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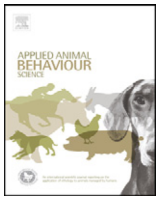

Juvenile pigs use simple geometric 2D shapes but not portrait photographs of conspecifics as visual discriminative stimuli

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ABSTRACT

Several animals living in social groups, such as monkeys, cows and sheep, have been shown to use facial discrimination for social recognition. Whether pigs can discriminate between faces of conspecifics purely based on visual stimuli provided by 2D portrait photographs, has not yet been investigated. Therefore, in this study piglets with a large birth weight range were trained in a visual discrimination task. Piglets were derived from different litters; from each litter same sex siblings with a low (LBW) and normal birth weight (NBW) were selected. With this setup it could be clarified whether pigs are able to discriminate between 2D photographs of conspecifics, and if LBW animals have more difficulty doing so than NBW siblings. Because pigs learn visual discrimination tasks slowly, we started with a simple discrimination task involving one of two geometric black-and-white stimuli, followed by a simultaneous discrimination task in which one of the black-and-white stimuli served as S^{plus}, the other as S^{minus}, followed by a reversal. Pigs needed on average 337 trials in the simple and 98 trials in the simultaneous discrimination task to reach criterion. Only 1/3 of all pigs reached criterion on a reversal (average of “learners”: 276 trials to criterion). None of the pigs learned to discriminate between 2D photos of heads of conspecifics, even after 289 trials, when training was discontinued. Birth weight did not affect learning. We conclude that pigs need input from more modalities than vision alone to enable discrimination between conspecifics.

1. Introduction

Animals living in social groups must be able to recognize group members. Recognition of group members is fundamental for establishing and maintaining a stable social relationship and group hierarchy (Sherman et al., 1993). Recognition can take place via different sensory modalities. Most animals use various unique cues and characteristics to build a mental representation of another individual for recognition. Golden hamsters use olfactory cues from different body parts to recognize an individual (Johnston and Bullock, 2001). Ring tailed-lemurs (*Lemur catta*), for example, are able to use urinary scent marks for discrimination and recognition (Palagi and Dapporto, 2006). A number of species, especially primates such as chimpanzees, rhesus monkeys and lemurs mainly rely on facial discrimination for recognition (Palagi and Dapporto, 2006; Marechal et al., 2010).

Abbreviations: LBW, low birth weight; NBW, normal birth weight.

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Investigations of facial discrimination are no longer restricted to primates, but have been extended to farm animals such as cattle and sheep, which are social animals. Coulon et al. (2009) performed a discrimination experiment with heifers, using 2D photographs of cows. All heifers were able to discriminate between heifers from their own breed (either familiar of unfamiliar) during the training and generalization phase. Almost all heifers could discriminate between cows from different breeds, but needed more trials during the generalization phase. Ferreira et al. (2004) performed a similar experiment with ewes that were first trained with a pair of photos of sheep faces. When they had learned this discrimination, they were shown photos of the same pair of sheep but at an older age in the generalization phase. The ewes learned this transfer more easily than a transfer to a photo pair of totally different individuals. Sheep also seem to learn to discriminate between photographs of conspecifics more easily than between geometric figures (Kendrick et al., 1996).

Pigs also live in groups, so they need to learn to recognize group members individually. A small number of experiments studied social discrimination and recognition in pigs. McLeman et al. (2005) demonstrated that pigs were able to discriminate between other (live) pigs using bimodal sensory cues, or using only one sensory modality. This implies that pigs were able to discriminate between other pigs relying exclusively on visual information. The pigs did not differ in learning ability according to the different sensory modalities.

Ewbank et al. (1974) studied the role of sight in hierarchy formation in pigs. Preventing pigs from seeing each other by putting contact lenses on their eyes did not prevent the formation of a hierarchy. This implies that they could still recognize each other. However, placing 'hoods' on the pigs' faces did prevent hierarchy formation. This could have been caused by the covering of pheromone producing areas.

It is not yet clear whether pigs use visual (facial) cues to discriminate between conspecifics. However, they are able to learn simple visual discrimination tasks. Moustgaard et al. (2004) showed that mini-pigs are able to perform a black-and-white discrimination task. Contingent on making an error, Moustgaard and colleagues applied 20 s of darkness as punishment and a tone as secondary reinforcer. Fourteen out of 16 piglets successfully learned the black-and-white discriminations. Graf (1976) trained 2.5–4-month-old piglets on a visual discrimination task with a "Landolt-C" symbol and an "O" symbol. The pigs needed between 120 and 200 trials to reach a level of 80% correct choices. As in the study conducted by Graf (1976), previous studies in our group also showed that pigs cannot be trained quickly to perform a discrimination task using visual stimuli (unpublished results). In contrast, sheep only needed 53 trials to learn to discriminate between a pair of 3-months old unfamiliar lambs, without pre-training with one stimulus (Ferreira et al., 2004). Pigs have a lower visual acuity than humans, sheep or cattle (Zonderland et al., 2008; Tanaka et al., 1995; Entsu et al., 1992). This may explain why pigs need more trials to learn a simple discrimination.

Thus, although pigs appear to be able to learn discrimination tasks with simple shapes as discriminative stimuli, data are inconclusive as to their ability to discriminate between conspecifics, solely based on visual information.

1.1. Effects of low birth weight on learning

In pigs, due to selective breeding, the number of piglets per litter has increased, and as a consequence the number of low birth weight (LBW) piglets has also increased (Quiniou et al., 2002). Research in humans has shown that birth weight and cognitive performance are correlated. Children with LBW often have learning problems and some may suffer from more severe cognitive and emotional issues (Kessenich, 2003). LBW babies of monkeys (*Macaca nemestrina*) have less developed learning abilities in a visual recognition task (Gunderson et al., 1989). Learning problems associated with a LBW are caused by brain injuries in most cases, induced by oxygen deprivation due to insufficient placental oxygen transfer (van den Broek et al., 2010).

LBW piglets may be used as a model for human LBW (Gieling et al., 2012). We recently adopted the spatial holeboard discrimination task for testing pigs. Successful learning in the holeboard task depends on orientation toward distal extra-maze (visual) cues (van der Staay et al., 2012). We found that pigs with a LBW showed delayed learning of the reversal, but not of the original learning task, compared with normal birth weight (NBW) siblings. This effect was seen for the working, but not the reference memory component of the holeboard task (Gieling et al., 2012). Lower cognitive abilities in piglets may also have an effect on welfare, due to less control over their environment (Wiepkema and Koolhaas, 1993).

1.2. Aim of the study

The aim of the present study was to investigate whether pigs are able to learn a simultaneous discrimination using 2D portrait photographs of conspecifics as discriminative stimuli, and whether birth weight affects their learning.

Because pigs appear to learn visual discrimination tasks slowly, visual discrimination tasks with increasing complexity were presented: (1) a simple discrimination task with one geometric black-and-white stimulus (2) a simultaneous discrimination task with two geometric black-and-white stimuli, followed by two reversals, and (3) a simultaneous discrimination task with portrait photographs of pairs of pigs as discriminative stimuli. The simple and simultaneous discriminations were included to train the pigs on the procedural requirements of the face recognition discrimination task, and because simple stimuli do not pose a serious challenge for the visual system. The reversal was included to detect possible differences in learning abilities between LBW and NBW piglets, as shown in a study by Gieling et al. (2012). Piglets with a low and a normal birth weight were tested. The five best performing animals that had mastered the simple and simultaneous discrimination tasks and their siblings were subsequently trained to discriminate between frontal portrait photographs of pigs. We hypothesized that piglets