

Unconventional uses of pigs

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Abstract: *Unconventional uses of pigs.* The study presents the possibilities of pigs' sensory organs and their sensitivity to odor stimuli (i.e. to search for truffles and drugs by pigs), as well as their role in the animal adaptation processes. We use the knowledge about the senses to more effectively enrich farming environment and in this way to improve the animal welfare. The pigs' ability to distinguish and remember sounds and the appropriate associated reaction can be used to create the desired behavior, improve welfare of pigs and their production results. Similarly, the pigs' ability to distinguish colors and their color preferences also enable to influence the behavior, welfare, and production effects of pigs. Miniature pigs are used as companion animals and in rehabilitation. The similarity in the anatomical structure of the pig and human organs, and the course of physiological and metabolic processes are used in medical research and creates hope for their use in so-called xenotransplantation. Transgenic pigs create new horizons in the unconventional use of pigs.

Key words: pigs, senses, animal welfare, medical tests, transgenic pigs

INTRODUCTION

Swine are the main source of meat both in the world (about 40%) and in Poland (almost 60% of meat and meat products consumed). This dominance will likely persist for a long time, given the growing demand for meat products, the undoubted

advantages of this species of animal and culinary traditions, which usually do not change quickly. Only a small percentage of the large pig population is used by humans for other purposes. Centuries ago, pigs were a source of meat and fat for humans, but they also loosened soil through rooting, aided in hunting and accompanied people in their everyday life. Also, human needs nowadays suggest the wide variety of pigs' qualities should be taken advantage of (Kaleta 1996, Grabowska 2014).

SENSE OF SMELL AND TASTE

Swine are animals with an extremely sensitive sense of smell that is necessary for their survival. Newborn piglets must recognize olfactory signals such as the smell of the mother, which makes it easier to reach the udder. Adult pigs use “information” encoded in smells to recognize the opposite sex and to locate potential breeding partners. Free-living wild boars and pigs also use their sensitive sense of smell to search for food, detect predators, and recognize own territory boundaries.

Sensitivity of pigs to scent-based stimuli, especially during mating season,

has found practical applications and prompted the production of synthetic substances stimulating the reproductive system to more strongly display oestrus symptoms, what is conducive to optimal introduction of semen and fertilization of females of this species (Adamczyk et al. 2015).

Highly sensitive sense of smell makes it easy for omnivorous pigs to find substances that are suitable for eating. Among the wide menu of wild boars and pigs there are also treats that man considers a luxury, such as truffles.

Well-developed olfactory system and instinct to use the nose to search for food means that swine are naturally predisposed to finding delicacies such as truffles, i.e. fungi from the ascomycete group, producing subterranean fruiting bodies. They have the shape of a tuber, surrounded by rough skin. Most often they grow in symbiosis with the roots of deciduous trees – oaks, limes, poplars and willows. Of the more than 150 species of truffles, of high culinary value are considered mainly: the black truffle (*Tuber melanosporum*), the white truffle (*Tuber magnatum*), the black summer truffle (*Tuber aestivum*), and the whitish truffle (*Tuber borchii*) (Gerhardt 2006). The main attraction of these fungi is the seductive taste and aroma, which depends on the type of tree they associate with. In addition, it is believed that the truffle has a similar scent as male wild boar pheromones, which makes pigs even more effective in their search – they can sniff out truffles even three feet underground.

Thanks to the sensitive sense of smell, unconventional uses of pigs are not limited to truffle search only. In recent

years, they have also become the terror of drug smugglers. In this new role, pigs do better than many trained dogs, checking the luggage of passengers of some airports for psychoactive substances and explosives, thus ensuring the safety of passengers and airport employees.

The case of a pig named Luisa “serving” in the Hanover police was widely publicized. Commissioner Werner Franke acquired Luisa as a young piglet from an animal shelter and trained her to search for cocaine and marijuana. For five years, Luisa made the life of smugglers a misery, achieving better results than many dogs. She eventually ended her service simultaneously with her retiring caretaker, as she turned out to be loyal at work only to the person who looked after her. Relationships between people and animals take on a variety of shapes.

It should also be made clear that animals of this species spend most of their lives in pig houses, the atmosphere of which contains certain amounts of harmful gases (mainly ammonia and hydrogen sulfide) adversely affecting mucous membranes of their upper respiratory tract (Mihina et al. 2012).

There is no doubt that the sense of smell plays a significant role in pig adaptation (Perry 1992, Kristensen et al. 2001, Jensen 2002, Nowicki and Klocek 2012). Swine use their nose not only to find food, but also for social purposes (Mendl et al. 2002). On the other hand, there are many reports that pigs do not have a particularly well-developed sense of sight (Hutson et al. 1993, Lomas et al. 1998, Tanaka et al. 1998, Zonderland et al. 2008). In commercial farming, the selection of environment enrichments for

pig pens is still often arbitrary (with the exception of bedding) (Szewczyk 2011). Behavioral needs of pigs are not taken into consideration. The consequence of this method of environment enrichment in pig farming is that animals very quickly lose interest in such objects (Day et al. 2002). In addition, elements placed on the floor of the pen can be very easily contaminated with faeces and swine – as animals with a very sensitive sense of smell – quickly scorn them (Blackshaw et al. 1997).

Therefore, suspended objects seem to be better able to maintain interest of pigs. Also, in memorization processes of these animals, smell plays a more important role than appearance of a given object (Croney 2003). Research on other animals, such as rodents and chickens, suggests that a previously known smell is attractive in a new environment, and its presence reduces fear (Jones and Gentle 1985).

Effective improvement of piglets' welfare level after weaning should result from the synergistic effect of the interesting smell of an enrichment object and the opportunities for its deformation, biting, chewing and, as a result, destruction. The latter features are mentioned in the literature as decisive for effectively maintaining interest of animals in such an object, and actually causing a reduction in aggression (Studnitz et al. 2007, Van de Weerd and Day 2009). Until recently, however, aromatization of environment enrichments in pig breeding was not associated with the above-mentioned benefits. An enrichment object integrating the sense of smell was constructed only in 2012 (Nowicki and Klocek 2012). An aromatic chew toy was made

of fabric strips attached to a metal frame, with a perforated container for vanilla aroma. The choice of scent was based on previous, unpublished, own pilot experiments. Subsequently, three years later an aromatic toy with option to switch scents was proposed, which ensured the possibility of long-term interest of pigs in such an enrichment. The preferences of pigs in relation to natural and synthetic fragrances were also determined (Nowicki et al. 2015).

SENSE OF HEARING

In the wild, the sensitive sense of hearing of wild boars and pigs allows them to pick out sounds that signal approaching danger. The crunch of dry leaves or cracking of breaking branches might mean a threat from a predator or hunter. The sooner these signals are located, the more likely the animal is to escape. In farming environments, in the pig pens, sound signals seem to be of secondary importance. However, the sharp sense of hearing still receives various sounds from the environment, produced by the animals themselves (vocalizations), as well as the sounds of various devices that are part of the piggery equipment: fans, heaters, feeders, automatic feeders, drinkers. These noises may cause chronic stress, often unnoticeable, but resulting in deterioration of animals' well-being, certain reactions of the endocrine system, worsening production performance indicators (weight gain, use of feed, delayed occurrence or intensity of oestrus symptoms) (Otten et al. 2004).

The response of individual animals to sound stimuli referred to as noise is highly varied – in more sensitive animals

they can cause depressive symptoms leading to atypical behaviors, known as behavioral stereotypies. The Swiss studies (Klocek et al. 2017) show that fan noise above 85 dB prolonged the finishing period by 14 days. More intense noise (95–110 dB) caused anxiety, increased heart rate. More spectacular may be reactions to sudden unusual noises of high intensity (loudness), leading to disruption of the farrowing process. In such a situation, the sow may delay the start of delivery or stop in the middle of farrowing, with all its consequences. The problem of excessive noise in pig rearing was reflected in legal acts specifying the acceptable noise levels. The ordinance of the Minister of Agriculture and Rural Development on minimum housing conditions for various farm animal species stipulates that “noise in pig pens: should not be constant or caused suddenly, and its intensity should not exceed 85 dB”.

The source of sound in animal farming environments are also people caring for the animals: their too loud conversations, commands given, shouting, whistling, singing as well as radio programs or music played. Such activities are intended to make the work of people caring for the animals more pleasant. The sounds make it easier for animals to identify individual caretakers or signal situations that are to take place: pen cleaning, changing out of the bedding, feeding or periodically performed treatments. These signals are also received by animals, which can react differently depending on the type of sound. If the sounds are repeated, they can create specific associations in the animals, both positive and negative. A particular type of music or song associated with a given

person or activity can have different consequences. Such associations, usually created spontaneously, can also be triggered by man in a conscious way to achieve a specific purpose.

Information on diverse reactions of swine to various types of sounds, including various musical compositions moved researchers to undertake more detailed research, both with cognitive and practical profiles.

Animal ability to distinguish and remember sounds and the appropriate associated reaction can be used for practical purposes. Jonge De et al. (2008) showed that playing music to piglets when they were given the opportunity to leave the pen freely builds positive associations between the mentioned stimuli. After weaning, replaying of the music track associated with this substitute for freedom was conducive to greater mobility, willingness to play and reduced aggression, which resulted in better health and greater daily increases. In our own research (Petrynka et al. 2015) on weaned piglets, an attempt was made to create positive associations between music and access to fruit in the animals. Music was played twice a day for 15 minutes. Piglet behavior and production indicators were monitored, and pulse rate was measured using a heart rate monitor. In groups of experimental pigs, an increase in exploratory behaviors, extended duration of food and water intake, and longer time spent on games and sham fighting were observed.

The referenced research results indicate the possibility of practical use of pig sense of hearing to improve both their welfare and production indicators.

SENSE OF SIGHT

Light is important for many animal life processes, including in the case of pigs (Anderson 2000, Canada 2014). Vision makes it easier to reconnoiter and penetrate the surrounding environment, search for food, and identify other individuals. Light is involved in stimulating reproductive processes, it accelerates sexual maturation, promotes earlier onset and stronger manifestation of oestrus symptoms after weaning of piglets, promotes an increase in the number of ovulated eggs and reduction of embryo mortality in the preimplantation period, and also increases vitality and development rate of piglets. Therefore for swine, especially those used for breeding, access to light, preferably natural, is very important.

From a practical point of view, it is important how pigs see and whether they distinguish colors. A pig's eye is very similar to the human eye in terms of dimensions and anatomical structure. Pigs can see in the panoramic range of 310 degrees, with binocular vision of 35–50 degrees. It is believed that the pig's eye has only a limited accommodation (ability to sharpen and focus the image). Many researchers believe that the anatomical structure of the pig's eye allows these animals to distinguish between blue and green wavelengths. With these premises in mind, interiors of most piggeries are dominated by various shades of gray – walls, floors, partitions, equipment items such as feeder pipes, supports, feeders, fans are usually finished in grey tones. Less often, some pieces of equipment are made out in green (usually cold dark green) or blue.

Coloured accents in pig pens are most often feed bowls or waterers for piglets, sometimes chew toys made of red or yellow plastic (Klocek and Mielczarek 2008). This chromatic range certainly does not promote an optimistic mood in pig caretakers; we also don't know much about how such world looks like from the pig's point of view.

Japanese scientists (Tanida et al. 1991) found – using the differential conditioning method – that piglets are probably not able to perceive the full range of light wavelengths, and of the three primary colors probably only perceive blue. The results of research on possibility of distinguishing colors by Asian wild boars indicate that these animals are able to discern blue from gray very well, green from gray to a lesser degree, and are unable to distinguish red from gray. In an extended experiment, the same authors proved that wild boars clearly distinguished different shades of blue from gray (Eguchi et al. 1997).

Deligeorgis et al. (2005) observed in their studies on piglets a higher intake of water from red and blue drinkers than from green ones. The profile of piglets using waterers of different colors depended on their sex. Females preferred blue drinkers and used them more often than male animals, which in turn tended to use red waterers with greater intensity. The authors referenced the known fact that color preference varies depending on gender in rats, primates, and also in humans.

The results of research by Poznański et al. (2004) suggest that piglets' preferences for specific colors change with age.

In our own research (Klocek et al. 2016) we attempted to determine the pref-

erences of piglets regarding the colors: blue, red and yellow. Piglets were showing more interest in blue and red feeders as opposed to yellow ones. Pigs took the most feed from blue feeders and the least – from yellow feeders. Similar ratios were observed also as concerned number of approaches to feeders and time spent by the feeders of different colors.

Currently, it is increasingly often emphasized that keeping animals in pens made out in colors they perceive positively may have a positive effect on their behavior and level of well-being and, as a result, on the achieved production indicators. Painting certain elements in pig pens in accordance with pigs' color preferences can make them easier to find and encourage (or discourage) their use.

Among many stimuli, visual stimuli can also be used by animals to recognize people (Hemsworth et al. 1994). Koba and Tanida (1999) showed that in distinguishing people swine use differences in color and/or brightness of overalls worn rather than dimensions and shapes. In later studies (2001) carried out on miniature Goetian pigs by these authors, it was observed that these animals could discriminate between people wearing overalls in the same or different colors. In addition to colors of protective clothing, pigs were also able to use characteristic scents and visual signals, such as caretakers' face and body size for identification (Tanida et al. 1995).

ANIMAL ASSISTED INTERVENTION WITH PIGS

Physiotherapists in one of the Dutch rehabilitation and revalidation centers came up with the unconventional idea

of using pigs as co-therapists. Interested in the benefits of introducing animals into the process of treatment and therapy (Odendaal 2000, Nimer and Lundahl 2007), they decided to involve not dogs or cats, but pigs. Their goal was to improve fitness and activity levels of the elderly, and emotional sensitization of young people participating in the conducted sessions. The element of surprise brought by miniature pigs led to patients participating in therapy with much greater energy and willingness. The appearance of such special guests was always bringing joy to those taking part in therapy sessions. The speed and willingness of pigs to learn new tricks meant that it was swine (Marino and Colvin 2015) that were a hit in therapy rooms, and not dogs, nowadays more and more commonly used for this purpose. In fact, the success of using miniature pigs was so great that other centers decided to include these charming, oinking animals as co-therapists in their programs. In the US, the cradle of animal therapy, some decided to go even a step further – organizations such as American Mini Pig Education promote the thought of using pigs as therapeutic animals.

It is quite a common practice in the United States to use pigs not only as pets, but also as emotional support, i.e. as Emotional Support Animals (ESA). Commonly known as “prescription animals”, they are intended for people struggling with mental problems and illnesses. They allow their owners to feel safer and more comfortable in everyday situations, as well as when traveling by air (they can travel with a passenger onboard an aircraft). Emotional Support Animals aid in the treatment process and minimize the risk of relapse.

It seems that such behavior has become a prologue to the next, unprecedented type of work that man entrusts to pigs. The well-recognized – by both people and science – fact that contact with animals has a peaceful, calming influence (Tsai et al. 2010) was taken advantage of in a rather unprecedented form at the San Francisco airport. In addition to dogs and cats, the task of soothing the troubled nerves of travelers afraid of air travel was entrusted to a miniature pig named LiLou. This idea was received with great approval, to the extent that the quadruped now has social media accounts, with thousands of followers on an ongoing basis. The popularity gained by the pig has prompted her caretakers to keep the animal's work schedule confidential so as not to create additional problems with airport capacity.

SWINE IN BIOMEDICAL RESEARCH

Significant similarity of the anatomical structure of pig and human organs, as well as similarity of physiological and metabolic processes of the two species have long been used in medical research. Hence the great demand for miniature pigs used in medical research (cardiological, pharmacological, toxicological, oncological, surgical, microbiological and many others). The mentioned similarity in structure and dimensions of various human and pig organs creates hope for their use in so-called xenografts (interspecies organ transplants) (Schoeckel et al. 1998, Diamond 2001). Although the discovery of HIV genes in pig genotype has significantly slowed down such work, the development of biotechnology is likely to aid us in overcoming these

difficulties as well. The use of animal organs and tissues often raises ethical resistance. And, as often happens, procedures that in many developed countries arouse controversy from an ethical or moral point of view find no barrier to being carried out in China.

Widely bred pig species grow quickly to large sizes, so their maintenance is relatively costly and care can be burdensome. That is why miniature pigs were bred for laboratory test purposes – they reach the body weight of about 40 kg after two years. This slower growth rate allows for long-term research that would not be possible to implement for standard-sized pigs that grow much faster (Hager and Rekiel 2016). Thus miniature pigs have been and are used:

- in research into the role of bacteria and other microorganisms in digestion, metabolism, and the importance of vitamins and mineral salts in the body;
- for research in pharmacology and toxicology of various chemicals and drugs;
- in microbiology, virology, immunology and allergology as well as dermatological research;
- for experimental surgeries; in bone, vascular, skin and organ grafts;
- in procedures on the brain, in open heart and gastrointestinal surgeries, in experimental fetal and plastic surgery;
- as well as in research in the field of radiobiology and radiation oncology – in the search for mechanisms of oncogenic action of ionizing rays (Klocek et Kalinowska 2002).

New perspectives for unconventional uses of pigs have opened up thanks to the progress of biotechnology in recent years,

especially the possibilities of genetic modification of animals – obtaining the so-called transgenic animals (individuals having in their genome certain genes from another species).

Another area of use for transgenic pigs are tissue and organ transplants between individuals belonging to different species, known as xenotransplants (Smorağ et al 2011). The development of xenotransplantation brings the hope of solving the problem of finding the sufficient number of organ donors for human transplant recipients. Medical data indicate that of the thousands of people whose lives can be saved only by transplantation of appropriate tissues or organs, only half have a chance of finding the right donor. The hope for others lies only in the possibility of using, at least temporarily, mechanical devices (e.g. artificial kidneys or heart valves) or obtaining suitable organs from animals. Also, pigs commonly used for fattening are used in medicine. Such pigs are a good substrate for research into the development and treatment possibilities of so-called lifestyle diseases: obesity, diabetes and a number of others. Swine, as it turns out, can be a model organism in research on formation, prevention and treatment of the so-called human metabolic syndrome (Szczerbal et al. 2009). And this is most likely not yet the limit to unconventional uses of animals of this species.

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Streszczenie: *Niekonwencjonalne użytkowanie świń.* W opracowaniu przedstawiono możliwości praktycznego wykorzystania zmysłów świń. Szczególna wrażliwość na bodźce zapachowe pomaga w wyszukiwaniu trufli i narkotyków oraz w bardziej efektywnym wzbogacaniu środowiska chowu i poprawie dobrostanu. Możliwość rozróżniania i zapamiętywania dźwięków przez świnię i odpowiedniej skojarzonej reakcji można wykorzystać praktycznie do tworzenia wywoływania pożądanego zachowań, poprawy dobrostanu oraz wyników produkcyjnych. Podobnie możliwości rozróżniania barw przez świnię oraz ewentualne preferencje także wskazują na możliwość wpływu na ich zachowanie, poziom dobrostanu, oraz efekty produkcyjne. Świnię miniaturowe wykorzystywane są jako zwierzęta towarzyszące oraz w rehabilitacji. Podobieństwo budowy anatomicznej narządów świń i człowieka oraz przebiegu procesów fizjologicznych i metabolicznych wykorzystywana jest w badaniach medycznych, oraz stwarza nadzieję na wykorzystanie ich w tzw. ksenotransplantacjach. Nowe horyzonty w niekonwencjonalnym użytkowaniu świń stwarzają świnię transgeniczne.

Słowa kluczowe: świnię, zmysły, dobrostan, badania medyczne, świnię transgeniczne

MS received 03.12.2019

MS accepted 30.01.2020

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