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# About Pigs

Pigs are highly intelligent, social animals, displaying elaborate maternal, communicative, and affiliative behavior. Wild and feral pigs inhabit wide tracts of the southern and mid-western United States, where they thrive in a variety of habitats. They form matriarchal social groups, sleep in communal nests, and maintain close family bonds into adulthood. Science has helped shed light on the depths of the remarkable cognitive abilities of pigs, and fosters a greater appreciation for these often maligned and misunderstood animals.

## Background

Pigs—also called swine or hogs—belong to the Suidae family[1] and along with cattle, sheep, goats, camels, deer, giraffes, and hippopotamuses, are part of the order Artiodactyla, or even-toed ungulates.[2] Domesticated pigs are descendants of the wild boar (*Sus scrofa*),[3,4] which originally ranged through North Africa, Asia and Europe.[5] Pigs were first domesticated approximately 9,000 years ago.[6] The wild boar became extinct in Britain in the 17th century as a result of hunting and habitat destruction, but they have since been reintroduced.[7,8] Feral pigs (domesticated animals who have returned to a wild state) are now found worldwide in temperate and tropical regions such as Australia, New Zealand, and Indonesia and on island nations,[9] such as Hawaii.[10]

True wild pigs are not native to the New World.[11] When Christopher Columbus landed in Cuba in 1493, he brought the first domestic pigs—pigs who subsequently spread throughout the Spanish West Indies (Caribbean).[12] In 1539, Spanish explorers brought pigs to the mainland when they settled in Florida. Throughout the 17th and 18th centuries, the colonists brought more pigs to America, and they were often raised as free-roaming animals.[13] These free-range and escaped pigs spread throughout the region that is now the southeastern United States.[14,15] During the 20th century, wild boar kept for hunting purposes were transferred west from the Eastern United States, where they interbred with existing populations of feral pigs.[16] They are now found throughout many southern states including Florida, Texas, and California.[17,18,19] Wild pigs have steadily expanded northward, mainly within the Midwest, and are now found in 39 states.[20,21]

## Habitat

Feral pigs and wild boar live in a wide range of habitats including forests, marsh land, scrub brush around watering holes, swamp, and grassland, especially in or near dense cover.[22] They alternate between wooded and open ground,[23] and mostly inhabit areas where the limited ground frost abets their diet of roots and tubers.[24] Heavy snowfalls and freezing temperatures limit the range area of wild boar[25,26] but, they are otherwise able to adapt to a variety of habitats.[27,28] The interbreeding with Eurasian wild boars, who are more rugged and more cold hardy than the domestic pig, may have helped wild pigs move into northern, less temperate regions.[29]

Home range sizes vary widely, from less than 100 ha (0.39 $mi^2$) to over 2,500 ha (9.65 $mi^2$),[30] depending on food availability and water sources, as well as other factors including their age and gender, and the degree of local human encroachment.[31,32] Pigs and wild boar may travel as much as 15 km (9.3 miles) in a single night.[33] Males are more nomadic, with larger home ranges compared to relatively sedentary female groups.[34]

## Diet

Pigs are omnivores. Although they subsist primarily on plant matter,[35, 36] pigs also supplement their diets with occasional small vertebrate and invertebrate animals, such as earthworms, insects, amphibians, reptiles, and rodents. They may also consume carrion when they find it.[37,38,39] Food choices depend on the seasonal availability of edible plant foods in their home ranges,[40,41] and often include berries, roots, tubers, grass, seeds, mushrooms, herbs, and foliage. Acorns may also be an important part of the pig's diet.[42,43,44] In fact, in medieval Britain, domestic pigs were allowed to forage in the forests for acorns, beach mast, and apples every September, a practice known as Pannage. Although it is no longer common, a few farmers in the New Forest of England keep up this traditional land management technique, clearing the ground of acorns, which are poisonous to the resident ponies and cattle.[45]

## Sensory Abilities

Pigs have an acute sense of smell. Their sensitivity to olfactory cues is as good as that of dog's, and pigs use scent to discriminate between familiar and unfamiliar pigs, to identify other specific individuals,[46] and to help them navigate and find hidden food items.[47] Pigs can detect and root out food that is underground[48]—a unique skill that has been exploited since the ancient Babylonian period to find truffles, a subterranean fungus that grows around the roots of broad-leafed trees and is highly prized by gourmet chefs.[49] In an impressive example of co-adaptation, truffles developed the capacity to produce a chemical copy of the active boar testosterone found in saliva. The sow, upon finding the scent, uses her snout to dig out the truffle, thus disseminating its fungal spores and enjoying a treat for her efforts.[50]

Pigs are known to have good hearing capacity,[51] and relatively good vision, but these sensory abilities differ from that of humans. While pigs cannot hear faint sounds as well as people do, they are better able to detect ultrasound, up to approximately 40 to 45kHz. They cannot see as accurately as humans, but have a wider field of vision.[52,53] In laboratory experiments, pigs can use their sense of smell and hearing to discriminate between littermates, even when they can't see them.[54]

## Natural Behavior

Although selective breeding by the pig industry has altered the appearance and physiology of domestic pigs, comparative studies show that their behavioral characteristics are fundamentally the same as those of the wild boar.[55,56] For example, the maternal behavior of domestic sows (female pigs), such as nest building, is seemingly innate and has not changed much despite domestication and artificial selection for such production-related traits important to the pig industry as efficient feed conversion or greater litter size.[57] David Wood-Gush and Alex Stolba, scientists at the University of Edinburgh in Scotland, observed domestic pigs in a semi-natural enclosure over several years and concluded that the social behaviour of the domestic pig still closely resembles that of the European wild boar, *Sus scrofa*.[58,59]

A major factor controlling the time budget of wild pigs is the search for food. When food is abundant, pigs spend less time foraging and more time resting, while in less favorable conditions, the time budget changes to accommodate more time traveling and feeding.[60]

The nasal disc on a pig's snout, while rigid enough to be used for digging, has numerous sensory receptors.[61] Pigs use their snout while exploring and searching for food items, to push objects, to flatten them, for scooping and for leveraging out thick roots.[62,63] Under natural conditions, pigs may spend 75% of their daily activity

engaged in rooting and foraging.[64,65] In contrast, farmed pigs in confinement systems are fed a concentrated diet that can be consumed in as little as 15 minutes per day.[66]

In cold weather, pigs may reduce their foraging activity to conserve energy[67] and be more active during the day, resting during the chillier parts of the night.[68,69] In areas with human disturbance or hunting pressure, they readily adopt more nocturnal patterns as well.[70]

Pigs sleep in communal nests, maintained by adding fresh bedding materials such as branches and grass.[71,72] Members of a group may greet one another with grunting noises and snout contact when they arrive together at the nest site, and segregate the duties of bringing in additional nest materials or arranging them in the nest. Nests are usually situated under the partial cover of branches or bushes, in areas such as ridges where they provide both shelter and an open view. [73]

Pigs use behavior to thermoregulate, or control their body temperature. They have very few sweat glands, and so wallow in water or mud to stay cool and prevent heat stress, and huddle together in their nests to stay warm.[74,75]

Pigs are naturally very hygienic animals and designate discrete sites for defecating and urinating away from their sleeping and feeding areas.[76,77,78] They are usually very clean unless kept in confined conditions were they are unable to choose a separate dunging area.[79] Even piglets as young as five days old will leave their nest to defecate and urinate.[80] Pigs do not usually groom each other,[81] or themselves. Rather, they keep their skin clean by rubbing on hard surfaces,[82] particularly after wallowing, when they may rub off the dried mud on rocks or bushes.[83] Pigs are also natural swimmers.[84]

Domesticated sows reach puberty at 5-8 months of age,[85] and European wild boars typically begin breeding when they are 18-20 months old.[86] For wild boars, breeding is seasonal, in late autumn[87] or early winter.[88] Females in estrus are attracted to boars, who make a 'chant de coeur' (heart song) vocalization[89] and release chemicals in their saliva and urine called pheromones that attract females.[90] Piglets are born in late winter or early spring. Occasionally, a second litter will be born in August or September.[91, 92]

## Social Habits

Highly social animals, pigs live in small, matriarchal groups, known as sounders,[93] usually comprised of 1-6 sows and their young.[94] Several generations of offspring may be present in one sounder. The structure of the group may change as young males leave,[95,96] as females farrow (give birth) and return with new litters, as sub-adults disperse, or with the arrival of adult males during the breeding season or in conjunction with an abundant food source.[97] Sub-adults may establish home ranges next to or within that of their mother,[98] forming loose associations with up to 30 members.[99] Feral and wild pigs are not territorial, and their home ranges often overlap.[100] In one study, large herds of nearly 100 animals were observed when several family groups converged on irrigated pastures in California.[101] The size of the core group may be limited by the availability of food.[102]

Juvenile males usually stay with their family groups until the dominant males in the area force the younger males to leave, at around 7-18 months of age, when the sows come into estrus.[103] They may form groups of their own, consisting of one to three animals; however adult males are usually solitary.[104] Males show aggression during the breeding season as they compete for females, but otherwise tolerate the presence of other males. [105]

Pigs belong to relatively stable social hierarchies, which play an important role in maintaining group harmony. Whereas unfamiliar pigs who are intensively confined and crowded in industrial operations will engage in aggressive, agonistic behavior,[106] in the wild, pigs are naturally gregarious animals and group members maintain close contact, often synchronizing their behavior.[107,108] The dominance order is maintained by subordinate animals who simply avoid provoking aggressive interactions.[109] Social recognition, or the ability to identify familiar individuals, is a key to forming these stable relationships.[110]

Within a sounder, two sows may become foraging and sleeping partners,[111] and siblings often maintain social ties into adulthood.[112]

## Communication

Pigs communicate with olfactory, visual, and acoustic signals.[113] Pigs can use odor from urine and facial glands to help them identify other pigs,[114,115] and even pigs who are experimentally blindfolded are able to recognize other individuals in their group, indicating the strength of their other senses.[116] Pigs also communicate by scent-marking prominent features in their home ranges.[117] Stressed pigs communicate danger by releasing alarm substances in their urine, a warning signal that other pigs detect by smell.[118]

Visual signals also communicate information about the state of a pig. Tail and ear movements indicate the emotional state of a pig,[119] and wild boar use signals such as bristle rising, ear position, and back arching to indicate their mood.[120] The tail, especially a piglet's tail, conveys important information about his state. The tail is usually curled, which is a sign of general well-being, but is straight when the pig is distressed, dozing, or sleeping. The tail is elevated and curled during greeting and courting,[121] although a curled tail may simply be the default position.[122] To avoid tail-biting—an abnormal behavior that develops in intensive farming situations—the tails of young pigs are often cut off by producers.[123,124,125]

Pigs display a rich variety of vocal signals with up to 20 different known types of vocalizations including those used during feeding and social behavior and to communicate danger.[126,127] Each vocalization can be further modified in frequency and amplitude, for example, to convey information about the sender such as their size, location, motivation and emotional state.[128] Staccato greeting grunts are given when two pigs are reunited,[129] and pigs give a short, strong alarm vocalization when threatened.[130] They also have a "bark" given during play.[131] If piglets are experimentally removed from the sow's vicinity, they call for their mother, and the quality of the call—its duration and frequency—reliably signal the piglet's state of need, with hungry and weak piglets calling longer and at a higher frequency.[132] When piglets scream, their mother will respond, and when adults scream, group members may arrive to assist.[133]

## Mothering and Piglet Development

In the wild, pregnant sows separate themselves from the group one to two days before farrowing, or giving birth, and begin to search for a suitable nest site.[134] The sow is particular about her nest site and she may examine several different spots before making a choice.[135] She may travel as far as 6 km (3.7 mi) to find a suitable location.[136] Often, she prefers a heavily vegetated, secluded area that is adequately sheltered by branches and other cover,[137,138] for example, under a tree on a slope.[139] She also usually chooses a location near water.[140] The sow constructs a comfortable nest by rooting and pawing out a hollow in the earth, insulating it with grass, leaves, and twigs, and lining it with branches.[141,142,143] The characteristics of the nest change depending on the ambient temperature; sows build well-insulated nests in cold weather and simple, bedded hollows in warmer weather. [144] The nest is usually complete two to four hours before the birth of the piglets,[145] but if no suitable material is available, the sow will continue to attempt to nest after birthing has begun.[146]

Like dogs and cats, pigs are polytocous, bearing multiple offspring at the same time. The average litter size is four to seven piglets.[147,148] The young are well-developed at birth, or precocial, which is rare among polytocous mammals.[149] They are among the most precocial newborns of all ungulate species, [150] but share the undeveloped metabolisms of other nesting mammals,[151] and are therefore susceptible to cold. They can see and hear at birth, and start to walk immediately.[152] Piglets quickly seek their mother's teats, and a teat order is formed on the first day, giving each piglet his or her own specific nursing place for the entire lactation period. Piglets fiercely defend their individual nursing location.[153,154] Newborn piglets lie in body contact to each other or to the mother sow for warmth, but they also prefer to be close to the mother sow, even when environmental temperatures are high.[155] They sometimes fall asleep at the teat or curled up next to their mother's udder after nursing.[156]

As piglets pass by the mother's snout, she learns to recognize them individually within the first day.[157] Early maternal identification of piglets is primarily mediated by olfaction.[158] Piglets can also recognize their mother's scent at one day of age, and also by using olfactory cues, their littermates within a week.[159]

The sow makes a distinct, deep-pitched grunt followed by rhythmic grunting to call the piglets when it is time to nurse. Nursing is episodic, as milk is let down only about 20 seconds every 40-60 minutes. The piglets quickly gather at the udder and suck simultaneously in response to their mother's call.[160] Piglets can distinguish between their own mother's vocalizations and that of other sows. A team of British scientists found that piglets who were only 36 hours old responded to recordings of their mother's calls, but most piglets ignored similar sounds from other sows.[161]

While the sow stays in the nest with her litter, isolated from the sounder for about 1-2 weeks, she is very protective, and this period of exclusive contact with her piglets enables the development of close bonds.[162,163] Exploratory behavior, such as rooting and sniffing at objects, develops within the first few days of life,[164] and the piglets soon begin to follow the sow on short excursions away from the nest.[165,166,167] When separated from their mother, piglets call to her with distinctive vocalizations, and the sow vocalizes in return.[168] The piglets increasingly spend more time, and venture greater distances, away from the nest and, with their mother, abandon the nest where they were born after 7-14 days to join the rest of the group.[169]

Piglets begin to play within the first day of life,[170] and by their second week engage in such group activities as chasing, frolicking, scampering, head tossing, and mock-fighting as well as individual play that includes rooting and mouthing novel objects—activities that continue into adulthood.[171,172,173] The bonds that develop between littermates are strong and are maintained when the sow brings her piglets to rejoin the larger group.[174] Although playful behavior declines with age, fresh straw provided to farm pigs can stimulate even adult pigs to play.[175,176]

Within the sounder, if the other sows are also nursing litters, the mother pigs may share maternal duties (although some sows can also be aggressive toward unfamiliar piglets),[177] and when groups of lactating sows are kept together on a farm, sows may nurse piglets other than their own.[178] At about 8 weeks of age, the piglets are fully integrated in the group, although the social bonds among siblings remain strong.[179] Weaning is a slow and gradual process, and the piglets continue to suckle until 14-17 weeks of age.[180,181]

## Intelligence and Emotion

Pigs possess a well-developed, large brain[182] and are widely known to be highly inquisitive, with considerable learning[183] and problem-solving abilities.[184,185] They have an outstanding ability to learn from experience, and combine new information with previously remembered events.[186] They have even been observed to work in collaboration to free themselves from their pens.[187]

After teaching pigs to control a special joystick with their snouts, researchers at Pennsylvania State University found that pigs could learn to play simple matching games by moving the cursor around a computer screen. The pigs demonstrated a capacity similar to primates for learning the task.[188]

In other laboratory experiments, pigs displayed the ability to discriminate between locations with hidden food of different relative value, to remember where these food sites are located, and to use this information to optimize their location choices. This kind of cognitive ability is adaptive, as it would be useful in responding to changing foraging conditions in a natural setting.[189]

Scientists have studied awareness in pigs, in part as a means of establishing the sentient nature of the species. Donald Broom, Professor in the Department of Veterinary Medicine at the University of Cambridge, and his colleagues devised an animal behavior experiment in which pigs had to locate a hidden item using a mirror. After some initial experience looking at and interacting with the mirror, pigs were able to use reflected images to find a food bowl behind a barrier, an accomplishment suggesting they understand where they were positioned

in relation to other features of their environment, and that they can hold that information in their minds while they go find the reward.[190]

Like chimpanzees, pigs can exploit the knowledge of other pigs by following them to a secret or hidden food site.[191] This suggests that pigs may possess high level social cognitive abilities, such as visual perspective taking—the ability to assume what others see—and are able to adjust their own behavior accordingly.[192,193] In behavior research, pigs also show evidence of possessing this ability by avoiding a hidden food site when they are being followed by a more dominant pig who might eat it the treats.[194]

As the editorial staff of *The New York Times* wrote in 2006:

> We keep probing the animal world for signs of intelligence—as we define it—and we're always surprised when we discover it. This suggests that something is fundamentally wrong with our assumptions. There is every reason to value other life-forms as much for their difference from us as for their similarity, and to act accordingly. That may be the only intelligence test worthy of the name.[195]

While pigs normally do very well in cognitive tests, their ability to learn and solve problems in behavioral research is influenced by the environment in which they are raised. When pigs are kept in barren, intensive housing, with little opportunity for interacting with and learning about environmental contingencies, their ability to perform well in operant task trials or mazes is diminished. Thus, pigs may suffer cognitive impairment due to being raised in industrial, agricultural production settings.[196]

Pigs show clear behavioral signs of emotional valence (that is, they experience positive as well as negative emotional states).[197, 198] In one test, pigs performed play behavior only when given access to a rewarding environment, a pen filled with straw that had chocolate covered raisins hidden within, while showing no play behavior in the opposing aversive test environment, an empty pen with temporary social isolation. They also showed more defecating, urinating, and less tail wagging and tail postural changes in the aversive condition. In further behavioral testing, pigs showed signs of "emotional contagion"; pigs that had never before experienced the rewarding or aversive environment showed different behavior depending on the condition a test pig anticipated or experienced. Naïve pigs waited with test pigs in a pen during the presentation of auditory (sound) and visual (light) cues indicating to which environment the test pig would be exposed, and remained in the pen while the test pig was moved to either the rewarding or aversive environment. The naïve pigs tended to hold their tail low during the display of cues preceding exposure of the test pig to the aversive condition and defecated more when the test pig was exposed to the aversive environment. Conversely, the naïve pigs played only when the test pig was in the rewarding environment.[199]

## Conclusion

Pigs are complex, intelligent, social animals, with specific behavioral needs, and they are fully capable of experiencing both a positive and a negative quality of life. Our attitudes towards these animals may stem in part from simple lack of understanding, and this has largely led us to disregard their suffering as they are raised for meat in industrialized agricultural production systems. In these concrete and steel facilities, pigs languish without ever seeing the sky, rooting in mud, foraging on pasture or feeling the sun on their faces. Increasing scientific inquiry into the true nature of these animals continues to uncover their previously unrecognized mental abilities and sociable nature, as well as their capacity to experience pain,[200] and emotions, which are influenced by their physical[201] and social surroundings.[202] As a society, we are ethically obliged to better regard their welfare.

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