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Behavioural reactivity, social and cognitive abilities of Vietnamese and Pitman–Moore weaned piglets

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ABSTRACT

Miniature pigs are increasingly used as alternative models in biomedical research, but little is known about their behavioural reactivity. However this should be taken into account when selecting breeds. In the present study, behavioural reactivity, social and cognitive abilities of 63 weaned piglets from the Pitman–Moore (16 females and 17 males) and Vietnamese (15 females and 15 males) miniature breeds were assessed in three test situations. They were first isolated in an open-field test and confronted with an unknown human. They were then confronted to the presence of familiar and unfamiliar piglets in a T-maze test. Finally, their reaction to the reunion with and separation from a littermate was assessed in a Y-maze test. Overall, Pitman–Moore piglets systematically expressed more locomotion, vocalisations and exploratory behaviour than Vietnamese piglets (principal component analysis; $P < 0.0001$). They were also more prone to initiate contact with an unknown human during an open-field test ($P < 0.05$), but less easy to catch in their home pen ($P = 0.001$). Piglets from both breeds spent 80% of their time close to either the familiar or the unknown piglet in a T-maze, male piglets preferring the unknown conspecifics ($P < 0.05$). While piglets of both sexes spent 75% of their time near their littermate rather than an empty pen in a Y-maze test, only females spent more time near the area that was previously associated with the presence of this littermate ($P = 0.012$), suggesting the acquisition of short-term social-conditioned place preference. In sum, these results provide a novel insight into the behavioural traits that characterise the temperament of the Pitman–Moore and Vietnamese minipig breeds, and open the way to further attempt at investigating their ontogenetic roots as well as selecting specific traits for better use of these breeds in research.

1. Introduction

Miniature pigs are increasingly used as alternative models in biomedical research but also as companion animals. Multiple breeds are currently available and most of them have been specifically selected for scientific purposes, such as the Hormel, Pitman–Moore and Göttingen minipigs. The only natural occurring miniature pig is the Yucatan pig, but there are also some particular cases such as the Ossabaw Island feral pig, descendant from Spanish pigs that became smaller due to insular dwarfism. The scientific literature, mainly focused on medical issues, has been mainly written on the Göttingen, Yucatan, Vietnamese and Pitman–Moore breeds, with the first one leading to three to

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five times more results than the others in bibliographic web databases such as ScienceDirect and PubMed. In addition to have numerous biological similarities with the human (in terms of anatomy, physiology, neurobiology, etc.), the pig is endowed with high cognitive abilities (Kornum and Knudsen, 2010), and miniature breeds can be more easily handled and subjected to medical examinations than conventional pigs. The pig, and especially minipig, has been described as a highly interesting alternative animal model in biomedical research (Vodicka et al., 2005), in comparison to rodents or non-human primates, and in many scientific fields such as neuroscience (Lind et al., 2007; Sauleau et al., 2009; Clouard et al., 2011; Val-Laillet et al., 2011), toxicology (Bode et al., 2010), and nutrition (Johansen et al., 2001; Spurlock and Gabler, 2008; Lee et al., 2009; Val-Laillet et al., 2010; Clouard et al., 2011).

Despite the high interest concerning the minipig in research, very few studies focused on the phenotypic variability between different breeds. Most of the authors compared physiological features between miniature and conventional pigs (Torronteras et al., 1996; Hennig et al., 2004; Oh et al., 2007; Reiner et al., 2010), while very few were interested in comparing different minipig breeds. For example, Neeb et al. (2010) demonstrated that the Ossabaw pig is a superior model of metabolic syndrome and coronary artery disease than the Yucatan pig. But to our knowledge, there has been no significant attempt to compare the behavioural traits of different minipig breeds or to assess variability. More striking is the fact that the most ambitious programmes of selection underestimated this criterion. The Göttingen minipig for example, which is the world's most widely used miniature pig in biomedical science, has been mostly selected on body weight and morphology, hair colour and litter size, without any selection on the temperament (Simianer and Köhn, 2010). Yet, as reminded by Simianer and Köhn (2010), it is important to include temperament traits in the selection procedure since pigs in general tend to be nervous and anxious whereas these characteristics are highly undesirable for minipigs used in biomedical research.

The Minnesota minipig and Vietnamese pig, founder breeds of the Göttingen population, are vaguely described as 'easy to handle' and 'aggressive and difficult to handle', respectively (Simianer and Köhn, 2010). Köhn et al. (2009) started to investigate the possibility to select Göttingen minipigs on their easiness to be handled. They demonstrated that the heritability of the reactivity to humans (handling, restraint by a human) was low to moderate, and that genetic correlations between all the traits recorded were moderate to high, suggesting that measurements of the behavioural reactivity can be included in selection procedures. Ideally, an adequate animal model should exhibit good social interactions with its congeners, but not to be dependent on them since isolation is regularly needed for experimental needs, as well as easy to handle and not afraid of unknown humans or in unfamiliar environments. An absence of fear of humans avoids the use of forced restriction and the administration of sedatives for blood samplings for instance (Tsutsumi et al., 2001). Also, they should not be too familiar with humans, since they could get frustrated in their absence, or intrusive in their presence. But more important is the fact that behaviour in itself can be the outcome of biomedical research and is the main interest of many groups investigating emotional and behavioural disorders in humans (e.g. depression, hyperactivity), neurodegenerative diseases (e.g. Parkinson's, Alzheimer's), as well as new therapeutic strategies (e.g. psychopharmacological interventions, cell replacements, vaccines, etc.). Assessing the behaviour of minipigs in experimental paradigms could help understanding the degree to which phenotypic traits are due to breed differences, experimental treatments or effects of genes being knocked out. Although transgenic and knock-in mouse models of varied neurodegenerative diseases have been created, limited representation in clinical aspects has been recognised and the rodent models lack true neurodegeneration. In contrast, non-human primates appear as models of predilection to study neurodegenerative diseases (Chan, 2004) but their use is costly and raises ethics questions. As stated before, the minipig model is emerging as a very good model for biomedical, cognitive and neuroscience research, and minipigs are open to phenotypic selection (Köhn et al., 2009; Simianer and Köhn, 2010), knockout gene technology (Luo et al., 2012), transgene expression (Sondergaard et al., 2012) and neuropharmacological interventions (Fjord-Larsen et al., 2010).

Several authors recently proposed comprehensive reviews on the behavioural paradigms and tasks used to assess behavioural reactivity, fear, learning and memory in (mini)pigs (Forkman et al., 2007; Kornum and Knudsen, 2010; Gieling et al., 2011). Behavioural responses to novelty and social challenges, social isolation in an unfamiliar environment, reactivity to an unknown human, discrimination between a littermate and an alien conspecific, responses to social reunion/separation, and acquisition of conditioned place preference can be assessed using various and complementary tasks (Forkman et al., 2007; Gieling et al., 2011). For example, the open-field test, including social isolation and unfamiliar environment, has already been used in minipigs to investigate the behavioural effects of antipsychotic drugs (van der Staay et al., 2009) or cocaine exposure (Laferrière et al., 1995). The same apparatus has also been used to assess the animal's reactivity towards the presence of a human (Siegford et al., 2008; Scott et al., 2009). The piglet's discrimination or preference between two stimuli, as well as spatial learning and memory can be evaluated using T-maze and Y-maze apparatuses (Kornum and Knudsen, 2010; Gieling et al., 2011). These tests should allow us to identify at a young age some breed and sex differences in situations regularly encountered in experimental and laboratory environment, which could be used for further selection processes and experimental results interpretation. Consequently, the major aim of this paper was to describe the behavioural reactivity and social cognitive abilities of piglets from the Pitman–Moore and Vietnamese minipig breeds, which are commonly used for biomedical research but for which little is known about their emotional and cognitive abilities. Our secondary aim was to assess their suitability in laboratory research and for selection purposes.