Past Experience Influences the Social Behavior of Cows (Bos taurus) and Pigs (Sus scrofa) in the Sanctuary Setting

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ABSTRACT

The long-term effects of early traumatic experiences in humans and some nonhuman animals are well documented. This study explored the role of a past history on the social behavior of cows and pigs in the sanctuary setting. Subjects were cows (N=8) and pigs (N = 10) housed at the Woodstock Farm Animal Sanctuary. The researchers recorded all social behavior amongst conspecifics and categorized behavior as either affiliative or agonistic. Social behavior was compared amongst animals divided into groups according to their previous setting (beef vs. dairy cows, free range vs. intensively farmed vs. neglected pet pigs). In both species, affiliation behavior showed clear differences based on past experience. Beef cows were significantly more affiliative than cows kept for dairy. Pigs raised in free-range settings showed significantly more affiliation than pigs from intensive farms or neglected pets, with the latter two groups showing no affiliation at all. Altogether, these results show a link between past experience and later social behavior, emphasizing the potential for both of these farmed species to experience long term psychological impacts as the result of traumatic experiences in the early settings they are placed in by humans.

Animal cognition and welfare research is increasingly underscoring the psychological stresses inflicted upon farmed animals. Research is now showing that farmed animals, including cows and pigs, can suffer highly stressful and likely traumatic experiences within industrialized animal agriculture as a result of commonplace practices (Arntz, de Groot, & Kindt, 2005). The emotional, cognitive and social responses to such traumas have not been widely investigated but some studies have shown behavioral and morphological changes among farmed animals in response to routine stressors (Daros, Costa, von Keyserlingk, Hötzel & Weary, 2014). These developments create a space for investigations of the psychological ramifications our current food production systems have on the animals we raise in them.

The impacts of various farming practices are emphasized by physiological and behavioral alterations in farmed species. For example, research exploring the breaking of mother-young bonds among mammalian animals in captivity has revealed that acute stress is caused by abrupt, early, permanent, and forced weaning (Newberry & Swanson, 2008; Weary, Jasper, & Hotzel, 2008). Typically, calves in the dairy industry undergo permanent maternal separation, which frequently occurs on the day of their birth. Calves in the beef industry, while still weaned earlier and more abruptly than in nature, typically stay with their mothers until about 6 months of age. This breaking of the cow-calf bond involves documented morphological, physiological, immunological and psychological mechanisms and can cause prolonged stress in calves (Enríquez, Hötzel, & Ungerfeld, 2011; Lynch, Earley, McGee, & Doyle, 2010). The stress of abrupt and early maternal separation in calves stimuli, indicating a predisposition towards negative emotions, and a decreased ability to habituate to novel environments and cope in social situations with conspecifics (Daros, et al., 2014; Stěhulová, Lidfors, & Špinka, 2008). Piglets who have undergone early and abrupt maternal separation also displayed physiological repercussions such as increased cortisol levels and decreased gene expression in the hippocampus (a portion of the brain important for cognition, particularly the ability to learn; Poletto, Steibel, Siegford, & Zanella, 2006a; Siegford, Rucker, & Zanella, 2008). These physiological alterations are correlated with mental and behavioral abnormalities in early-weaned piglets, which include stereotypic and aggressive behaviors (Poletto, et al., 2006a, Orgeur, et al., 2001). The abnormal behaviors in animals that have experienced maternal deprivation have been likened to the behaviors of institutionalized humans (Latham & Mason, 2008).

In addition to unnaturally early maternal separation, the rearing environment of industrialized production systems tend to lack physical and social enrichment. This has also been linked to physiological and behavioral alterations in these two species. Veal calves

reared in social isolation in personal crates exhibited more agonistic behavior and lower hierarchical positions compared to those reared in a group (Veissier, Gesmier, Niendre, Gautier, & Bertrand, 1994). This suggests that social isolation may lead to decreased social competency later in life. Similarly, pigs reared in unenriched environments that did not provide them with biologically significant tasks, showed increased cortisol and inhibited hippocampal development (Siegford, et al., 2008). Poor environments, such as the farrowing crates in which pigs in industrial agriculture frequently live, have also been correlated with a bias towards pessimistic judgments, inhibition of spatial learning which can lead to increased fear responses later on, as well as increased aggression, decreased social skills, increased social stress, and difficulty mediating stress in general (De Jonge, Bookers, Schouten, & Helmond, 1996; Douglas, Bateson, Walsh, Bédué, & Edwards, 2012; Siegford, et al., 2008). Further research showed that social isolation led to the suppression of cognitively relevant gene expression in the frontal cortex of this species, implying that social isolation my compromise neurological development and function (Poletto et al., 2006a,b). Behavioral alterations in pigs have also been linked to social experience with isolation leading to a decreased ability to cope in group situations and form social stable hierarchies (Arey & Edwards, 1998; D'Eath, 2005).

Examinations of the long lasting impacts of early life stressors in farmed species are a relatively recent development. However, numerous studies have demonstrated a significant relationship between negative early life experiences and later social deficits within our own species, establishing that frequently children who were rejected by their mothers, neglected, or abused are generally more likely to display aggression and less likely to exhibit positive social behaviors than children with non-traumatic backgrounds (George & Main, 1979; Hoffman-Plotkin & Twentyman, 1984; Reidy, 1977). Overall studies have documented that child victims of violence displayed less empathy later in life, more negative social tendencies,

and were more likely to act violently themselves, indicating emotion dysregulation as a result of abuse and underscoring the connection between adverse early experience and the inability to relate to others in a socially positive way later in life (Schwartz & Proctor, 2000; Shakoor & Chalmers, 1991; Song, Singer & Anglin, 1998; Straker & Jacobson,1981). It has been found that chronic abuse or neglect impacts neurological development on a variety of levels including altering the hypothalamic-pituitary-adrenal axis and causing the underdevelopment of certain portions of the brain, and ultimately reduced brain volume (Teicher, Anderson, Polcari, Anderson, Navalta & Kim, 2003, Glaser, 2000) These early stresses thus interfere with brain development on a neurohormonal and structural level. Their long-lasting ramifications are also potentially explained by the fact that stress hormones such as adrenaline and cortisol sharpen attention to detail and enhance encoding of emotional memories (Arntz, de Groot, & Kindt, 2005; Cahill & McGaugh, 1996; Paul, Harding, & Mendl, 2005; Marin, Pilgrim & Lupien, 2010).

The long-term psychological trauma have additionally been explored in certain other species outside of our own. In bonobos, for example, early life trauma is also related to later psychological and social deficits, such as the inability to express empathy (Clay & de Waal, 2013). Further, a study of chimpanzees who had endured previous human-induced trauma including isolation, maternal separation, and biomedical experimentation, showed that their abnormal behaviors could be clustered into and satisfy the criteria currently used to diagnose Post Traumatic Stress Disorder (Ferdowsian et al., 2011). Research continues to suggest that nonhuman animals do not lively purely in the present moment but are psychologically shaped by their past. This, combined with the fact that stress alters neurobiology on a sustained level and strengthens memory formation, suggests that nonhuman species involved in industrialized agriculture, may be particularly likely to display altered social behaviors which reflect traumatic pasts (Mendl & Paul 2008).

In the current study, we examined long-term influences of past experience on social behavior in two species of industrially farmed animals currently housed in a sanctuary setting. This setting provides a unique opportunity to examine the behavior of farm animals that have previously experienced a wide range of agricultural settings, and look at whether specific practices predict later social deficiencies. We predicted that past experiences typical of some agricultural settings would be associated with social deficits such as decreased affiliation or increased agonistic behavior. Specifically, we predicted that individuals who experienced premature weaning, limited movement, and poor physical environments would show greater deficits than those who had not experienced those situations.

Methods

Participants

Participants in this study were the cows (N = 8) and pigs (N = 10) living at Woodstock Farm Animal Sanctuary in Willow NY. A personal history of each individual was obtained from the sanctuary. Prior to arrival at the sanctuary, cows came from a variety of intensive farm settings: 5 were dairy cows, including former veal calves, and three were beef cows. Three of the pigs came from intensive farming, three were neglected pets, and four were from free-range farms. We used these histories to group the individuals by prior setting for analysis. All of the individuals studied were different ages and had been living at the sanctuary for varying amounts of time. See Table 1 for a description of each individual's personal history.

Table 1.

Name (Sex)	Age (years)	Breed	Past Setting	Time at Sanctuary (months)
Cows				
Andy (M)	11	Holstein	Dairy	113

Dillon (M)	8	Holstein	Dairy	102
Elvis (M)	11	Holstein	Dairy	113
Junior (M)	3	Angus Mix	Beef	22
Kayli (F)	4	Charolais	Beef	31
Maribeth (F)	1	Jersey	Dairy	8
Maybelle (F)	8	Shorthorn	Beef	25
Ralphie (M)	11	Holstein	Dairy	113
Pigs				
Andy (M)	7	Yorkshire	Free- Range Farm	68
Antonio (M)	2	Yorkshire	Free- Range Farm	19
Bertha (F)	2	Yorkshire	Free- Range Farm	19
Curly (F)	3	Duroc	Free- Range Farm	28
Judy (F)	7	Yorkshire	Neglected Pet	81
Little Dude (M)	4	Yorkshire	Neglected pet	42
Missy Pig (F)	6	Yorkshire	Intensive Farm	47
Olive (F)	4	Yorkshire	Intensive Farm	28
Patsy (F)	7	Yorkshire	Neglected Pet	81
Stanley (M)	4	Yorkshire	Intensive farm	40

Procedures

We conducted focal animal samples on individual cows and pigs for three one-hour sessions on three different days when no visitors or tour groups were present at the sanctuary, and for two 30-minute periods on Saturdays and Sundays when the sanctuary was open to the public. Thus, we observed each individual on five different occasions. The order in which we observed individuals was determined randomly; we observed all individuals once prior to

repeating any individuals. All observations were taken between the months of January and July of 2014 and observations took place at various times between 1100h and 1900h. Since social behavior may vary by time of day, care was taken that each individual was observed at least once mid-day (1100-1300h), once in the afternoon (1300-1500h), and once in the late afternoon/early evening (1500h-1700h). The time, temperature, weather condition and location of the individual were recorded at the beginning of each observation. At times, due to weather conditions or unexpected husbandry needs at the sanctuary, individual observation sessions may have been cut short; the remainder of the session was completed at another time. All observations were done by one observer (L.S.) for internal consistency.

During each focal sample, we recorded all instances of social behavior with conspecifics including the initiator, recipient and what type of behavior. Affiliative behavior included social licking, gentle contact, contact standing, sitting or sleeping, and social play, with similar behaviors across both cows and pigs. Agonistic behavior included biting, moving another, and chasing in both cows and pigs, as well as head butting in cows only. See Table 2 for a complete ethogram. The ethogram was based on validated behavioral measures from the Welfare Quality Reports Series (Forkman & Keeling, 2009a,b). All social behaviors were converted into a rate per hour for analysis.

Table 2.

PIGS	
AGNOSTIC BEHAVIOR	
BITING	Initiator opens mouth and sinks teeth into the skin of the recipient
MOVE OTHER	Initiator pushed firmly on the flank of the recipient, resulting in the recipient moving
CHASE	Initiator pursues recipient at high speed (accompanied by jerky head movements)
FIGHT	Firm contact from the initiator to recipient, must be accompanied by intense vocalization from either individual

SUBMISS	Recipient flees or moves away from initiator of agnostic behavior
UNK AG	Movement of initiator causes startle response in recipient; interaction does not include any of the behaviors listed above
SOCIAL BEHAVIOR	
LICK	Initiator licks recipient
NOSING	Initiator's nose makes gentle contact with another individual, does not elicit a startle, agonistic or submissive response, often accompanied by positive vocalizations from either individual
GENTLE MOVE	Initiator gently moves a part another, does not elicit a startle, agonistic or submissive response from other individual, often accompanied by positive vocalizations from either individual. Recipient does not move away from contact.
REUNION	Running towards one another, being in physical contact, nosing or gently moving another, positive vocalizations after brief separation
CONT STAND	Standing in contact with recipient
CONT SIT	Sitting in contact with recipient
CONT SLEEP	Sleeping in contact with recipient
PLAY SOC	Two individuals engaging in mutual gentle contact of the snout, head or shoulder. Characterized by frequent turn taking and non-aggressive responses.
SNIFF	Approaching another with interest, sniffing without the nose making physical contact
COWS	
AGONISTIC BEHAVIOR	
HB NODISP	Initiator butts, hits, or strikes the recipient with the forehead using a forceful movement. The recipient does not move (no displacement).
HB DISP	Initiator butts, hits, or strikes the recipient with the forehead using a forceful movement. The recipient moves away from the initiator (displacement)
CHASE	Initiator pursues recipient at high speed (accompanied by jerky head movements). Only score if both individuals were already standing.
FIGHT	Both individuals put their heads together and exerting force against each other.
CHASE-UP	The initiator uses forceful physical contact, which makes the receiver rise from a lying position.
UNK AG	Movement of initiator causes startle response in recipient; interaction does not include any of the behaviors listed above.
SOCIAL BEHAVIOR	

LICK SPONT	Initiator licks recipient, without overt initiation from the recipient (spontaneous licking)
LICK SOL	Initiator licks recipient following clear solicitation (see next definition of solicitation)
SOL LICK FROM	One individual approaches another individual in a submissive posture of head and neck. May gently touch the other cows mouth with neck.
GENT CONT TO	Non-aggressive contact with another individual indicated by a non-startle, non-aggressive response on the part of the recipient. Also indicated by sustained contact or positive vocalizations.
GENT CONT FROM	Non-aggressive contact from another individual indicated by a non-startle, non-aggressive response on part of the focal individual. Also indicated by sustained contact or positive vocalizations
CONT STAND	Standing in contact with recipient
CONT SIT	Sitting in contact with recipient
CONT SLEEP	Sleeping in contact with recipient
PLAY SOC	Two individuals jumping, kicking, running. Characterized by frequent turn taking and non-aggressive contact.

Table 2. Ethogram of affiliative and agnostic behaviors used in this study. Behaviors for both species were adapted from the Cardiff Welfare Quality Reports (pigs: Forkman &Keeling (eds.), 2009a; cows: Forkman & Keeling (eds.), 2009b).

Analysis

Due to the small sample sizes, non-parametric tests were used in this study. To help determine whether past experience influenced rates of social behavior, we divided the cows into two categories: those raised for beef (N = 3, 1 male) or those raised for dairy (N = 5, 4 males). We used a non-parametric Mann-Whitney test to compare these two groups on agonistic behavior and affiliation. Because the sex ratio was not equal across groups, we ran a follow-up Mann-Whitney test with sex as the grouping factor for significant findings. Pigs were divided into three categories: those raised on free-range farms (including a “heritage” farm; N = 4, 2 males), those raised on intensive farms (N = 3, 1 male), and those that were rescued as neglected pets (N = 3, 1 male). A Kruskal-Wallis test was used to compare social behavior across these three groups. All analyses were run using IBM Statistics version 22.

Results

Cows

Agonistic behavior was rarely observed, averaging 1.08 acts per hour across all sessions for all cows. Cows reared in two different settings, beef and dairy farms, were compared. There was no significant difference in the rates of agonistic behavior for beef and dairy cows (Mann-Whitney U = 8, p = 1.000; Figure 1).

Figure 1.

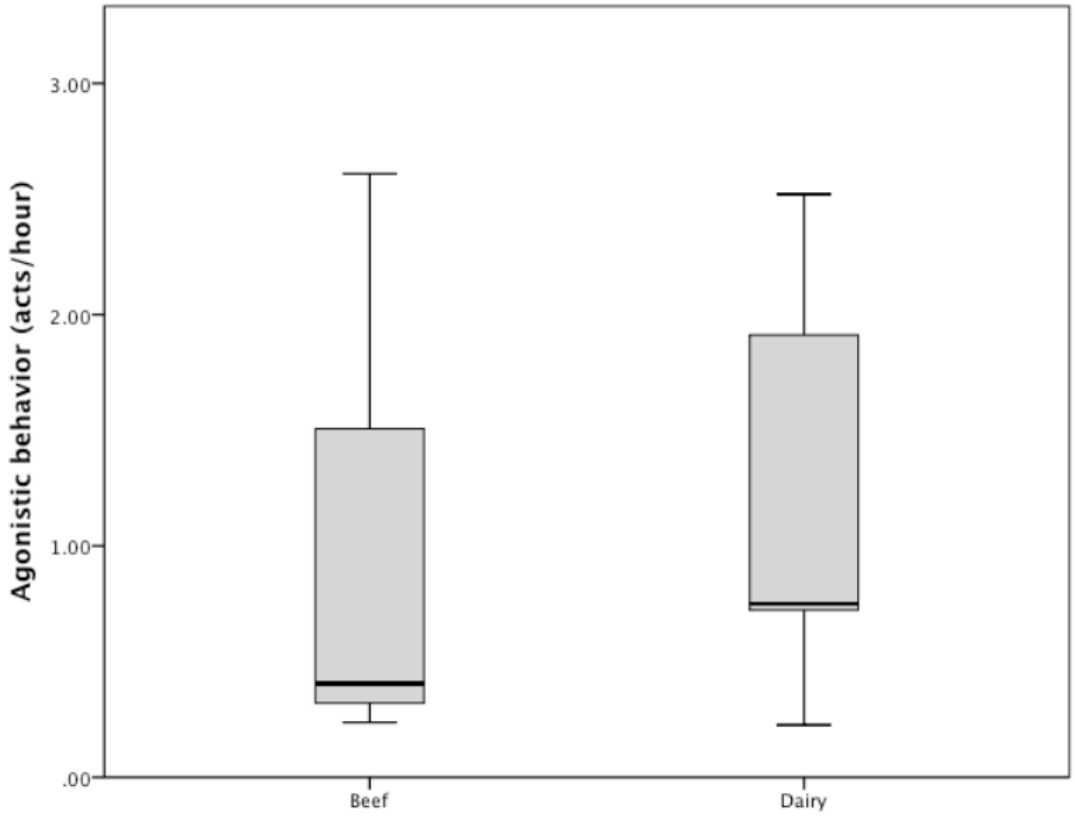

Figure 1. Agonistic behavior of beef and dairy cows. There was no significant difference in the rate of agonistic behavior of beef and dairy cows in this study. The box-and-whisker plot shows the median (dark line), upper and lower quartile (grey box), and range (error bars) of the data.

Affiliation occurred approximately twice as often as agonistic behavior, averaging around 2.02 acts per hour. Cows raised for beef showed significantly more affiliation than dairy cows (Mann-Whitney U = 0.000, p = 0.036; Figure 2). The test statistic of zero indicates that all of the members of one group (beef) were ranked higher than all of the

members of the other group (dairy). Since there was an uneven sex ratio with 4 out of 5 dairy cows, but only 1 out of 3 beef cows being male, we ran a follow up to rule out sex as a confounding factor. There was no significant difference in affiliation between the sexes, although there was a trend (Mann-Whitney U = 14.000, p = 0.071).

Figure 2

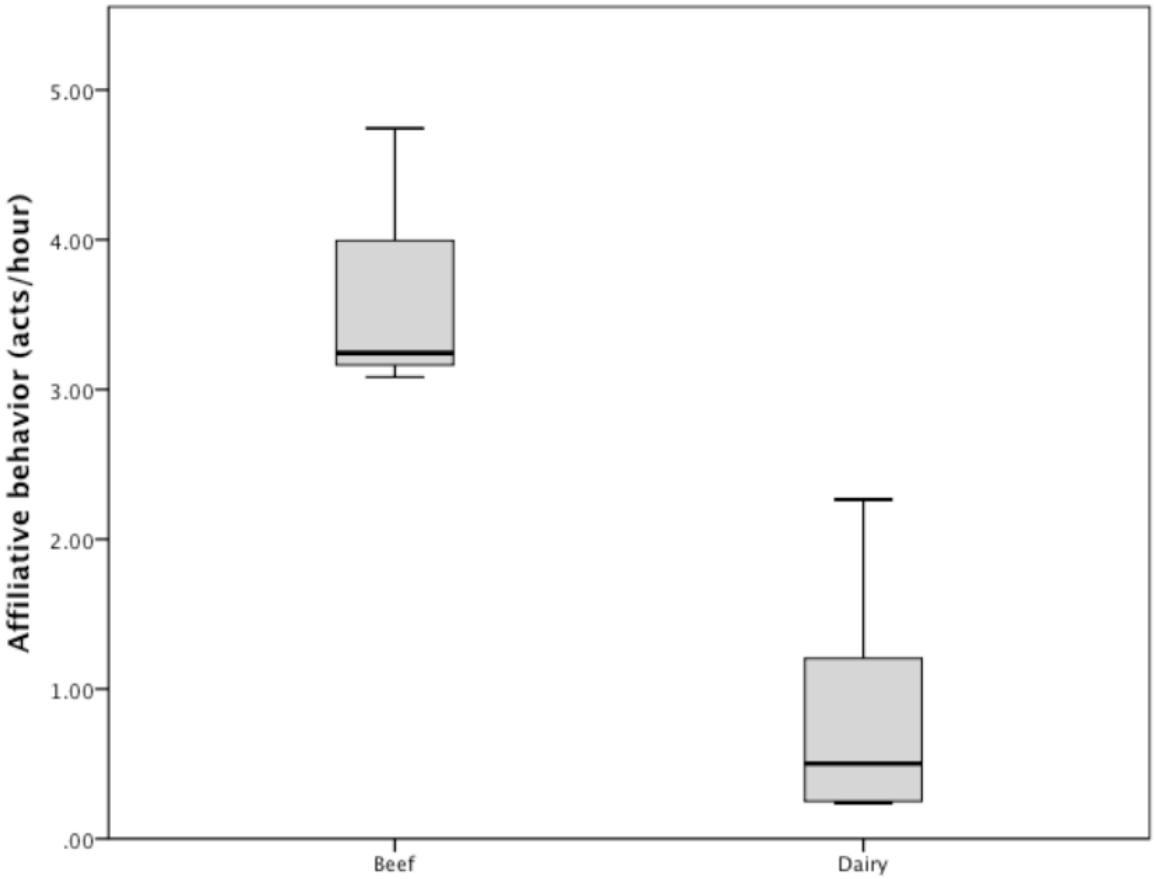

Figure 2. Affiliative behavior of beef and dairy cows. Beef cows showed significantly more affiliation than dairy cows. The box-and-whisker plot shows the median (dark line), upper and lower quartile (grey box), and range (error bars) of the data. * indicates $p < 0.05$.

Pigs

Agonistic behavior occurred at a slightly higher rate in pigs as compared to cows, 2.77 acts per hour, although the overall rate was still low. Three different rearing settings were compared: intensive farms, free-range farms, and neglected pets. There was no

significant difference in the rate of agonistic behavior among pigs raised in these settings (Kruskal-Wallis H(2) = 2.664, p = 0.264; Figure 3).

Figure 3

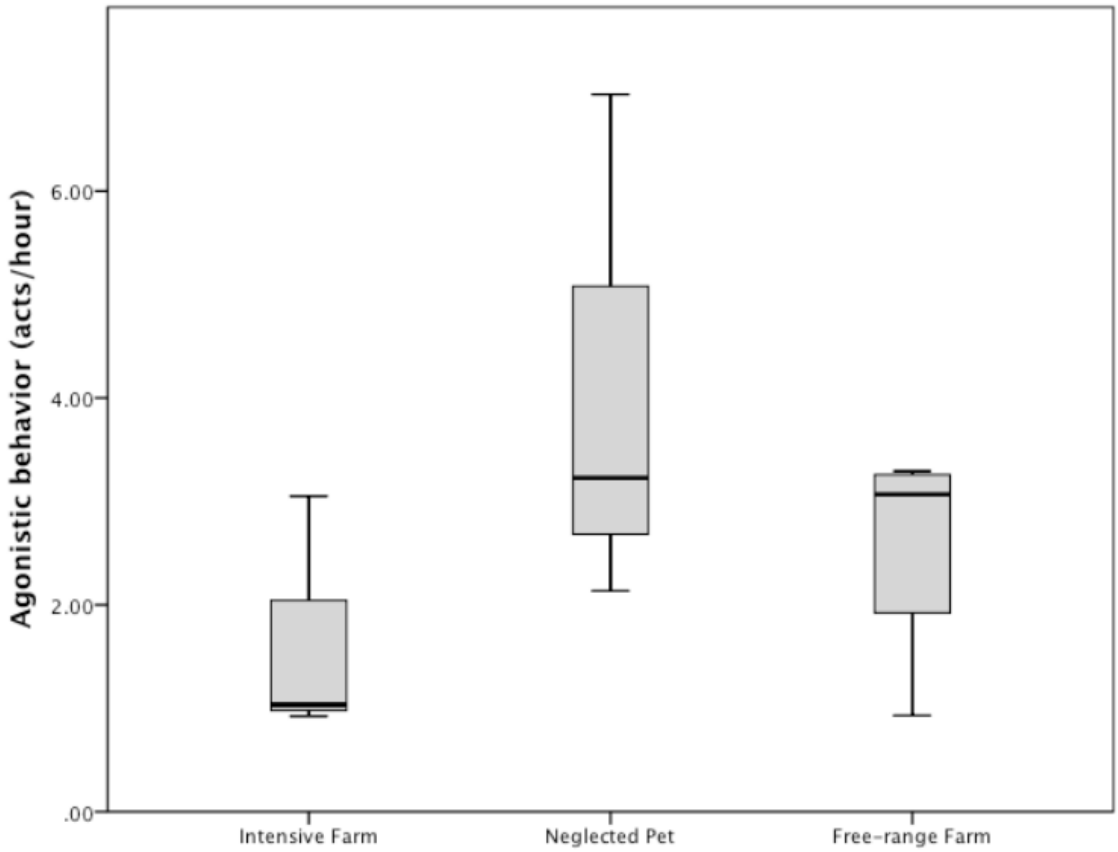

Figure 3. Agonistic behavior of pigs from different settings. There was no significant difference in the rate of agonistic behavior of pigs from the different settings in this study. The box-and-whisker plot shows the median (dark line), upper and lower quartile (grey box), and range (error bars) of the data.

The pigs rarely showed affiliation at all, averaging only 0.74 acts per hour. There was a significant difference between the three rearing settings (H(2) = 8.308, p = 0.016; Figure 4). All of the pigs who were raised in free-range housing showed affiliative behavior, whereas none of the pigs in the other two settings showed any affiliation.

Figure 4

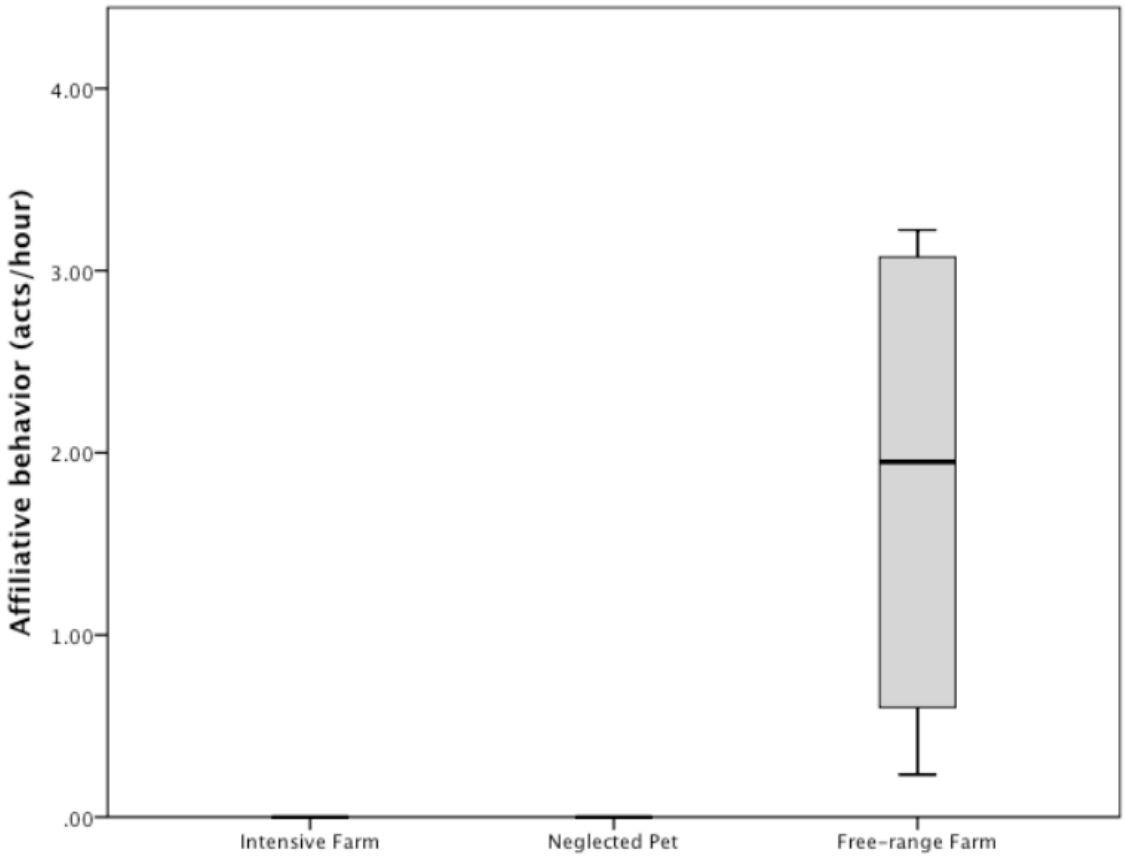

Figure 4. Affiliative behavior of pigs from different settings. Pigs from free-range farms were significantly more affiliative than pigs from intensive farms or neglected pets. The box-and-whisker plot shows the median (dark line), upper and lower quartile (grey box), and range (error bars) of the data. * indicates $p < 0.05$.

Discussion

For both the cows and pigs in this study, their previous housing settings and the traumatic early life experiences they indicate, were predictive of later social behavior. The results of the analyses show that although there was no significant difference in agonistic behavior between groups, for both species there were significant differences in affiliation between groups. Affiliation among social animals such as cows and pigs can be viewed as an important aspect of positive welfare (Yeates & Main, 2008). Deficits in affiliation may reflect long-term effects of earlier traumatic experiences.

Cows from the beef industry showed significantly higher levels of affiliation than dairy cows. It is possible that this difference could emerge as a byproduct of breed differences between the two groups. With three different breeds of dairy cows and two different breeds of beef cow, it is difficult to determine from the current sample what genetic basis these behaviors might have. A future study with a larger, more homogenous population would shed light on these differences. The trend for a sex differences in affiliation means that it is also possible that males are simply less affiliative than females. However, this test failed to reach significance and thus could not explain the variation in the data as well as the industry the animals came from. In further support of the idea that the difference in affiliation between beef and dairy cows is not merely a sex difference, all of the beef cows showed more affiliation than any of the dairy cows regardless of sex. Thus, the male beef cow showed higher levels of affiliation than the female dairy cow. Finally, research from groups of feral cows shows that in nature the males do form affiliative relationships with each other, either in mixed sex groups or small bachelor herds (Bouissou, Boissy, Le Neindre, & Veissier, 2001), suggesting that any difference observed may be a byproduct of the industry they were reared in.

An alternative explanation is that a number of common practices in dairy farming may lead to future social deficits. Most notably, the dairy cows in our sample were separated from their mothers within a week after birth, well prior to a natural weaning time, a common practice in the dairy industry (Hudson & Mullord, 1977). There is considerable evidence that this practice causes distress and can lead to the development of abnormal behavior later in life (Latham & Mason, 2008; Newberry & Swanson, 2008; Stehulová et al., 2008; Weary et al., 2008). Furthermore, three out of four males in our dairy cow sample were rescued as veal calves. Thus, they spent a large portion of their early lives socially isolated and tied up in a veal crate. Social isolation is well known to cause lower social competency if the cows are

integrated into groups later on (Veissier et al., 1994). Given that orphan apes show empathy deficits when older, early experiences with the mother may be important for developing prosocial behavior later in life (Clay & de Waal, 2013).

The only pigs that showed any affiliation at all were those raised in free-range environments. Two groups of pigs, those raised on intensive farms and those who came from cases of neglected pets, did not show any affiliative behavior at all. As all of the pigs except one were of the Yorkshire breed and the sexes were relatively equally distributed across groups, breed or sex are unlikely to account for these differences. Rather, this result highlights the importance of early social experience. Free-range pigs likely had much greater social and environmental enrichment early in life. While much work has shown that limited social experience in pigs leads to increased aggression and destabilized social hierarchies (D'Eath, 2005; De Jonge et al., 1996), we did not find that to be the case. This is potentially due to the sanctuary setting, in which the animals have a free choice of where to go (e.g., in the barn, pasture, etc.) and plenty of space, there may be less of a need for agonistic behavior than in a more confined area (Arey & Edwards, 1998). In our study we found that pigs with limited early social experience exhibited no affiliation. A lack of affiliative behavior may reflect the decreased social competency seen in individuals with a lack of social experience (De Jonge et al., 1996). This result expands upon the current literature, which primarily explores regulation of aggression and formation of a stable dominance hierarchy as signs of social competency. While these are undoubtedly important aspects and dysfunction in these areas can lead to calves. Thus, they spent a large portion of their early lives socially isolated and tied up in a veal crate. Social isolation is well known to cause lower social competency if the cows are integrated into groups later on (Veissier et al., 1994). Given that orphan apes show empathy deficits when older, early experiences with the mother may be important for developing prosocial behavior later in life (Clay & de Waal, 2013).

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Altogether, the results of this study clearly demonstrate long-term influences of earlier experience on the social behavior of sanctuary housed farm animals. The variety of factors that had explanatory power suggests that there are a number of early experiences, these species have when intersecting with our own, that can negatively impact later social behavior. Across both species, a link appeared between animals from settings that

compromise early social experience and lower affiliative behavior later in life. As is typical of many animal sanctuaries, our subjects arrived at the sanctuary resulting from diverse circumstances. Furthermore, our sample size was quite small. A larger, more homogenous population might help elucidate causal relationships between particular traumatic events and later behavior. The dissociation between earlier findings on agonistic behavior and our findings on affiliation suggests that, while there is a common association between traumatic early experience and later social deficits, the exact mechanism behind each type of deficit may be slightly different or may be influenced by a constellation of factors.

The presence of long-term effects opens the door to an examination of how these early experiences may be influencing later behavior. There are two possible, non-mutually exclusive mechanisms that might result in early experiences leading to later social deficits. First, early associations and long-term memory may be playing in these situations. Research in both human and nonhuman subjects, has shown that adrenal stress hormones such as epinephrine and glucocorticoids modulate memory formation and long-term memory consolidation across species, making it likely that a diversity of species similarly store memories in instances of intense stress or trauma (McGaugh & Roozendaal, 2002). Studies are increasingly demonstrating that stress hormones and the action of the amygdala facilitate priority storage of emotionally significant memories across species as well (Mendl, Burman, Laughlin & Paul, 2001). Memory formation and storage in other species is a particularly interesting in terms of long term psychological trauma. This study will hopefully motivate work that may potentially confirm the ability of both of these industrially farmed species to experience Post Traumatic Stress Disorder, as was documented in the above mentioned study of chimpanzees (Ferdowsian et al., 2011). While we were able to explore and document elements of certain criterion for PTSD such as negative alterations in cognitions and moods (as displayed through diminished interest in positive social activities) and alterations in

reactivity (as displayed through irritable and aggressive behaviors) in rescued animals who had experienced trauma, the documentation of other criteria was not possible. Currently, many members of these species experience years of what has been classified as trauma within our system of industrial agriculture (Arntz et al., 2005). In light of this, there should be opportunities for research to determine how many of these animals, living amongst their triggers (e.g. certain machinery, noises or even individual humans who many have personally abused them) are now exhibiting behaviors which satisfy all the criterion for what is diagnosed as PTSD among humans.

Second, early deficits in welfare have been liked to permanent changes in the brain in rodents, nonhuman primates, and humans (Sanchez, et al., 2001; Sapolsky, 1996, 1999). In mammals, the excess glucocorticoids experienced under chronic stress have profound effects on the nervous system including disruption of learning and memory, decreased synaptic plasticity and if extreme, neuron cell death (reviewed by Sapolsky, 1999). More specifically, early deprivation, including maternal and other social deprivation is associated with inhibited neurogenesis (Sanchez et al., 2001; Kempermann, 1997). In pigs, early social isolation resulted in suppressed gene expression in the prefrontal cortex, an area of the brain important for cognition and organization of behavior (Poletto et al., 2006b). Neural changes are also associated with the development of stereotypies and other abnormal behaviors and persist even after the individual's environment is changed to alleviate the problem (Garner & Mason, 2002; Mason, 1991). The nature of these changes suggests that even improving the quality of life of an individual by moving them to the sanctuary setting does not completely alleviate the negative neurological effects of prior living in an environment with poor welfare, which may jointly explain their long-lasting impacts.

Finally, the results of this study underscore the individual sentience of animals involved in agribusiness and provide evidence of long-term welfare issues related to some of

our most routine interactions with farm animals. These findings indicate that these two species in agriculture do not live purely in the present moment, nor do they exist on a purely physical plane. Instead, their trauma seems to be influential on a sustained psychological level, with exposure to negative early life experiences shaping later behavior. As with traumatized human children, the damage lingers long after the instance of fear or pain is over.

The capacity to be altered by trauma in a way that mirrors alterations in children of our own species is of particular ethical significance as, on a cultural level, we intersect with pigs and cows as though they are simple physical commodities rather than cognitive beings. These animals are reacting similarly to humans who have also endured things such as maternal separation and neglect, and we are implementing their traumas on an industrial scale. The results of this study evidence the long-term impacts of the experiences cows and pigs endure in some of the most standard practices of our food system. Morally, we may have to look more critically at the cognitive experience of trauma as it occurs outside of our species, but by our hands, in farmed animals. As more evidence of this nature is produced, we may also have to reevaluate the ethical implications of a food system that routinely produces individuals with traumatized psyches as indicated by social deficits.

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