categories "familiar" and "stranger." This study also suggests that the cows treated the images as visual representations of real individuals, much as we would likely interpret a family photograph in a neighbor's home as a visual representation of an actual family.

Spatial Navigation

Moving through a physical environment to avoid danger, secure shelter,

and acquire food can require animals exercise a complex set of cognitive skills. An animal's ability to learn about, remember, organize, navigate, and use information about her environment — like, which food source have I depleted already, and which should still yield a meal? — falls under the category of "spatial cognition." This kind of learning requires that animals draw on short and long-term memories to form mental representations, or mental maps, of previously visited locations. Birds who store food for later use are well-known for their skill in forming mental maps,[23] and dogs,[24] pigs,[25] and chimpanzees[26] also demonstrate developed capacities in spatial navigation, learning, and memory. Fish[27] and cats[28] use spatial cognition to help navigate and forage in their environments.

Like other grazing animals such as pigs and sheep, cows are skillful maze navigators, an indication that they remember their environments very well. Two related studies — one that focused on heifers and the other on steers — found that cows could successfully learn to navigate two different kinds of mazes, associate several different locations with food, and remember the information they learned for up to eight hours.[29] Cows also use systematic search strategies when foraging; that is, they exercise organized, deliberate methods in their search for food that require them to draw on their memories of already-visited locations.[30] What's more, steers can remember the location of food buckets for at least 48 hours.[31]

Cows' spatial memory even enables them to learn quite complex mazes (i.e., a maze with multiple "arms") when provided with the opportunity to learn the maze in a step-by-step fashion. After learning such a complicated task, they can remember the maze configuration for up to six weeks.[32] As further testament to their long memories, cows can remember to associate a visual cue (such as a plastic tub) with a food reward for at least a year.[33]

V. EMOTIONS

Cows are not only individuals who think; they are also individuals who feel. As complex combinations of behavioral, cognitive, and physiological processes, emotions play a key role in determining how cows and other

animals learn, think, and remember. Cows experience a broad range of emotions; that is, they experience not only basic emotions such as fear and contentment, but also complex emotions. In this paper, we define complex emotions as those that interact with other mental domains such as cognition and social behavior. The complexity of cows' emotional range makes clear that they have the capacity to lead deeply felt and intricately emotional lives.

Cows experience emotional reactions to learning; specifically, they show signs of pleasure when they master a task.[35]

Emotional Reactions to Learning

Once she discovers a fresh treat, a cow might demonstrate excitement. But what if she also demonstrates excitement when she figures out that she knows how to perform the task that rewards her with treats? That is, what if she gets excited not about the treat itself, but over her realization that she can control a situation? Such a scenario describes an emotional reaction to learning, or the emotional effects that result from someone having improved on a task and realizing that she can control a situation and get closer to achieving a goal. Some researchers suggest that this kind of complex emotional experience requires at least some level of self-awareness.[34]

Cows experience emotional reactions to learning; specifically, they show signs of pleasure when they master a task.[35] In one study, two groups of heifers were given a food reward, but only one of the two groups had control over the delivery of the food. During the study, the group of cows who had control over the situation got more excited than the group without control; importantly, their excitement corresponded to moments of learning, and in particular, the cows' discovery that performing certain behaviors could provide a desired result. The researchers involved in this study speculated that the cows' increased excitement was a direct result of the cows' sense of self-efficacy, or their belief that they can reach a goal. As these cows know, successfully completing a task confers a special joy.

Cognitive Bias

The term "cognitive bias" describes the effect of negative emotions or positive emotions on cognitive decision-making; when it influences human

decision-making, we often refer to cognitive bias as either "pessimism" or "optimism." Both human and nonhuman animals who have recently experienced a negative emotion may be less likely to take on a new challenge or perform well on a task, for example. Animals as diverse as European starlings,[36] sheep,[37] dogs,[38] capuchin monkeys,[39] bottlenose dolphins,[40] and honeybees[41] experience cognitive bias.

Cows, too, experience cognitive bias, a finding that provides additional evidence for the complex interplay between a cow's emotional experiences and her performance on tasks. For example, one study showed that young calves were reluctant to approach a screen displaying ambiguous colors for at least 24 hours after they had been "dis-budded" (the term for the removal of a calf's horn bud without anesthesia) with a hot iron. Even after the intense pain associated with the procedure had abated, the calves' negative emotions persisted; this "pessimism" affected their engagement with a cognitive task.[42]

Emotional Contagion

In addition to the emotions cows experience on an individual level, they also "catch" each other's feelings. Emotional contagion occurs when one individual experiences an emotion by witnessing that emotion in another individual.[43] Some researchers consider emotional contagion a simple form of empathy, the ability to feel another's emotional state from her perspective.[44] Many socially complex species, including humans, show emotional contagion. Such a sophisticated capacity allows animals to use social cues to respond to important, often challenging situations.

Cows' demonstration of emotional contagion suggests how tuned in they are to one another's feelings. In particular, cows can determine the level of stress experienced by a fellow cow through the use of smell. When they encounter peers who are stressed, previously unstressed cows "catch" the feeling of stress and behave accordingly: They eat less and produce an increased quantity of the stress-related hormone cortisol.[45]

Cows' demonstration of emotional contagion suggests how tuned in they are to one another's feelings.

Steers Frank and Blitzen in the cow pasture.
Photo from Farm Sanctuary

Numerous studies reveal that cows depend on each other extensively for emotional support.

Social Buffering

What do cows have in common with The Beatles? The answer: They both "get by" with a little help from their friends! For many mammals, being "social" does not just mean remaining in close proximity to members of their own kind. Rather, it means depending on one another for interaction and, by extension, emotional support. "Social buffering" refers to the fact that many social animals react less intensely to negative stresses when they are with friends and family members; moreover, the mere presence of others in their social circle can calm many social mammals. This also means that social isolation inflicts great stress on social mammals, including cows.[46]

Numerous studies reveal that cows depend on each other extensively for emotional support. Steers raised for beef experience less stress when handled by humans before slaughter if allowed to be in physical contact with or even just see their social groups.[47] Further, stressed cows will seek out cows who are not stressed, presumably for the calming effect of being with a tranquil friend.[48]

Considering how much cows appreciate and benefit from each other's company, it is no wonder that they prefer to be housed together rather than in isolation, and many studies show the positive emotional and cognitive effects they experience when they can live with other cows.[49] Even from

a young age, cows have a strong desire for companionship, and calves especially appreciate unrestricted physical contact with others.[50] What's more, dairy calves raised in diverse, complex social groups tend to be better at coping with change, a finding that suggests an important connection between sociality and the development of cows' emotional and behavioral flexibility.[51] The calm that cows experience from the presence of friends and family members testifies to their strong social bonds and how important it is for their well-being that they live together, not apart.

Gary the calf playing in the fields of Farm Sanctuary's New York Shelter.
Photo from Farm Sanctuary

VI. PLAY

Whether it's by galloping, bucking, play-fighting, gamboling, chasing after balls, or a combination of all five, cows love to play! For most mammals (including cows),[52] birds,[53] reptiles, and fish,[54] play is serious business. That is, play represents an important indication of an animal's curiosity and ability to innovate; it also helps animals learn many of the social skills necessary for successful interactions with members of their own species.[55] Play also indicates pleasure, and researchers conducting learning experiments have

found that animals often love to be rewarded with the chance to play with friends.[56]

Although cows love to play, the conditions of their living situations often have significant impacts on whether they feel like initiating a game or bursting into a gallop. For example, being released from confinement increases the likelihood that calves will buck and gallop, two forms of movement-based play.[57] Calves housed in pairs are more likely to engage in forms of social play than calves housed by themselves.[58] Moreover, calves who are weaned early and permitted to consume smaller quantities of milk engage in running as a form of play less frequently than calves who nurse and stay with their moms for a longer duration.[59] Unsurprisingly, cows subjected to various forms of pain play less frequently.[60] Taken together, these findings suggest that better welfare conditions — including access to fellow cows, more time spent nursing as a calf, and fewer experiences of pain — increase a cow's play behavior and, by extension, help enable the range of pleasures cows can experience.

VII. SOCIAL COMPLEXITY AND LEARNING

For cows and other members of a social species, any study of individual psychology must be accompanied by a consideration of those individuals' sociality, or how they understand themselves in relationship to a group. To better understand the dynamics between individual cow and herd, researchers ask questions such as: How many different relationships with others does one cow maintain? And, how much knowledge does each individual cow have about her fellows? Cows' complex social structures, ability to learn from each other, and the bonds between mothers and their calves all show that a consideration of cows' emotional and cognitive repertoire simply cannot be accomplished without a study of their sociality.

Social Structure

Understanding the difference between your mother, sister, best friend, acquaintance, and rival — that is, understanding who others are in relation to you — requires a lot of mental processing power. When given the

opportunity, cows form a large central community and demonstrate preferences for associating with certain individuals over others, suggesting that they establish and maintain relationships. In one study, cows with similar traits such as gregariousness, a shared breed, and number of lactations tended to interact with others who showed similar traits.[61] Female cows constitute the leaders of herds,[62] and harmonious, friendly relationships keep the herd together far more than relationships that generate or require conflict.[63]

By observing her fellow cows, an individual can pick up on and learn behaviors passed down through generations of cows. This method of learning is termed “social learning,” and it forms the basis of culture.

Social Learning

As a social species, cows benefit from group living in many ways, including the opportunity to learn from each other. By observing her fellow cows, an individual can pick up on and learn behaviors passed down through generations of cows. This method of learning is termed “social learning,” and it forms the basis of culture.

In studies that examine how cows behave in different housing conditions — some that facilitate social interaction, others that restrict it — cows demonstrated the ability to learn by observing their fellow cows. For example, cows who have never grazed before learn how to do so more quickly when housed with cows who already know how to graze than they do if they are housed with cows who do not.[64] When it comes to learning social behaviors, too — the conventions of conduct essential for navigating day-to-day relationships with friends and family — cows who live with full social access to other cows engage in more social behaviors than calves housed by themselves with only limited access to others. These findings present evidence not only of cows’ social learning, but also that cows require the company of others to develop socially in a natural, healthy, species-specific way.

Mother-Calf Bonding

The strength of the bond between a mother cow and her calf cannot be overstated. When researchers investigated the individual personality differences between mother cows, they found that all mothers show a

Mother Liz and her calf Cashew are bonding.
Photo from Farm Sanctuary

Fierce motherly love is a trait widely shared among cow moms.[65]

strong sense of maternal protectiveness over their calves, suggesting that fierce motherly love is a trait widely shared among cow moms.[65] In one fascinating study, for instance, researchers watched to see how a mother cow would respond to an unfamiliar utility vehicle approaching her and her calf. An astonishing 99% of mother cows observed in the study moved between the vehicle and their calves as if to provide a physical, protective barrier for their calves.[66] Even though cow moms demonstrate an almost universal protective tendency over their calves, mother cows can also adapt their maternal strategies to meet the needs of their children. For example, mother cows provided even more protection and time nursing to their calves with low birth weights.[67]

Fundamental to a calf's social and psychological well-being is her relationship to her mother; this fact makes the separation of mother and calf that is so central to the success of the dairy industry thoroughly troubling. Indeed, both mother and child experience significant distress when separated from each other, distress that is alleviated after they reunite.[68] (But in commercial farming, the separation is lifelong.) Mother cows separated from their

calves will walk around, urinate, and vocalize continuously, signs that all point to the suffering they experience in the absence of their babies.[69] Moreover, calves raised without their mothers explored a test area less than calves who enjoyed continual access to their mothers; further, calves with access to their moms experienced less physical stress and more sociability.[70] Clearly, the relationship between mother cows and their calves requires that we take these social relationships seriously from both a scientific and welfare perspective.

VIII. PERSONALITY

Personality represents an important way we recognize an individual human or nonhuman animal as a unique, irreplaceable being. If you recognize that your pet dog relishes a romp in the mud but despises bath time, or if you know your pet cat's favorite spots to scratch and be scratched, such stable patterns of behavior, thinking, emotions, and preferences contribute to an understanding of another individual as an individual (indeed, because our pets are familiar to us, they are among the easiest animals to recognize as having distinct personalities). Many animals less familiar to us also have unique personalities: A range of fish, bird, and mammal species show personality features particular to each individual.[71]

Comparable to humans and other animals, cows have distinct personalities and individual traits.

Comparable to humans and other animals, cows have distinct personalities and individual traits. In one study, researchers subjected cows to a known source of stress: social isolation. All of the cows involved demonstrated unique, individual responses to the stress of isolation; they walked, vocalized, and defecated in ways unique to each individual cow.[72] In another study, researchers studied cows' behaviors prior to exposing them to an object they had never interacted with before. Interestingly, the researchers observed that cows who made more contact with the new object were also the cows who had previously been less likely to lie down. Cows less fearful of humans also lied down less frequently, findings that point to stable connections between cows' behaviors and interactions with an unfamiliar object.[73] These studies provide scientific backing to what people familiar

with cows already know: namely, that each cow is a distinct individual.

IX. THINKING, FEELING COWS: AN OVERVIEW OF CURRENT FINDINGS

The available scientific research indicates that cows lead rich, socially complex lives; experience a range of emotions; and rely on one another for comfort. To review, scientific studies show that cows

- show excitement and signs of pleasure when they master intellectual challenges, suggesting that cows are self-aware and have an understanding of their own actions;
- differentiate between individual humans, other cows, and animals of other species;
- possess long-term memories;
- navigate complex mazes;
- love to play with objects and one another;
- experience judgment bias, a cognitive effect on decision making analogous to what we call “pessimism” and “optimism”;
- experience emotions, exhibit emotional contagion, and show some evidence for feeling empathy;
- stay calmer and less stressed when accompanied by fellow cows even during stressful situations;
- form strongly bonded social groups, with mothers and calves sharing an especially powerful emotional connection;
- learn from each other; and
- have distinct, individual personalities.

Even though these conclusions from the scientific literature are highly suggestive, the available research only scratches the surface of cows’ cogni-

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tive, social, and emotional capabilities. To get a better understanding of these fascinating animals, more non-invasive research must consider their unique personal behaviors, tendencies, and emotional proclivities. Until then, we hope that insight into the feeling, thinking lives of cows inspires a future in which cows are not used as commodities but, rather, celebrated for who they are. We think Cincinnati Freedom and her friends would agree.

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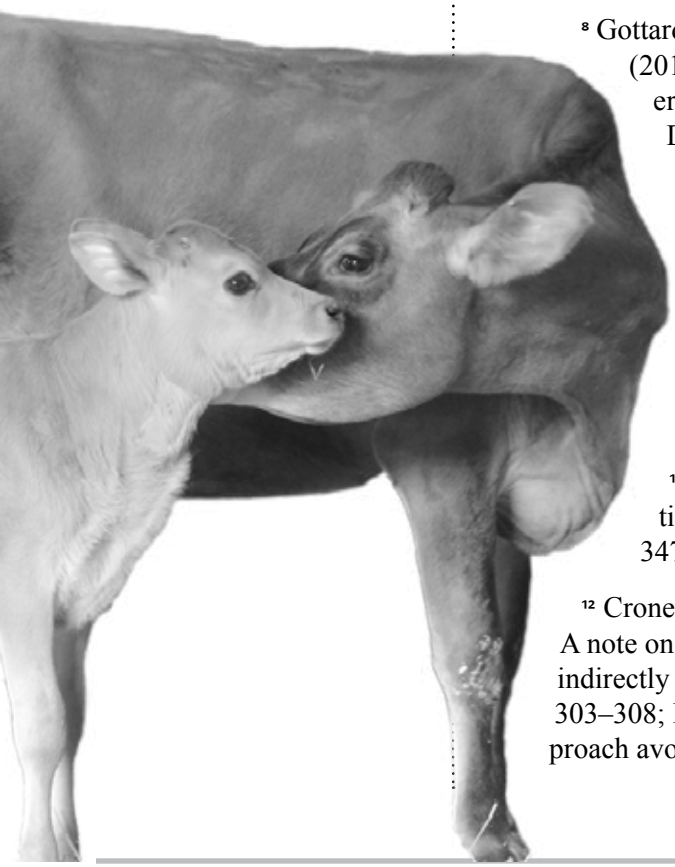

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THE SOMEONE PROJECT

The Someone Project is a joint undertaking by the Kimmela Center for Animal Advocacy and Farm Sanctuary to compile, review, and publish scientific evidence for cognitive and emotional complexity in farm animals and to support promising research in these areas.

Farm Sanctuary advocates observational and cooperatively designed studies with farm animals in a sanctuary setting to build upon existing research and to elevate awareness and respect for the magnificent beings they are.

Visit farmsanctuary.org/learn/the-someone-project/

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