Sentience in pigs

What is sentience?

Sentience is the ability to experience feelings, such as hunger and pain, as well as emotions, such as fear and joy. This means that sentient animals have the capacity to suffer, but also to experience pleasure.

Sentient animals have feelings which matter to them. Although being able to 'feel' is at the core of what it means to be sentient, sentience is commonly associated with other capabilities, such as 1) consciousness (at least a basic form), meaning sentient animals may have an awareness of the world around them including their own actions and the actions of others, and 2) the ability to learn and remember things. These abilities enable an animal to avoid things that make them feel bad and seek out things that make them feel good. This allows the animal to maximise its chances of survival and produce as many future generations as possible. Therefore, we can see why sentience is likely to have evolved in many animals.

If animals lack sentience, it means they are simply robot-like machines that are able to react to their environment, but are not aware of what they are doing, and cannot feel anything associated with what is happening to them. Many people will intuitively know that this is not the case with most animals. Indeed, the famous scientist Charles Darwin wrote, "The fact that the lower animals are excited by the same emotions as ourselves is so well established that it will not be necessary to weary the reader by many details" (Darwin, 1872). So even 150 years ago, it seemed to be accepted as common knowledge that animals are capable of feeling.

However, the way we studied animal behaviour, and so thought about animals, changed dramatically in the first 70 years of the 1900s, due to the introduction and popularity of "Behaviourism". This was a field of science in which it was only acceptable to study behaviour that we can see. Therefore, it was frowned upon in the scientific world to even discuss things like feelings and emotions, because these things could not be directly observed or measured. This appeared to have a knock-on effect of weakening the acceptance of animals as sentient beings – in both the scientific world and by the general public. In addition, with farm animals especially, it has always been easier on our consciences if we believe that these animals are incapable of feeling and understanding, and so how we keep them and kill them makes no difference. We can simply treat them as food-producing machines. Farm animals are often represented as stupid, unfeeling beasts in this way by humans.

Evidence for sentience

Things changed towards the end of the 1900s, when more and more scientists turned their attention to animal sentience. Since then, it has become an important field of research. It should be noted that studying sentience is very difficult, because we can never know exactly what an animal is experiencing. We can't even know exactly what another human is experiencing. Most humans can tell us how they are feeling (unless they are babies or unable to speak), but there is always the chance that they are lying or exaggerating, and even if they do describe their feelings truthfully, we can't know if their experience is exactly the same as ours. Nonetheless, there are ways of gathering the best evidence we can to show that animals are capable of feeling. Thanks to this, we now have a wealth of scientific evidence to show that many animals, like us, are sentient beings.

Why does sentience matter?

If we know that an animal is capable of feeling, this means that how we treat them matters. Sentient animals deserve lives where they are not only protected from suffering, but also have the opportunity for pleasure. Unfortunately for farm animals, since the 1950s our farming system has become more and more intensive and industrialised, leading to what is known as 'factory farming'. Factory farming is where the space per animal is reduced, and animals are often confined indoors and even in cages. This means that more animals can be farmed within a given space, and with the improvement of technology, less people are needed to look after the animals. The idea behind this is that more meat, eggs and dairy can be produced at a lower cost. However, this type of farming comes at a cost to the animals: see https://www.ciwf.org.uk/factory-farming/animal-cruelty for more information. Animals in factory farms are treated as units of production, rather than sentient creatures capable of suffering.

Sentience in pigs

In this report, we discuss scientific evidence for sentience in pigs (*Sus scrofa domesticus*). Globally, around 1 billion pigs are farmed every year for their meat, and at least half of these are reared in intensive systems.

We can break down the evidence for sentience discussed here into the following categories:

- Awareness
- Learning and memory abilities
- Ability to experience feelings such as pain
- Ability to experience emotions

This report will present evidence from some of the scientific studies in each of these categories, although the results of some studies fit into more than one category. At the end of the report, each study will be explained in terms of what the researchers did and what they found, enabling you to judge the evidence for yourself.

Awareness

Awareness of your surroundings includes awareness of the animals you share your surroundings with. Pigs have been shown to recognise other pigs and distinguish between familiar and unfamiliar ones (de Souza et al. 2006) and find being with unfamiliar pigs stressful (de Groot 2001).

Pigs are social animals. They show an awareness of when they are alone compared to when they are with other pigs, and they find being alone stressful, as indicated by physiological and behavioural indicators of stress. Their individual personalities affect how they respond to this stress (Ruis et al. 2001).

Learning and memory

Pigs have memories. They are able to learn where food is hidden and remember that location after a period of time (Mendl et al. 1997).

Pigs can learn and remember where to find hidden food and learn to alter their behaviour to their own advantage, based on another pig's behaviour. This indicates an awareness of the actions of others. It also shows behavioural flexibility, and the ability to learn and form memories – these are believed to be markers of intelligence (Held et al. 2000, Held et al. 2002).

Pigs can use a mirror to find a hidden food bowl after being given an opportunity to learn about a mirror. This indicates that pigs can learn what a mirror image is (i.e. a reflection) and can use this information to solve a problem. They can remember this information and hold it in their heads along with a map they have learnt about their environment, which shows a type of mental awareness (Broom et al. 2009).

Pigs can learn to find their way through a maze. Going through a painful experience affects their ability to learn (Siegford et al. 2008).

Pain

Pigs can experience pain, as shown by multiple studies which have found pain receptors in pigs, and behavioural indicators of pain. Such indicators include decreased or abnormal movements, abnormal postures, turning their heads towards the painful area, reduced feeding, and vocalisations such as squealing, following a painful event such as castration without anaesthetic. Providing an anaesthetic reduces these signs of pain. (Rault et al. 2011).

Emotions

Being slow to approach and explore a new object, as well as avoiding it, are taken as an indication of fear, and being treated with an anxiolytic drug (a drug that reduces anxiety and fear) reduces this behaviour in pigs. This indicates that pigs experience fear (in this case when confronted with an unfamiliar object, which could be dangerous) (Dalmau et al. 2009).

Pigs feel fear as shown by their response in several different situations commonly used to indicate fear in animals. Not only this, they also show individual differences in how fearful they are, suggesting that they have individual personalities (Anderson et al. 2000, Brown et al. 2009).

Pigs are not only capable of experiencing negative emotions such as fear, but also positive ones. Pigs are playful animals that can feel positive emotions associated with play behaviour (Horback et al. 2014). Pigs have been found to enjoy a brain-teaser: pigs were able to figure out a mentally-challenging task and had positive feelings while doing so (Zebunke et al. 2011).

A pig's environment affects their emotional wellbeing: an 'enriched' environment leads to a positive emotional state, whereas a barren one leads to a negative emotional state, as shown by a 'cognitive bias test'. This test looks at how optimistically or pessimistically animals (including humans) respond to something, which can tell us how positive or negative their state of mind is. A pig's emotional wellbeing suffers if the quality of their environment is reduced (Douglas et al. 2012).

Pigs are affected by the emotions of others. When one pig was experiencing something unpleasant, a second pig showed signs of negative emotions, and when the first pig was experiencing something pleasant, the second pig showed signs of positive emotions (even though the second pig could not see the first pig or what was happening to it). This indicates that the second pig was picking up on signs (such as sounds and smells) from the first pig about how that pig was feeling. This is evidence that pigs have at least a basic form of empathy – the ability to understand and share the emotions of others (Reimert et al. 2013).

Conclusion

The fact that pigs are sentient is supported by a wealth of scientific evidence. Pigs are aware of their surroundings including other pigs, and even the actions and emotions of other pigs. They have their own individual personalities and are intelligent, with the ability to learn and remember information, to understand something as complex as a mirror, and they even enjoy mentally challenging tasks. They are capable of experiencing positive emotions such as pleasure, and they also have the capacity to feel pain and experience negative emotions such as fear; therefore, they can suffer.

Knowing this, we must protect pigs from both physical and mental suffering and provide them with every opportunity possible to enjoy a good life. This cannot be achieved with factory farming. To read more about the suffering of pigs in factory farms, and ways we can give them a good life rather than a life that is not worth living, go to https://www.ciwf.org.uk/farm-animals/pigs/pig-welfare.

The studies in more detail

Here we cover in more detail each of the studies discussed above.

Awareness

Pigs have been shown to recognise other pigs and distinguish between familiar and unfamiliar ones (de Souza et al. 2006), and find being with unfamiliar pigs stressful (de Groot 2001).

Study 1. de Souza et al. 2006: Pigs can recognise each other.

The study involved 12 litters of piglets. In phase one of the 'familiarisation process', each litter of piglets was given the chance to become familiar with the litter of piglets in the pen next to them. The two litters had access to a pen in between their home pens which was split down the middle with netting. The netting meant that each litter was kept separate from each other (and so could not fight with each other) but could see and have physical contact with each other. The piglets could come and go into this middle pen over the course of one day.

The second phase of the familiarisation process was to familiarise a pair of piglets from one litter to a pair from another litter. One pair was placed on one side of the middle pen, and the other pair in the opposite side. Again, the pairs were separated by the netting but could see and touch each other. The pairs were closed inside this pen for 10 minutes, then put back in their home pens for 10 minutes, and then put back in the middle pen with the netting for another 10 minutes.

After the familiarisation process, some of the litters remained in their original home pens, while some were moved to new home pens. The piglets were then tested to see if they could recognise familiar individuals by placing pairs of piglets that were either familiar with each other (due to the familiarisation process) or unfamiliar (they had never seen each other before) into the middle pen, for five minutes. The netting was removed so that the piglets could interact with each other.

The piglets that had never met each other before spent more time investigating each other than the piglets which were familiar with each other, a result that has been found in other studies of social recognition in pigs. This suggests that the piglets could recognise the piglets they had already investigated in the familiarisation process. Therefore, they were not as interested in investigating these familiar piglets compared to the new piglets they had never met before. This provides evidence that pigs can recognise each other.

Study 2. de Groot 2001: Pigs are stressed in the company of pigs which are unfamiliar.

In intensive farming systems, pigs are mixed with unfamiliar pigs after weaning and sometimes later in life to form groups that will be ready for slaughter at the same time.

To test what impact putting a pig into a group of unfamiliar pigs has, in this study each pig was either paired with an unfamiliar pig of the same gender or paired with a littermate of the same gender. The pigs mixed with unfamiliar pigs showed a reduced immune response to infection with a small amount of disease which they had recently been vaccinated against, and more clinical signs of this infection. A weakened immune system is a sign of stress in animals. The male pigs paired with unfamiliar pigs showed more fighting behaviour and had higher levels of hormones associated with stress.

Together these results suggest that being mixed with an unfamiliar individual is stressful for pigs. For male pigs this may be at least in part because of the fighting involved. Pigs establish dominance hierarchies in groups to allow for peaceful group-living, so being mixed with other pigs disrupts means that pigs have to re-establish a hierarchy, which involves fighting.

This tells us that pigs are aware of the other pigs around them and can recognise individuals in order to know who is familiar and who is unfamiliar.

Isolation and stress

Pigs find being alone stressful, as indicated by physiological and behavioural indicators of stress. Their individual personalities affect how they respond to this stress (Ruis et al. 2001).

This study looked at whether a pig's personality type affected how they deal with being alone, something that is known to be stressful for pigs.

Female piglets between 2 – 4 days old were categorised into two different personality types, according to how they responded to being placed on their back. During the 1 minute they were on their back, those which made two or less attempts to escape were classed as 'reactive' pigs. Those that made five or more attempts to escape were classed as 'proactive' pigs. These personality types are related to how an animal copes with threats. They have previously been called active (instead of proactive) and passive (instead of reactive) coping styles: reactive pigs are more passive in response to a threat, e.g. they are more cautious and tend to try to stay hidden and safe, whereas proactive pigs are more active, e.g. they tend to try to escape from or fight the threat. In support of this, the same researchers in a different study (Ruis et al. 2000) showed that pigs which made a lot of escape attempts when placed on their back (the proactive pigs) were more aggressive when there was competition for food. The piglets that showed few escape attempts when placed on their back (the reactive pigs) were more cautious and reluctant to approach an object they had never seen before, or to enter a new area (both of which could be dangerous).

74 piglets were classified as reactive, and 70 proactive. All piglets remained in their litters until they were weaned at 4 weeks of age. When they were 7 weeks old, 12 reactive and 12 proactive piglets were put in pens on their own for 2.5 hours, over three weeks. The researchers tested the piglets' cortisol levels (this is a hormone released in response to stressful situations), catecholamine levels (these are a group of chemicals released in response to stressful situations) and body temperature (stressful situations cause a decrease in body temperature). The piglets' behaviour was also recorded.

The researchers found that all piglets, regardless of whether they were proactive or reactive, found being on their own stressful. This was shown by the release of the hormone cortisol, and a decrease in body temperature in all piglets. All the piglets also showed increased exploration, which is thought to be because they were trying to look for their littermates. They also made more vocalisations, which could be because they were calling for their littermates, but pigs also vocalise more when they are afraid. That pigs find being on their own stressful has been found in lots of other studies. This makes sense because pigs are social species: being around other pigs is important to them.

However, the piglets reacted to the stressful situation differently according to their personality type. Reactive piglets appeared to find being on their own more stressful than the proactive piglets to begin with – they showed a higher level of the stress hormone cortisol. However, after the first day of being on their own, proactive piglets vocalised more on average than reactive piglets, their catecholamine levels increased over the three-week period, and their body temperature did not return to normal – whereas the reactive piglets' body temperature returned to normal after the first day. This suggests that the proactive piglets appeared to find being on their own stressful for longer, as their stress levels did not drop over the study period.

Learning and memory

Remembering where food is hidden

Pigs have memories. They are able to learn where food is hidden and remember that location after a period of time (Mendl et al. 1997).

This study set out to test whether pigs can use their memory to find food.

Eight male pigs were put one by one into an arena where they could search for food hidden in one of 10 troughs hidden behind barriers. This was known as the 'search trial'. Once the pig had found the food, it was taken out of the arena and the food was hidden in the same place. After either 10 minutes or 2 hours, the pig was put back into the arena and allowed to find the food again ('relocate' it) – this as known as the 'relocation trial'. In the search trials, the pigs avoided going back to empty troughs that they had already looked in, suggesting that they weren't just searching randomly but using their memory to remember which areas of the arena they had already visited and not found food. In the relocation trials, they quickly found the hidden food again, making less mistakes (visits to empty troughs) than expected if they were searching randomly. Again, this suggests that the pigs were using their memory to remember where the food was hidden, and that they could remember this information after 10 minutes and 2 hours. This type of memory is known as 'spatial memory'.

Pigs can exploit the knowledge of other pigs and try to avoid being exploited

Pigs can learn and remember where to find hidden food and learn to alter their behaviour to their own advantage, based on another pig's behaviour. This indicates an awareness of the actions of others. It also shows behavioural flexibility, and the ability to learn and form memories – these are believed to be markers of intelligence (Held et al. 2000, Held et al. 2002).

Study 1. Held et al. 2000: Exploiting the knowledge of other pigs

In the first of two studies from the same project, researchers investigated a) whether pigs could use their own knowledge to find hidden food by remembering where it had previously been hidden, and b) whether pigs who did not have this information could use the knowledge of other pigs to find the food.

The study involved sixteen juvenile female pigs, and an arena containing eight buckets. Each of these buckets contained food covered with wire mesh. This was so that all of the buckets smelled like food, so the pigs couldn't use smell to locate the correct bucket. One of the buckets also had food on top of the wire mesh so it could be eaten. This was known as the 'baited bucket'.

Training phase – informed pigs

Eight of the pigs were known as the 'informed pigs'. In the training phase, these pigs were given two training trials a day. The first trial was known as the 'search trial', where one of the eight buckets was randomly selected to be the baited bucket. The pig was allowed to search the different buckets until she had found the baited bucket and eaten the food. She was then removed from the arena and the same bucket had food added to it. The same pig was brought back into the arena for the 'relocation trial', where she had to relocate the same baited bucket. This was repeated every day. The informed pigs therefore learned that in the second trial, the relocation trial, food could be found in the same bucket as in the first trial, the search trial. The pigs showed that they had learnt this by going almost straight to the correct bucket in the relocation trial (allowing for no more than one error of searching an incorrect bucket in three-quarters of the trials).

Pigs have a good spatial memory

The results of this training phase show that the pigs were able to remember the food location from the search trial and use their memory to find this food in the relocation trial. This highlights the memory capabilities of pigs, providing evidence for a well-developed spatial memory in pigs.

Training phase – non-informed pigs

The other eight pigs were known as the 'non-informed pigs.' These pigs were only given a search trial each day, meaning that they learned that one of the buckets would contain food, but they would not know which one (as which bucket was to be the baited bucket changed each day in the search trials). This meant that the non-informed pigs searched the buckets at random find the food.

Test phase

In the test phase, each non-informed pig was paired with an informed pig. In each pair, the non-informed pig was heavier than the informed pig, and so more dominant – it could physically push the informed pig out of the way and gain priority access to food. The informed pig was released on her own in the test arena as usual for the search trial, to learn where the food would be hidden. Then, in the relocation trial the non-informed pig was released into the arena with the informed pig.

All eight non-informed pigs located the food using fewer bucket investigations compared to when they were searching randomly. In addition, non-informed pigs were found to investigate buckets immediately after they had been investigated by the informed pigs. This suggests that the non-informed pigs were following the informed pigs and so using their knowledge to locate the baited bucket, rather than searching the buckets randomly as they had in the training phase.

Non-informed pigs exploit informed pigs after following them

Six of the eight non-informed pigs displaced their informed partners (pushed them out of the way) from the baited bucket significantly more than half of the time. This shows that most of the time, most of the non-informed pigs exploited the informed pigs by using their knowledge to gain priority access to the food.

Learning and flexibility

Although from this experiment we can't be certain whether the non-informed pigs understood that the informed pig knew something that they didn't, it certainly shows us that pigs can learn to change their behaviour to their own advantage based on another individual's behaviour. The non-informed pigs learned to forage more efficiently in the presence of a knowledgeable but weaker pig: instead of continuing to search at random for the food, they learnt to switch tactics by following their companion, who led them more or less directly to the food, and then claiming that food for themselves. This awareness of the behaviour of others is a component of sentience, and such learning capabilities and flexibility in behaviour are taken as hallmarks of complex cognition, or what we tend to call intelligence.

Study 2. Held et al. 2002: Pigs can try to avoid being exploited.

In the second study from the same project, the researchers investigated whether the exploited informed pigs changed their foraging tactics in response to being exploited by the dominant non-informed pigs.

Behaviour recorded

During the trials where the informed and non-informed pigs were together, every time the informed pig changed its direction or visited one of the buckets, the researchers recorded what the non-informed pig was doing. They also looked at how closely followed the informed pig was by the non-informed pig, and the percentage of trials in which the non-informed pig displaced the informed pig from the baited bucket before she could eat the food. This was to assess the level of exploitation each informed pig was experiencing.

Exploited pigs altered their behaviour

The researchers found that the informed pigs altered their foraging behaviour predictably in response to exploitation by the non-informed pigs. In six of the eight pairs, the informed pigs were more likely to move towards the baited food bucket when the non-informed pigs were moving away from it, or when the non-informed pigs were out of sight, far away from the baited bucket or far away from the informed pig. The informed pigs were more likely to visit the baited bucket when the non-informed pigs were out of sight, far away, moving away from the informed pig, or not moving at all.

The foraging behaviour of the informed pigs was also related to their experience of exploitation. The informed pigs that had experienced higher exploitation levels displayed a strategy of moving towards or visiting the baited bucket when the non-informed pigs were likely to be elsewhere, of changing direction towards the baited bucket when the non-informed pig was moving away or far away.

The results of this study suggest that the informed pigs were changing their behaviour in order to avoid meeting the non-informed pig at the food source, and to increase their chances of arriving at the baited bucket before the non-informed pig. This would give them the opportunity to eat the food in the baited bucket before the more dominant pig arrives and displaces them.

This demonstrates an awareness of and learning about the behaviour of other pigs, and the ability to use this information to alter their own behaviour to increase the chance that they get food – evidence of sentience as well as complex cognition – or what we might call ‘intelligence’.

Pigs can learn how to use a mirror image to find the location of food

Pigs can use a mirror to find a hidden food bowl after being given an opportunity to learn about a mirror. This indicates that pigs can learn what a mirror image is (i.e. a reflection) and can use this information to solve a problem. They can remember this information and hold it in their heads along with a map they have learnt about their environment, which shows a type of mental awareness (Broom et al. 2009).

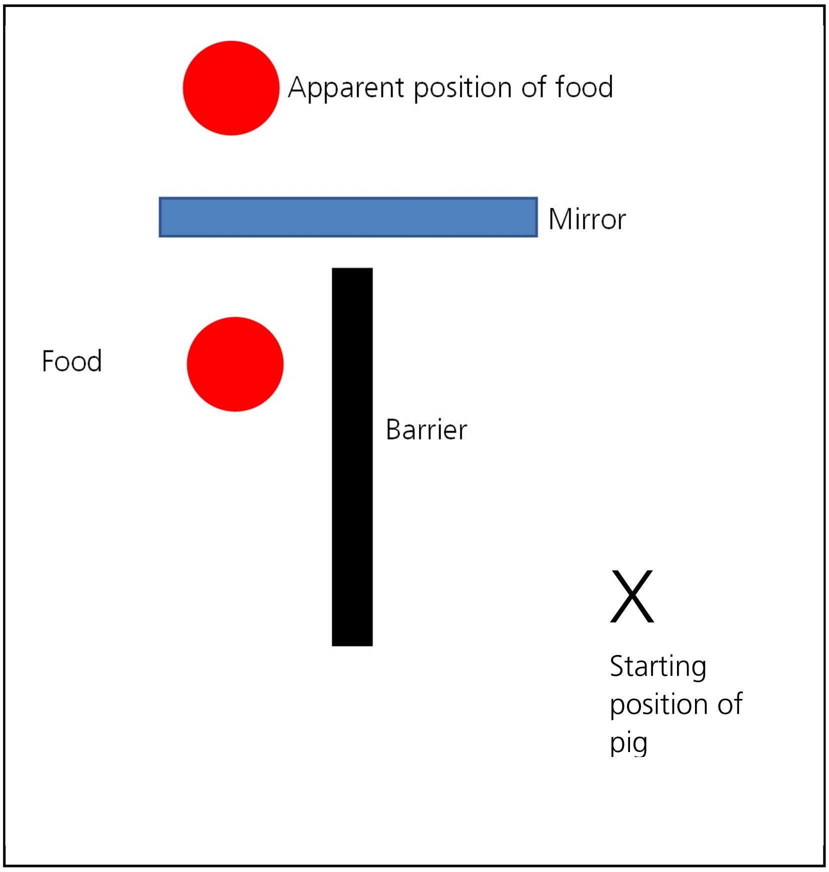
This study set out to test whether pigs could use information from a mirror to locate an object that could only be seen in the mirror. Eight pigs, aged 4 – 6 weeks, were put into pairs. Each pair was put in a pen with a mirror in it for 5 hours. This gave them the opportunity to learn about the mirror. The researchers put the pigs in pairs at this stage because pigs are social animals and so are happier when in pairs than when alone.

Initially the pigs reacted to the mirror as if it was another pig, but then they started looking at it as they moved, suggesting they were monitoring their own movements in the mirror image.

A test (the 'mirror test') was then set up as shown in the diagram below. A mirror was placed in the pen, with a barrier at a 90 degree angle to it in the middle. A food bowl containing food was placed to the left of the barrier. A fan was placed behind and above the food, to waft the scent of the food away from the bowl and around the room, so that the pig could not use the smell to locate the position of the bowl.

From their starting position in the test pen, the pigs could only see this bowl in the mirror. If you don't understand that a mirror shows a reflection of what is in front of it, then a mirror would seem to be a window, and the bowl would appear to be through that window – this is marked by 'apparent position of food bowl' in the diagram below.

In the mirror test, each pig was put in the pen on their own and left for one minute, to see what they would do. Pigs had to be on their own at this point, so they didn't copy what another pig did.



Of these eight pigs that had experience with a mirror, after looking at the mirror, all but one of the pigs walked straight to the left-hand side of the barrier to where the bowl was, rather than walking behind the mirror.

Eleven pigs of the same age that had never seen a mirror before were put one by one into the mirror test. Almost all these pigs (nine of the eleven) approached the mirror and then walked behind the mirror to where the bowl appears to be (see 'apparent position of food bowl' in diagram above), but where there was no food.

Next, in the test pen the mirror was replaced with a frame the same size as the mirror, with wire mesh inside the frame, so that the pigs could see straight through it. The food bowl was put behind the frame in the same position as it would have appeared in the mirror image (i.e., behind the frame – see 'apparent position of food bowl' in the diagram above).

The eight pigs with previous experience with a mirror were each given one minute inside the pen again. This time, almost all these pigs (six of the eight) went behind the wire-mesh frame and reached the food.

Taken together, these results reveal that the pigs given time to experience a mirror were able to learn and understand what a mirror image is: it is a reflection, so the image you see is what is in front of the mirror. They also knew that what they were seeing with the wire-mesh frame was different: this is not a reflection, so the image you see is what is on the other side of the frame. They understood that the mirror image reveals objects that are not directly visible (i.e., hidden by a barrier and only visible in the mirror), and that have an actual position that is different to the position it appears to be in (i.e., the bowl appears to be 'through' the mirror but is actually in front of it). The pigs were able to use this information to find a food bowl. By turning away from the mirror to go around the barrier to reach the bowl, this shows that the pigs were able to remember the information given by the mirror ("the food bowl is on the left of the barrier"). The results also show that they can hold a map of the environment in their heads, and they are aware of how to move according to this map and the information they have learnt from the mirror. This shows a type of mental awareness which has been called 'assessment awareness'.

In mirror studies with human children where they show an understanding about mirror images, the children have had much more experience with mirrors and are usually given information about mirror images by their parents. In this study, it took pigs only five hours of experience with the mirror to show an understanding of mirror images, which demonstrates an impressive learning ability and what we might call intelligence.

Pigs can learn to find their way through a maze

Pigs can learn to find their way through a maze. Going through a stressful experience affects their ability to learn (Siegford et al. 2008).

In intensive farming systems, piglets are not given the opportunity to engage in natural behaviours that help stimulate brain development, particularly spatial learning e.g. having a complex environment to explore, the opportunity to root and search for food, or the need to remember the location of the nest. The part of the brain that is involved in spatial learning is also important in determining an animal's response to stress. Therefore, providing an animal with opportunities to stimulate development of this part of the brain not only helps an animal to be able to find its way around its environment, but also to feel less distressed when faced with potentially stressful situations. This study set out to investigate whether a task for piglets that involved spatial learning and memory (learning to find their way around a maze) would reduce the stress associated with early weaning. In intensive farming systems, piglets are weaned (taken away from their mother and fed solid foods) at a much younger age (3 – 4 weeks) compared to the age their mothers would naturally start weaning them (3 – 4 months).

Sometimes they are weaned even earlier, at less than two weeks of age. Weaning of piglets on farms is agreed to be stressful for the piglets.

Twenty-seven piglets, aged five days, were split into three groups. For a week, all the piglets were taken away, one at a time, from their mother and littermates, for 30 seconds. After these 30 seconds, the piglets in group one were returned to their mother, so the only thing these piglets experienced was being handled - this was known as the 'sow control' group. Piglets in the second group were left on their own after the handling, so had experience of being handled *and* being on their own – this was known as the 'isolation control' group'. Finally, piglets in the third group were given the maze task, where they had to find their way through a maze to get back to their mother and littermates. Therefore, these piglets had experienced of being handled, of being left on their own, *and* of learning to find their way through a maze – this was the 'maze task' group. At first the maze was made very easy for them, and then harder (more turns to navigate), and the layout also changed, so that it was a challenge for the piglets to learn how to navigate the maze and find their way back to their mum and siblings.

When this week came to an end, the piglets were weaned (aged 12 days). Samples of their saliva were collected to test their cortisol levels before and after weaning – this is a hormone produced by animals in stressful situations and is used as a measure of how stressed they are – higher cortisol levels indicate higher stress levels.

To test whether the piglets in the 'maze task' group had developed better spatial learning and memory, when the piglets were 14 days old they were all given a 'water maze task'. This took place in an inflatable swimming pool filled with water to a depth that meant that the piglets had to swim. A platform was placed close to the edge of the pool. The piglets were placed in a different part of the pool and had to swim until they reached the safety of the platform. After they had done this once, the task was repeated (piglets placed into the same part of the pool) another four times, and the average time it took the piglets to reach the platform was calculated. This was taken as a measure of how well they could remember the location of the platform.

To test whether the piglets in the 'maze task' were less fearful than the pigs in the other groups, the piglets were given an 'open field test'. This is a test of fear because prey animals (like pigs) find it distressing to be in open environments with nowhere to hide from potential predators, and as social animals, being on their own is also stressful. Piglets were placed in an open arena on their own for five minutes and their behaviour was recorded. Another test of the piglets' fearfulness was the 'novel object test'. More fearful animals are more likely to react to something they have never seen before as if it was a threat, and so act fearfully around it (e.g., be slow to approach it or avoid it completely). The novel object was a basketball which was lowered into the open arena using a rope. Finally, the piglets' reaction to humans was tested using a 'human approach test': an unfamiliar human entered the area and sat in a chair. Humans are a potential threat and so again, more fearful animals are likely to act more fearfully around a new human. Saliva samples were collected after all the tests described above, to test cortisol concentrations and so stress levels of the piglets.

The researchers found that cortisol concentrations were higher in all piglets two hours after they were weaned, suggesting that weaning is indeed stressful for piglets. Furthermore, the cortisol concentrations of piglets in the 'isolation control' group remained high for 16 hours after weaning, suggesting that the social isolation experienced by these piglets may have made them more sensitive to being isolated (i.e., taken away from their mother and siblings), or decreased their ability to handle stress in general.

The ‘maze task’ piglets touched the unfamiliar person more quickly and more times in the ‘human approach test’. This suggests that giving piglets the opportunity to develop their spatial learning and memory, by giving them a maze task for a week before weaning, resulted in decreased fear of unfamiliar people compared to animals receiving similar handling (the ‘sow control’ group) or similar handling plus an equal amount of time being on their own (‘isolation control’ group).

Finally, the researchers found that the males in the ‘maze task’ group and females in the ‘isolation control’ group were faster at learning the water maze task than male pigs in the ‘isolation control’ group. This is interesting because the male pigs were castrated without anaesthesia, as is common practice, when they were one day old. Pain is known to decrease an animal’s ability to learn, and this may have been made even worse by social isolation and lack of a stimulating environment, resulting the ‘isolation control’ males struggling to learn their way around the water maze task. Conversely, the spatial learning training the ‘maze task’ males experienced may have counteracted the effects of pain on learning, meaning they performed as well as the ‘isolation control’ females on the water maze task.

There is a lot we can learn about sentience in pigs from this study. Piglets can learn to solve a maze task, they feel pain, and this affects their ability to learn, they show signs of fear when confronted with new and potentially threatening objects and situations, but are less fearful given an environment that stimulates learning and brain development. The study also gives us information on one way to improve pig welfare on farms. Providing young piglets with a complex environment which encourages exploration and spatial learning is important for brain development and improves not only their ability to learn, but to cope with stressful situations, which will improve their welfare.

Pain

Pigs can experience pain, as shown by multiple studies which have found pain receptors in pigs, and behavioural indicators of pain. Such indicators include decreased or abnormal movements, abnormal postures, turning their heads towards the painful area, reduced feeding, and vocalisations such as squealing, following a painful event such as castration without anaesthetic. Providing an anaesthetic reduces these signs of pain. (Rault et al. 2011).

This paper summarises multiple scientific studies which provide evidence that pigs feel pain when castrated. The evidence discussed is as follows:

The testes of pigs contain pain receptors (known as nociceptors), which are responsible for detecting pain. This means that pigs have the sensory capacity to feel pain when their testes are surgically removed.

Responses to castration are reduced by applying a local anaesthetic (something that causes a loss of feeling in the area it is applied to). This suggests that a pig’s pain is eased by anaesthetics, just like in humans.

Multiple studies have found that pigs show behavioural indicators of pain after castration, such as decreased or abnormal movements, abnormal postures, slow movements of the tail, turning the head towards the hindquarters (i.e., the location of the pain), alternate lifting of the hind legs, and reduced feeding and maintenance behaviours e.g. cleaning themselves.

Pigs respond vocally to castration, indicating pain. This includes an immediate vocal response to the cutting of the scrotum, and increased high frequency calling (i.e., squealing) when the testes are extracted and the spermatic cord is severed.

Pigs show these indications of pain in response to castration no matter how old they are. This suggests that castration is a painful procedure regardless of age.

Emotions

Pigs experience negative emotions such as fear

Being slow to approach and explore a new object, as well as avoiding it, are taken as an indication of fear, and being treated with an anxiolytic drug (a drug that reduces anxiety and fear) reduces this behaviour in pigs. This indicates that pigs experience fear (in this case when confronted with an unfamiliar object, which could be dangerous) (Dalmau et al. 2009).

How animals react to new, unfamiliar situations is often used to assess fearfulness. This study used a novel (meaning new) object test to investigate fearfulness in pigs. A novel object test involves presenting an animal with an object (or sound or smell) which is new to them, and so could be dangerous. Being slow to approach and explore the new object, as well as avoiding it, means that the animal thinks the new object is dangerous. This is taken as an indication of fear, because fear is an emotion caused by the threat of danger.

In this study, half the pigs were given an 'anxiolytic' drug – a drug that reduces anxiety and fear, two related negative emotions – to see if this drug would affect the pigs' behaviour in the novel object test.

Pigs were trained to enter a test pen and eat chopped apples out of a trough. In the novel object test, the pigs were exposed to three different new things – an object, a sound and a smell. The object was a ball hanging above the feeding trough which appeared when the trough was opened. The sound was a horn (hidden behind a curtain next to the trough) which sounded when the trough opened and then again 1 minute later. The smell was carbon dioxide gas which filled the trough.

In the novel object test, the pigs which were not treated with the anxiolytic drug retreated away from the trough, spent less time near the trough, and more time facing the door (i.e., the way out) rather than the trough, compared to the drug-treated pigs. Thus, these pigs showed more avoidance and less exploration of the new things. This indicates fearfulness.

In contrast, the pigs treated with the anxiolytic drug showed increased feeding behaviour, increased time spent in the trough area and increased time facing the trough, compared to the pigs that weren't given the drug. Thus, these pigs were carrying on as normal (feeding) in the presence of the new things, and showed less avoidance behaviour and more exploration of the new things. This indicates that the drug-treated pigs were not experiencing fear.

Therefore, the pigs that weren't treated with the drug showed signs of fearfulness, whereas the pigs treated with the drug, which is known to reduce fear in other animals, did not. These results suggest that pigs can experience fear, and that anxiolytic drugs can reduce anxiety and fear in pigs, like they can in humans.

Some pigs are more fearful than others

Pigs feel fear as shown by their response in several different situations commonly used to indicate fear in animals. Not only this, they also show individual differences in how fearful they are, suggesting that they have individual personalities (Anderson et al. 2000, Brown et al. 2009).

Study 1. Anderson et al. 2000

In this study, researchers used several different behavioural tests which have been used to indicate fear in other species.

The first was the 'tonic immobility' (TI) test. Tonic immobility means freezing on the spot, which is an automatic, reflexive response to something frightening in many animals. This is sometimes thought of as 'playing dead'. In the TI test, young pigs were exposed to a handling experience which was unpleasant and so may induce fear. Each pig was taken out of its pen, put in a transport box, moved to separate room, lifted out of the box by its hind legs, placed on its back, then a sand-filled cloth bag was placed on its chest and its hind legs were gently stretched out, and it was restrained in this way for 5 – 10 seconds before being released. After release, the time the pig remained frozen (the duration of TI) was recorded.

The next test was an 'elevated plus maze' (EPM) – so called because it is shaped like a plus sign (+) and elevated from the ground. The maze consists of two arms which are enclosed by walls, and two arms which are open – they have no walls (apart from a 2cm high ledge). An avoidance of these open arms, where an animal may feel more exposed and vulnerable, is believed to indicate fear. The young pigs were placed in the maze one at a time, and the number of entries into and time spent in the open arms were recorded.

The third test was the 'light/dark test' (L/D test). This consisted of placing young pigs in a box made up of a brightly-lit compartment with white walls, and an equally-sized dark compartment with brown walls and no light. An avoidance of the brightly-lit compartment is thought to indicate fear, again because animals may feel more exposed in this compartment. Therefore, number of entries into and time spent in the brightly-lit compartment were recorded.

Finally, young pigs were given an 'open field test'. This consisted of a circular open arena. Like in the EPM, animals may feel exposed and so fearful in an open area. Therefore, a low activity rate (keeping still and not venturing further into the open space) is believed to indicate fear in animals in an open field test. The distance pigs moved from the spot in which they were placed was recorded, as well as the number of entries into the centre of the arena.

The researchers found that pigs showed signs of fearfulness in all these tests. Most pigs showed a TI response in the TI test. In the EPM, pigs spent around two-thirds of their time in the closed arms, showing that they preferred to avoid the open arms. Likewise, the pigs spent on average around two-thirds of their time in the dark compartment in the L/D test, showing that they preferred to avoid the lit compartment. In the open field test, the pigs only entered the centre of the field on average three times, again suggesting that they preferred to avoid this exposure. Furthermore, the behavioural measures from these different tests showed some correlation with each other, suggesting that they are measuring similar fear-related behaviour.

Pigs also showed individuality in their responses to the tests. In the EPM, there was large variation in the amount of activity pigs showed in the maze. In the TI test, almost a quarter of the pigs didn't show a TI response. In the L/D test, over a quarter of pigs didn't enter the lit compartment at all. In the open field test, different pigs moved by different amounts in the open arena. This suggests that pigs differ in how fearful they are, indicating that they have individual personalities.

Study 2. Brown et al. 2009

Pigs were tested in different situations used to indicate fear. In the 'human approach test', which indicates fear of humans, a human entered the pen, and the time it took the pigs to approach the person, if at all, was measured. No approach or a longer time to approach indicates a greater level of fear.

In the 'open door test', which indicates fear of leaving the safety of their home pen, the pen door was opened and the time it took the pigs to leave the pen, if at all, was measured. A longer time to leave or no leaving at all indicates greater fear.

These tests were repeated over three days to see if the pigs would respond in the same way each time.

The researchers found that an individual pig would react in a similar way in both these tests of fear, and in each test, they reacted in a similar way over the three days. Behaving in a similar way over time and in different situations indicates that the behaviour being measured is a stable personality characteristic. Therefore, these tests were revealing each pig's personality characteristic of fearfulness.

Furthermore, individual pigs reacted differently to each other in these two tests, indicating that they all have their own individual personalities (specifically here, that they show individuality in their fearfulness).

Pigs can experience positive emotions

Pigs enjoy playing

Pigs are not only capable of experiencing negative emotions such as fear, but also positive ones. Pigs are playful animals that can feel positive emotions associated with play behaviour (Horback et al. 2014).

This study brought together evidence from lots of different studies to show that pigs are playful animals.

Pigs show lots of different types of play. 'Locomotor play' is play formed of movements, such as leaping, hopping, scampering, sprinting, trotting and head tossing. This type of play is seen more often in piglets than adult pigs.

'Object play' involves interacting with moveable objects, such as twigs and rocks. Pigs move such objects around with their snout or front limbs. Behaviours associated with this type of play include biting, sniffing, pushing, kicking, licking and chewing the object. Adult pigs show this type of play behaviour as well as piglets.

'Social play' involves playing with other individuals. Piglets may play with their mother, for example by climbing on them, nudging them, biting her snout, ears, hooves and tail. The mother may play with her piglets by nudging and mouthing them. This type of play behaviour between mother and piglet is important in establishing a bond between the two. Piglets play with each other too, for example by play fighting, known as rough-and-tumble play. This type of play is only seen in piglets, not adult pigs. Piglets begin this type of play with a 'play signal', such as a head toss.

Play is known to be accompanied by positive feelings, because it is linked with the release of chemicals in the brain (neurotransmitters) known as the 'pleasure neurotransmitters', and activity in areas of the brain that are associated with feeling good. Play has also been suggested as an indicator of positive emotions as it does not usually occur in situations of threat i.e. when an animal would be experiencing negative emotions such as fear. Therefore, we can take play behaviour as evidence that pigs have the capability to feel positive emotions such as pleasure and joy – when they are playing, they are having fun and enjoying themselves.

Pigs have been found to enjoy a brain-teaser

Pigs were able to figure out a mentally-challenging task and had positive feelings while doing so (Zebunke et al. 2011).

Twenty-four pigs living together in a stall were each assigned a different noise. In phase one of the experiment, every time a pig walked past the feeding station, its individual noise was played, and food was released.

In phase two, these individual noises were played throughout the day. The correct pig had to approach the feeder in response to their individual noise for food to be released. The pigs learnt to correctly respond to their noise (and ignore the noise for other pigs) after just one day.

In phase three, the pigs had to learn that when they heard their individual noise, they needed to press a button by the feeder at least once to release the food, and later on, at least five times to get the food. Again, it took the pigs just one day to figure out what to do. However, the time between hearing their noise and performing the correct behaviour was longer to begin with in this phase than in phase two, suggesting that the pigs found this task more challenging – it took them longer to figure out what to do.

The speed of the pigs' heart beats (known as heart rate) was measured throughout the experiment, as changes in heart rate indicate an emotional response to a task. How much each pig's heart rate changed increased throughout the experiment. Increased change in heart rate has been found to indicate positive emotions, for example in humans and sheep. This suggests that as the experiment became more mentally challenging, the pigs experienced positive emotions.

The conclusion we can draw is that pigs are not only smart enough to solve mentally-challenging tasks, but they enjoy doing so (although whether we can label this positive emotion experienced by the pigs as 'enjoyment' remains to be determined). We could liken this to humans enjoying puzzles – mentally-challenging tasks we do for fun.

The emotional state of pigs is better in enriched environments

An 'enriched' environment leads to a positive emotional state, whereas a barren one leads to a negative emotional state, as shown by a 'cognitive bias test'. A pig's emotional wellbeing suffers if the quality of their environment is reduced (Douglas et al. 2012).

Scientists have come up with a way to investigate animal emotions, called a 'cognitive bias' test.

A 'cognitive bias' refers to the way that an individual thinks about something, and this can indicate how they are feeling. For example, if you are in a negative emotional state (for example, you are feeling depressed), you may be more likely to focus on the negative aspects of your environment and behave more pessimistically. Conversely, if you are in a positive emotional state (for example, you are feeling happy), you may be more likely to focus on the positive aspects of your environment and behave optimistically.

A classic example of this is the 'glass half full or half empty' scenario. A glass that is neither full nor empty, but rather half-way between the two, is 'ambiguous' – it has more than one possible interpretation. A person in a negative emotional state may focus on the negative aspect of this object and call it half **empty** – a pessimistic response. A person in a positive emotional state may focus on the positive aspect and see it as half **full** – an optimistic response.

A cognitive bias test presents an animal with something ambiguous. If an animal is experiencing a negative emotional state it will interpret something ambiguous negatively, and behave accordingly (respond pessimistically). Conversely, if the animal is experiencing positive emotions, it will interpret something ambiguous positively, and respond optimistically.

Because emotional well-being is a key component of good welfare, an animal's emotional state can tell us about their welfare. Positive emotions indicate good welfare, whereas negative emotions indicate poor welfare. This study aimed to investigate the effect of different housing conditions on pigs' emotional states, and so their welfare, using a cognitive bias test.

The cognitive bias test involves a training phase and a test phase.

During the training phase, pigs were trained that when they heard one sound (a note on a glockenspiel), they would receive a food reward (an apple) if they approached a hatch. They were also trained that if they heard a different sound (a click of a dog-training 'clicker'), they would be punished (in the form of an unpleasant experience: a plastic bag waved in their face) if they approached the hatch. The pigs showed that they learnt the difference between these sounds by approaching the hatch when they heard the glockenspiel (showing that they knew this sound meant they would get a reward at the hatch) and not approaching the hatch when they heard the clicker (showing that they knew this sound meant they would get punished at the hatch).

During the training phase, half the pigs were housed in an 'enriched environment' and half were housed in a 'barren environment'. In the enriched environment, the pigs had more space, a solid floor with clean straw, and things to play with and make their environment more interesting (suspended metal chains and logs, sticks and cardboard boxes). These things 'enrich' (improve) the pig's environment, and so are known as 'environmental enrichment'. Providing environmental enrichment has been shown to improve the welfare of pigs and many other species. In the barren housing, pigs had less space, a less comfortable floor, and only a wood log on the floor to play with.

After the training phase came the test phase, where the pigs were given an 'ambiguous' sound – the squeak from a dog sound. This was ambiguous to them because they hadn't been trained using this sound. Therefore, it could signal either a reward or a punishment. The pigs were given neither a reward nor a punishment if they did approach the hatch when they heard this sound. The researchers just wanted to see what their response to the sound would be.

They found that the pigs housed in the enriched environment were more likely to approach the hatch when they heard the ambiguous sound, as if they were expecting a reward. This expectation of reward when given ambiguous information is an optimistic response, and indicates a positive emotional state. Therefore, this suggests that an environment with more space, comfortable material to sleep on and things to interact and play with induces a positive emotional state in pigs, and so improves their welfare.

Conversely the pigs housed in the barren environment were less likely to approach the hatch when they heard the ambiguous sound, suggesting that they were expecting a punishment, which is a pessimistic response. This indicates a negative emotional state in the barren-housed pigs. This suggests that housing with less space, no comfortable material to sleep on and not much to play with leads to a negative emotional state in pigs and so poorer welfare.

Finally, the pigs had their housing switched, so that the pigs originally housed in the enriched environment were put in the barren housing, and vice versa. They were given the test phase of the cognitive bias test (the ambiguous sound) again.

The researchers found that the pigs now housed in the enriched environment were more likely to show an optimistic response than those now in the barren environment, so the same result as before. In addition, they found that the pigs originally housed in the enriched environment were even more pessimistic when in the barren environment than those pigs originally housed in the barren environment. This suggests that pigs which were taken away from an enriched environment and put in a barren one were experiencing even more negative emotions than those which had only known the barren environment. Therefore, this indicates that pigs are sensitive to changes in their housing and suffer emotionally when the quality of it decreases. This has important implications for pig welfare as the quality of pigs' environments can diminish as they get older (e.g. outdoor-reared pigs being finished indoors), which means their welfare will decrease.

This research also disproves the argument that if a pig has not experienced an enriched environment, then 'it does not know what it is missing', and so being housed in a poor-quality environment will not mean that the pigs have poor welfare. These results show that even if pigs have no prior experience of an enriched environment (i.e. those that were housed in the barren environment from the start), they nonetheless experience negative emotional well-being when housed in barren environments.

Pigs are affected by the emotions of others.

When one pig was experiencing something unpleasant, a second pig showed signs of negative emotions, and when the first pig was experiencing something pleasant, the second pig showed signs of positive emotions (even though the second pig could not see the first pig or what was happening to it). This indicates that the second pig was picking up on signs (such as sounds and smells) from the first pig about how that pig was feeling. This is evidence that pigs have at least a basic form of empathy – the ability to understand and share the emotions of others (Reimert et al. 2013).

The first aim of this study was to see if pigs showed indicators of positive and negative emotions when waiting for and then experiencing a pleasant or an unpleasant event. To do this, pigs were trained that when they saw and heard one type of signal (the 'pleasant signal' - a light and a sound), they would be given a pleasant experience. This pleasant experience was access in pairs to a pen with materials to explore and root around in (an activity that pigs enjoy) and look for hidden chocolate raisins (a food that these pigs were known to really like). They were also trained that when they saw and heard another type of signal (the 'unpleasant signal' – a different coloured light and a different sound), they would be given an unpleasant experience. This involved being put into a pen on their own (pigs do not like being on their own because they are social animals) and have a person come in at a random time to restrain them or move them around (the unpredictable nature of this making the experience more unnerving).

The researchers found that in response to the pleasant signal, pigs nosed the door to the pleasant event pen more and looked towards the door the researcher would come through to let them into the pleasant pen. This suggests that they knew they were going into the pleasant pen and perhaps that they were eager to get in, but no other indicators of positive emotions were seen. Likewise, pigs turned their heads towards the unpleasant event pen in response to the unpleasant signal, indicating that they had learnt that they were about to enter the unpleasant pen, but showed no behavioural indicators of negative emotions. The researchers suggested that perhaps the 'anticipation period' (time between the signal and being let into the pleasant or unpleasant pen) wasn't long enough for the pigs to start showing behavioural indications of how they were feeling. In addition, because the pigs were in pairs at this point, and pigs like being with other pigs, it may have protected them from feeling too negative when they were expecting the unpleasant event.

Once in the pleasant or unpleasant pens though, pigs showed behavioural indicators of how they were feeling. Pigs only played in the pleasant pen and produced 'play barks'. Play is a reliable indicator of positive emotions, signifying that the pigs were feeling positive emotions in this pen. They also showed more tail movements such as tail wagging, which the researchers suggested indicates positive emotions in pigs. In the unpleasant pen, pigs tried to escape and showed more defecating (passing waste), urinating (passing urine) and freezing, all of which are believed to be associated with negative emotions. The pigs also showed certain ear and tail positions (ears back and tail low) as well as more ear movements in the unpleasant pen, which the researchers proposed indicate negative emotions. Therefore, it appeared that the pigs were experiencing negative emotions in the unpleasant pen.

The next part of the study was to see whether other pigs are affected by the emotions of their pen-mates. The transfer of emotions from one individual to another is known as 'emotional contagion' and is considered the basic form of empathy. To investigate this, the researchers put two pigs (the 'naïve' pigs) which had not been trained in with the trained pigs. The naïve pigs did not know what the different signals meant or what would happen to the trained pigs in the pleasant or unpleasant pens.

When the trained pigs were in the unpleasant pen, the naïve pigs showed more defecating, indicating that they were experiencing negative emotions, whereas when the trained pigs were in the pleasant pen, the naïve pigs played. The naïve pigs couldn't see the trained pigs when they were experiencing the pleasant or unpleasant events, so they were not simply copying their behaviour. This suggests that the naïve pigs were picking up on cues, such as sounds and smells, from the trained pigs about how they were feeling when they were inside the pleasant and unpleasant pens. When the trained pigs were feeling positive emotions in the pleasant pen, the naïve pigs showed signs of positive emotions too. When the trained pigs were feeling negative emotions in the unpleasant pen, the naïve pigs showed signs of negative emotions too. This indicates that the naïve pigs took on the emotions of the trained pigs. This ability to feel what others are feeling forms the basis of 'empathy' – the ability to understand how another individual is feeling. So not only do pigs feel emotions, but they are sensitive to the emotions of others too.

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