Positive welfare indicators of the domestic pig (*Sus scrofa domesticus*): a review

Which of the indicators are being used for the on-farm evaluation of pig’s positive welfare?
Abstract

Since the 1960s the focus of animal welfare has been mainly on the negative aspects of welfare and on minimizing and alleviating these negatives. Lately, the focus has been not only on the negative features of welfare that should be kept above a minimum standard, but also on the positive ones that should be enforced. Positive welfare goes a step beyond the common welfare approach and focuses additionally on the positive aspects that animals should have in their lives. This review analyses the behavioral indicators that have been proposed as positive welfare indicators of the domestic pig and have been studied theoretically or experimentally. Various behavioral indicators have been proposed but play is the positive indicator that has been studied the most, followed by exploratory and social affiliative behaviors. Vocalizations and ear and tail postures have also been proposed as promising positive welfare indicators but more research is needed to clearly understand the expression of these behaviors and the affective states that they indicate. According to the literature results, the Welfare Quality protocol for pigs is the only protocol that evaluates the positive welfare of the pig on the farm level. Play, exploratory and social affiliative behaviors are being measured. In addition, positive emotions are being measured via Qualitative Behavioral Assessment (QBA).

Sammanfattning


Key words

Pig, Sus scrofa domesticus, positive welfare, positive welfare indicator, positive welfare assessment, play, social affiliative behaviors, vocalizations, Welfare Quality protocol for pigs

Acknowledgments

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TABLE OF CONTENTS

1. POSITIVE ANIMAL WELFARE ................................................................. 1

2. OBJECTIVE .......................................................................................... 2

3. MATERIALS AND METHOD .................................................................... 2

4. RESULTS .................................................................................................. 5
   4.1 POSITIVE WELFARE INDICATORS OF THE DOMESTIC PIG .............. 7
      4.1.1 EXPLORATORY AND FEEDING BEHAVIOR ..................................... 5
      4.1.2 PLAY ............................................................................................... 7
      4.1.3 SOCIAL AFFILIATIVE BEHAVIORS ............................................... 9
      4.1.4 SYNCHRONIZATION ..................................................................... 9
      4.1.5 MOTHER-YOUNG BONDING AND MATERNAL CARE ..................... 10
      4.1.6 PRO-SOCIAL BEHAVIORS ............................................................. 10
      4.1.7 SEXUAL AND MATING BEHAVIOR ............................................. 11
      4.1.8 EAR, TAIL AND BODY POSTURES ............................................. 11
      4.1.9 VOCALIZATIONS .......................................................................... 12
   4.2 POSITIVE WELFARE INDICATORS USED AT THE FARM LEVEL ........... 13
      4.2.1 THE WELFARE QUALITY PROTOCOL FOR PIGS ............................ 14
      4.2.2 OTHER STUDIES OF PIG’S ON-FARM WELFARE ASSESSMENT ....... 16

5. DISCUSSION ............................................................................................ 19
   5.1 DISCUSSION OF THE RESULTS ......................................................... 19
   5.2 DISCUSSION OF THE METHOD .......................................................... 24

6. ETHICAL CONSIDERATIONS .................................................................... 24

7. CONCLUSION ........................................................................................... 25

8. LIST OF REFERENCES ................................................................................ 25

APPENDIX 1: GLOSSARY ............................................................................. 30

APPENDIX 2: ANIMAL WELFARE ............................................................... 33

APPENDIX 3: WELFARE QUALITY PROTOCOL SCORE CALCULATION ........ 36
1. Positive Animal Welfare

Since the 1960s the focus of animal welfare has been mainly on the negative aspects of welfare and on minimizing and alleviating these negatives. Lately, the focus has been not only on the negative features of welfare that should be minimized and kept above a minimum standard, but also on the positive ones that should be enforced. This new concept of welfare, positive welfare, is a step beyond the common welfare approach and supports that since vertebræ are sentient beings, a life without negatives, as in humans, is not necessary a “good life” (Main & Yeates, 2008). The immunological, biological and neurological studies of animals’ emotions and cognition of the last decades have contributed to this new welfare direction (Boissy et al., 2007; Lawrence, Sandøe & Vigors, 2019). In addition, in 2009 the Treaty of Lisbon recognized officially animals as sentient beings. This was determinant for this redirection from the common welfare approach to the positive welfare approach (Lawrence, Sandøe & Vigors, 2019).

According to the positive welfare concept, there is need for redirection of the common welfare approach to a life with positive aspects that can push forward the debate of animal welfare (Lawrence, Sandøe & Vigors, 2019). The Five Freedoms, “freedom from hunger and thirst, freedom from discomfort, freedom from pain, injury and disease, freedom to express normal behavior and freedom from fear and distress”, were developed in 1992 by the Farm Animal Welfare Council (FAWC) and have influenced animal welfare globally. The motivational word “freedom” was easily understood and adopted and the Five Freedoms were effective during the period that they were developed, but today an updated animal thinking is necessary (Mellor, 2016). In addition, the words “freedom from” create the misconception that the negatives can be eliminated, but this is biologically impossible. This is because the neurological base of particular negative affects elicits behaviors that are essential for survival, like thirst and hunger. Furthermore, the Five Freedoms approach focuses mainly on the negatives with only the exception of the freedom to express natural behavior (Lawrence, Sandøe & Vigors, 2019; Main & Yeates, 2008).

There have been different approaches to positive animal welfare: the “quality of life” approach, the positive emotions approach, the positive affective states approach, and the happiness approach (Lawrence, Sandøe & Vigors, 2019). The reasons for having different approaches for defining welfare is because animal welfare in general is not only science-based, but also value-based. Scientists are humans and approach and define animal welfare influenced by their personal values (Fraser, 2008).

“Quality of life” (QoL) as a feature of animal welfare, was introduced by McMillan (2000). McMillan defined QoL in animals as the subjective, conscious, mental experiences of animals. He proposed that exclusively affect can only influence the QoL, that affect is a multidimensional continuum and that QoL varies along this continuum. He proposed a two domain model to describe it: comfort-discomfort and pleasures. McMillan (2000) insisted on that QoL should be judged by the animal’s point of view and that we should try to understand and validate the animal’s personal preferences and values with proxy measurements. The aim of QoL should be to give to the animals a better life with some pleasures and comforts and a right balance between the positives and the negatives (Lawrence, Sandøe & Vigors, 2019).

The positive emotions concept was introduced some years later. According to Lawrence, Sandøe and Vigors (2019), this concept was introduced due to the fact that results of different scientific areas have proved that animals are not only capable of experiencing short term emotions triggered from events in their environment, like pleasure, but also long term emotions, like happiness. There is strong
relationship between emotions and cognition and understanding animals’ emotions can contribute to improving their welfare (Boissy et al., 2007). Lawrence, Sandøe and Vigors (2019) support also that the positive emotions approach was develop as a reaction to the strong focus that the common welfare approach has on the negative emotions and experiences of animals.

Main & Yeates (2008) went a step further, by stating that positive animal welfare is not only correlated with positive emotions in general, but also with happiness in particular. Boissy et al. (2007) had also stated that animals are capable of experiencing happiness, but Main and Yeates (2008) suggested that there may be some equivalents between animal and human happiness. Webb et al. (2018) support that animal happiness is based on an affective component of happiness, has to do with how animals feel most of the time and is a long-term state that reflects welfare. Emotions are short-term in contrast to happiness that is long-term. This leads positive welfare a step further (Main & Yeates, 2008; Webb et al., 2018). Still much more research is needed in order to understand and study animal happiness (Webb et al., 2018).

Finally, the positive affective states concept of positive welfare was introduced by Mellor (2015a). The term “affective states” is broader than emotions and includes all subjective feelings and experiences of animals. According to Mellor (2015a) affective states may be understood to include all feeling and emotions that are consciously experienced as pleasant or unpleasant and motivate animals to behave in particular ways. They motivate animals to behave in goal directed ways which may accompany success of failure to achieve their goals.

So, it can be concluded that positive welfare focuses on “a good life” of animals, a life with positive emotions, positive affective states, happiness and “a good quality of life”, since the alleviation of the negative aspects of welfare is not enough for a good welfare. In theory, it is a step beyond the common welfare approach and it can improve the life of animals. Still, in practice, the measurement and evaluation of positive welfare is even more difficult than the evaluation of the common welfare and a challenge that requires a multidimensional scientific approach.

2. Objective

The aim with this review is to analyze the positive welfare indicators that, according to the literature, can be used for the domestic pig (Sus scrofa domesticus). I am also going to describe the positive welfare indicators that are used specifically for the on-farm assessment of pig’s welfare. The main questions that I would like to answer with this thesis are:

Which are the behavioral positive welfare indicators that can be used for the domestic pig?

Which of the positive welfare indicators are being used already for the on-farm evaluation of pig’s welfare?

3. Materials and method

This is a literature study based on scientific papers and books. All the material was retrieved through Google Scholar and the search period has been limited to the period 2010 to 2021.

Which are the behavioral positive welfare indicators that can be used for the domestic pig?
For the first question, I started by finding the keywords of my search. The population that I want to study is the domestic pig. So, the keywords that I have used for my search regarding the population are: pig* OR swine* OR “Sus scrofa” OR hog* OR piglet* OR sow* OR gilt* OR boar*. I used all these keywords in order to be able to find information about all types of groups of pigs. I have used the words “Sus scrofa” instead of “Sus scrofa domesticus”, nonetheless all the results referred to the domestic pig and none to the wild boar. I have used also the keywords “positive welfare” OR “positive state*” OR “positive emotion*”. I chose to proceed so, because positive welfare indicators are expressed when an animal is in a positive state or experiences positive emotions. Positive welfare is a relatively new field in welfare science and using all these phrases in my search gave a broader range of results. In addition, I used the keyword indicator*. By combining all the above, I build my main search as following:

“positive welfare” OR “positive state*” OR “positive emotion*” AND indicator* AND pig* OR swine* OR “Sus scrofa” OR hog* OR piglet* OR sow* OR gilt* OR boar*

The results were 2,150, they were sorted after relevance and were presented in pages of 10 articles. 16 articles were chosen. Only 60 pages were examined, since the articles were sorted after relevance. All 16 articles were selected by page 49. No more articles were selected after page 49, the articles seemed less relevant in the last pages and enough material was already gathered, so at stopped my research at page 60.

The selection of literature was done according to the following criteria: the articles referred to the domestic pig directly or to farm animals or domestic animals in general. The articles that referred to farm or domestic animals mentioned also the domestic pig or applied on its ethology. All the articles referred to positive welfare and positive welfare indicators. The positive welfare indicators that were described were based on pure theoretical analysis or experimental studies, but they did not have to be applied or studied on the field for the evaluation of positive welfare. They could be just proposals for future on-field studies. Only behavioral positive welfare indicators were selected. When more than one results appeared from the same author and referred to the same indicator, I selected only the more recent article. I selected two articles of the same author referring to the same indicator in only one case (Brown et al., 2015; Brown et al., 2017) because it was relevant for my analysis to compare the results of the two studies. If more than one articles of the same author were selected (Marcet-Rius et al., 2018a; Marcet-Rius et al., 2018b; Marcet-Rius et al. 2019) they referred to different positive welfare indicators. The selected literature results were all articles except two that were book chapters (Lawrence, Newberry & Špinka, 2018; Keeling, 2019). I summarize the results and chosen literature in the table 1, according to the above criteria.

Table 1: Searches and results about the positive welfare indicators that can be used for the domestic pig (*Sus scrofa domesticus*) according to theoretical and experimental studies.

<table>
<thead>
<tr>
<th>Search</th>
<th>Number of hits sorted after relevance</th>
<th>Number of examined literature</th>
<th>Number of selected literature</th>
</tr>
</thead>
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<tr>
<td>“positive welfare” OR “positive state*” OR “positive emotion*” AND indicator* AND pig* OR swine* OR “Sus scrofa” OR hog* OR sow* OR gilt* OR boar*</td>
<td>2.150</td>
<td>600</td>
<td>16</td>
</tr>
</tbody>
</table>
Which of the positive welfare indicators are already being used for the on-farm evaluation of pig’s welfare?

Regarding the second question, it was difficult to find material. I have tried the following searches, as analyzed in table 2:

Table 2: Searches and results about the positive welfare indicators that are already being used for the on-farm welfare evaluation of the domestic pig (Sus scrofa domesticus) or have been tested in pilot studies of on-farm welfare assessment protocols.

<table>
<thead>
<tr>
<th>Search</th>
<th>Number of hits sorted after relevance</th>
<th>Number of examined literature</th>
<th>Number of selected literature</th>
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<tr>
<td>“positive welfare assessment” OR “positive welfare evaluation” AND pig* OR swine* OR porcine</td>
<td>15</td>
<td>15</td>
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<tr>
<td>“on-farm welfare assessment” AND pig* OR swine* OR porcine</td>
<td>743</td>
<td>743</td>
<td>4 (Rice et al., 2013; Temple et al., 2011a, 2013; Vitali et al., 2020)</td>
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<tr>
<td>&quot;positive welfare indicator*&quot; AND &quot;welfare assessment&quot; AND pig* OR swine OR porcine</td>
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<td>26</td>
<td>1 (Rice et al., 2013) (this article was also retrieved through search 2)</td>
</tr>
<tr>
<td>&quot;on-farm welfare assessment&quot; AND &quot;positive welfare&quot; AND &quot;pig* OR swine OR porcine</td>
<td>131</td>
<td>131</td>
<td>2 (Rice et al., 2013; Vitali et al., 2020) (these articles were also retrieved through search 2)</td>
</tr>
<tr>
<td>“Welfare Quality protocol” AND application OR assessment AND pig* OR swine OR porcine</td>
<td>765</td>
<td>765</td>
<td>3 (Czycholl et al. 2016, 2017; Temple et al., 2011b)</td>
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The criterion for the selection of articles retrieved by searches 1 to 4 was that the articles should refer to behavioral positive welfare indicators that are already being used for the on-farm positive welfare evaluation of the pig or have already been used in pilot studies of on-farm welfare assessment protocols. Literature about positive welfare indicators that are proposed for future studies of the on-farm assessment of positive welfare but are not already used were not selected. Since the 2 out of the 4 selected articles through searches 1 to 4 referred to the Welfare Quality Protocol for pigs, I read and used in my study the Welfare Quality protocol for pigs (2009). I made additionally search 5 in order
to gather more information about the reliability and validity of the behavioral positive welfare indicators analyzed and used in the protocol. Regarding the reliability, data for inter-, intra-observer and test-retest reliability were selected. Articles that were selected via search 2 were not selected by search 5. Since it was difficult to find material to answer the second question of this thesis, more than one articles of the same authors were selected.

4. Results

4.1 Positive welfare indicators of the domestic pig (*Sus scrofa domesticus*)

In this subchapter, I am going to describe the behavioral positive welfare indicators that, according to the literature findings, can be used for the domestic pig. The analysis includes both positive welfare indicators that have been studied experimentally and positive welfare indicators that have been analyzed and proposed pure theoretically. In total, nine welfare indicators were retrieved. The results are summarized in table 3. The table indicates which of the sixteen selected literature results contain information for each of the nine positive welfare indicators that were retrieved.

4.1.1 Exploratory and feeding behavior

Two literature findings were retrieved that propose strongly exploratory and feeding behavior as a positive welfare indicator: Mellor (2015b) and Keeling (2019). Mellor (2015b) focuses more on the feeding behavior and the pleasure that the animal acquires by exploring and tasting the food. On the other hand, Keeling (2019) focuses exclusively on the exploratory behavior. Keeling (2019), in contrast to Mellor (2015b), supports also that attention is needed because although exploratory behavior is a good candidate as positive welfare indicator, sometimes it can be performed by the animals due to fear. Both articles refer to all domestic animals in general, and not specifically to the domestic pig. The fact that pigs have a strong natural need to explore and to root and in nature forage half of their time (Špinka, 2017) makes exploratory and feeding behavior promising positive welfare indicators for the domestic pig.

According to Mellor (2015b), exploratory and food acquisition behavior are likely to be accompanied with positive affects for the animals. The animals experience positive affective states while performing these behaviors and persist on performing them because of the appetitive rewards that they expect and the pleasurable consummatory reinforcement that they experience after they have achieved their goals.

Keeling (2019) explains that an animal that explores a new object has the choice to approach or not and a secure base (can be both a location and a familiar individual) to approach from. According to Keeling (2019), there are two types of exploratory behavior: the inquisitive exploration when the animal is looking for a change and the inspective exploration when an animal responds to a change. The first one is always linked to positive states since animals are inquisitive only when they have the opportunity and at the same time they feel safe. On the other hand, inspective exploration can be linked both with fear and positive states, like excitement. Keeling (2019) highlights also that exploration is strongly linked to cognition. Individuals that experience positive states appraise the environment as good and seek out for cognitive stimulation. This is another factor that indicates that exploratory behavior is a good potential indicator of positive states in animals.
Table 3: Selected literature results about behavioral positive welfare indicators of the domestic pig that have been studied theoretically or experimentally. The table indicates which literature contains information for which indicator.

<table>
<thead>
<tr>
<th>Author (year of publication)</th>
<th>Exploratory and feeding behavior</th>
<th>Play behavior</th>
<th>Social affiliative behaviors</th>
<th>Synchronization</th>
<th>Mother-young bonding and maternal care</th>
<th>Pro-social behaviors</th>
<th>Sexual and mating behavior</th>
<th>Ear and tail postures</th>
<th>Vocalizations</th>
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<tr>
<td>Alhoy-Dallaire, Espinosa &amp; Mason (2018)</td>
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<td>Brown et al. (2015)</td>
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<td>Camerlink &amp; Ursinus (2020)</td>
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<td>Held &amp; Spinka (2011)</td>
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<td>Keeling (2019)</td>
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<td>Laurijs et al. (2021)</td>
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<td>Lawrence, Newberry &amp; Špinka (2018)</td>
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<td>Levivełd et al. (2019)</td>
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<td>Marcet-Rius et al. (2018a)</td>
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<td>Marcet-Rius et al. (2019)</td>
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<td>Martin, Ison &amp; Baxter (2015)</td>
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<td>Mellor (2015b)</td>
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<td>Rault (2019)</td>
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<td>Yang et al. (2018)</td>
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</table>
4.1.2 Play behavior

Play is the behavior which has been studied the most as positive welfare indicator, not only for pigs but for all domestic animals. Ten literature findings were retrieved. Five of them are articles of experimental studies performed on the pig. Most of these experiments have been performed on pre-weaned pigs (Brown et al., 2015; Brown et al., 2017; Martin, Ison & Baxter, 2015; Yang et al., 2018). The study of Brown et al. (2017) continues also post-weaning until the animals are eight weeks of age. Only the study of Marcet-Rius et al. (2018a) has been performed on older animals of six months of age. In this study, in contrast to all the others, the animals are mini-pigs. The other five literature findings (Ahloy-Dallaire, Espinosa & Mason, 2018; Held & Špinka, 2011; Keeling, 2019; Lawrence, Newberry & Špinka, 2018; Mellor 2015b) analyze play as positive welfare indicator theoretically. The article of Lawrence, Newberry and Špinka (2019) refers exclusively on the domestic pig. The other four articles refer to all domestic animals in general, but mention also the domestic pig.

Various aspects of play behavior make it appropriate as positive welfare indicator. Firstly, play is a luxury behavior, performed when there are no threats to fitness. It is also sensible to food availability and weather conditions (Held & Špinka, 2011). Under environmental conditions that risk fitness, play behavior is reduced or even disappears in both adult and young animals (Ahloy-Dallaire, Espinosa & Mason, 2018). Play can be suppressed not only in quality but also in quantity when the welfare of an individual is compromised, so both quantity and quality of the behavior can be potential positive welfare indicators. Secondly, an animal that plays experiences pleasure, and so has an immediate positive impact on its welfare. Playing can be exciting, thrilling, relaxing and rewarding (Mellor 2015b). The self-rewarding nature and neurobiological base of play indicate that a playful animal is in good state of welfare (Held & Špinka, 2011; Mellor, 2015b). According to Ahloy-Dallaire, Espinosa and Mason (2018), animals are strongly motivated to play because of the pleasure they experience, and they should be allowed to play in order to experience a good welfare. Thirdly, play has in addition to immediate, long term positive welfare benefits for the individual. It contributes to developing competencies, enhanced skills and somatic qualities that will help the individual to adjust flexibly to changes and stressful conditions in the future (Held & Špinka, 2011). The animal trains the behavior as juvenile and can use it successfully when needed as adult in the future. As a result, animals deal more effectively in the future with unexpected challenging events. So, play has a significant role in improving welfare not only in the present, but also in the future (Mellor, 2015b). Fourthly, play is socially contagious, indicates good group functioning (Held & Špinka, 2011) and contributes to bond affirmation when including at least two individuals (Mellor, 2015b). For these four aspects it is considered promising as positive welfare indicator. The first aspect alone is not sufficient, since the absence of fitness threats does not indicate necessary a good welfare- more likely the absence of negative states. According to the positive welfare approach, since animals are sentient beings a life without negatives, as in humans, is not necessary a good life (Main & Yeates, 2008). However, together with its self-rewarding nature and its immediate and long term positive impacts on welfare, play becomes a strong positive welfare candidate.

Among animals under human care, the domestic pig is one of the most playful species. It has been proved that play has both immediate and long-term benefits on pig’s welfare. By playing with other individuals, pigs enhance their social status, decrease tension and aggression and experience less social stress. They develop their socio-cognitive ability and they are trained to deal more effectively with stressful situations and novelties in the future. Martin, Ison and Baxter (2015) observed the behavior of piglets that were raised in a neonatal environment of a conventional farrowing crate compared to the behavior of piglets that were raised in a complex neonatal environment with more space and environment enrichment including toys. Post-weaning both groups were kept in the same
The piglets that were held in the complex environment pre-weaning developed play behaviors earlier, played more pre-weaning and resolved their post-weaning aggressions quicker than the pigs that were kept in the conventional neonatal environment as piglets. Furthermore, the pigs that were held in the enriched crate and played more as piglets, performed better in cognitive tests post-weaning: they were better at discriminating between familiar and novel objects. So, the scientists concluded that play is fundamental for a successful socio-cognitive development in piglet's life. In another study, Yang et al. (2015) showed that piglets that were held with extra neonatal enrichment (in this study hanging objects and wood bark substrate) showed more object play after lactation, in contrast to the group of pigs that was held without extra neonatal enrichment pre-weaning. More importantly, the group that was held with the extra neonatal enrichment showed improved ability to cope with weaning stress, since salivary cortisol did not increase post-weaning compared to pre-weaning, in contrast to the group of pigs that was held without the extra neonatal enrichment pre-weaning. The results of both Martin, Ison and Baxter (2015) and Yang et al. (2015) indicate that play in the neonatal period can reduce the weaning stress and the post-weaning aggression.

Marcet-Rius et al. (2018a) studied mini-pigs of six months age. In their study the play group participated in play sessions with the provision of toys, one or two sessions per day for three weeks. The control group did not participate at all in play sessions. At the end of each week the difficulty/ease of working with the pig was marked in a visual analogue scale. In addition, blood samples were taken before and after each play session and the oxytocin level was measured. There was no significant difference for the difficulty/ease of working with the pigs, but this was explained by the fact that all animals were socialized to humans before the study. Regarding oxytocin, the oxytocin level of the play group was stable before and after the play sessions in contrast to the oxytocin level of the control group that was higher after the play sessions. It was concluded that the animals in the play group were already in balanced state due to the environmental enrichment and the experience of playing. In contrary, the control group demonstrated increased oxytocin level after two blood samplings due to trying to cope. These results of Marcet-Rius et al (2018a) are in accordance with the results of Martin, Ison and Baxter (2015) and Yang et al. (2015) and support that the pigs who play have the ability to cope easier with stressful situations.

Another significant positive effect of play on pig’s welfare is that it is a contagious activity that can be described as “emotional contagion” (Held & Špinka, 2011). As a result, raising play levels only by a moderate degree in captivity for few individuals can stimulate play and pleasure in a whole group of animals. Pigs are highly social animals and play is usually synchronized within litters. Brown et al. (2015) studied spontaneous play behavior between and within litters and observed that 50% of the variance in play behavior was found between litters and only 11% between piglets of the same litter. It was concluded that this was due to the contagiousness of the behavior.

The existing literature suggests that pigs play more in better welfare conditions, so the different levels of spontaneous play between two environments can serve as indicator of positive welfare differences between them (Lawrence, Newberry & Špinka, 2018). Still, play behavior varies between and within species. This flexibility of the behavior is a difficulty for defining, identifying and using play in practice as positive welfare indicator (Ahloy-Dallaire, Espinosa & Mason, 2018; Held & Špinka, 2011). The behavior presents sexual dimorphism, with male pigs engaging in more social play and female pigs in more locomotory play (Brown et al., 2015; Brown et al., 2017; Martin, Ison & Baxter, 2015). In addition, males engage in play fighting more than females (Brown et al., 2015). There is also the opinion that play may be adequate as positive welfare indicator only for the neonatal and not for the adult pigs. Moreover, the behavior is expressed more in young pigs and declines with age.
When the previous mentioned study of Brown et al. (2015) was performed for the play behavior post-weaning, the pre-weaning litter differences in play behavior were not constant post-weaning with the exception of non-harmful fighting. It was suggested by these results that play may be a sensitive positive indicator only for the neonatal pigs (Brown et al., 2017). In order for play to be used as a positive welfare indicator for pigs more effectively, more work needs to be done in the direction of understanding the structure and the fitness benefits of the behavior.

4.1.3 Social affiliative behaviors

Three literature findings were retrieved regarding social affiliative behaviors and their use as positive welfare indicators. All three are based on theoretical analysis. The articles of Mellor (2015b) and Keeling (2019) analyze the behaviors for all domestic animals in general. Lawrence, Newberry and Špinka (2018) describe social affiliative behaviors as positive welfare indicator exclusively for the domestic pig.

All results describe that these behaviors are typical for social animals since they initiate and strengthen the relationship between individuals and the cohesion in a group. Social affiliative behaviors are associated with bonding and bond affirmation and a strong motivation to attain and maintain the comfortable and comforting positive affects of affectionate companionship or protection (Mellor, 2015b). Bonding within a species may occur both at group level and between individuals, especially individuals that have been reared together or are related (Mellor, 2015b). These behaviors have a social buffering effect that helps the individuals to recover better from stress thanks to the presence of conspecifics (Keeling, 2019).

Social affiliative behaviors are important for social species like the pig since they can help social animals to feel bonding and group cohesion and cope easier with stressful situations (Lawrence, Newberry & Špinka, 2018). The domestic pig is a highly social animal that lives in flexible social grouping (Špinka, 2017). Expression of these behaviors can indicate positive affective states and contribute to less stress in the whole group.

4.1.4 Synchronization

Only one result was retrieved for this potential positive welfare indicator (Keeling, 2019) although results of play behavior describe that a positive aspect of play behavior is that it is contagious and synchronized within pig litters (Brown et al., 2015).

According to Keeling (2019), synchronization could be potentially a positive welfare indicator for group-housed social species like the pig since being synchronized in a group is rewarding and positive for social animals. Behavioral synchronicity and social affiliative behaviors create cohesion and security in a group. A behavior is spread through individuals and this behavioral contagion implies positive affective states. Pigs tend to synchronize their behaviors. So, synchronization could be a good candidate as positive welfare indicator. However, little work has been done yet for its validation. Another complicated factor is that welfare is the characteristic of the individual while synchronization is a group phenomenon (Keeling, 2019). Nonetheless, it could be studied for group-housed social species like the pig in parallel with other positive welfare indicators that apply on the individual.
4.1.5 Mother-young bonding and maternal care

Only one article refers to mother young bonding as positive welfare indicator. Mellor (2015b) states that mother-young bonding and maternal care are strongly motivated by animals and generate affiliative emotions. Young animals and newborns are strongly motivated to experience the maternal care, while mothers are strongly motivated to care for and protect their young. The fact that mother-young bonding can even develop between different species, is according to Mellor (2015c) an evidence of the positive affective states caused by this mechanism.

Expression of the maternal behavior could generate positive affective states both to the sow and the piglets. In addition, it could enhance the sow-piglet play behavior and the positive affects caused by play to the animals.

4.1.6 Pro-social behaviors

Pro-social behaviors, only described by Rault (2019) as possible welfare indicator, are actions in which an individual engages in order to benefit others. Pro-social behaviors by definition result to benefits on the target of the behavior (recipient), but do not necessary preclude benefits to the emitter of the behavior (donor) and exclude social behaviors with no evident benefit for the recipient (Rault, 2019). They can also be described as “helpful” or “other-regarding” behaviors.

The repertoire of pro-social behaviors is diverse. It includes various behaviors like parental care, affiliation, sharing, social teaching, cooperation and other types of helpful behaviors towards others. Care giving (mostly refers to parental care), social affiliative behaviors and behavioral synchronization are the pro-social behaviors that have been studied the most. Nonetheless, there is lack or research in other types of caring and sharing behaviors, since the definition is quite broad (Rault, 2019).

According to Rault (2019), pro-social behaviors can be interpreted as positive welfare indicator if they occur regularly, because of their beneficial nature and the positive welfare states that they promote to the recipient. Maternal care, social affiliative behaviors, social play and synchronization have already been analyzed above as positive welfare indicators for the pigs. Still, there are other pro-social behaviors that also could be studied as potential positive indicators, since the definition of pro-social behaviors is broad. An example is sharing behavior, namely sharing resources of space and food with other individuals in the group. Another advantage that pro-social behaviors have as positive welfare indicators for future studies, is that in most cases the behavior is beneficial not only for the recipient but also for the donor (although this is not necessary by definition). So, they can be positive indicators of bilateral nature. In addition, they reflect that a social group is functioning, which is important for group-housed social species like the pig.

On the other hand, since pro-social behaviors are mostly promoted in stable social group structures, it is difficult to measure and study them in intensive systems due to the often mixing and separation of animals (Rault, 2019). Furthermore, many pro-social behaviors can be observed only in feral pigs or the wild boar and not in the domestic pig, for example behaviors like responses that promote foraging or protection from predators.
4.1.7 Sexual and mating behavior

According to Mellor (2015b), which is the only literature result that was retrieved for this indicator, sexual behavior is another animal-to-animal interactive behavior which indicates that the individuals are experiencing positive affective states. The behavior is pleasurable for both sexes and in some species performed even outside the breeding season. As for all animals, the sexual behavior of the pig could indicate the experience of pleasure. Still, in pig husbandry systems the mating occurs mainly artificially and without any sexual activity, so this behavior would not be applicable as positive welfare indicator. However, the sow is usually kept under boar contact after the weaning so that the oestrus can be promoted. The sow can see and smell the boar, but usually not touch him.

4.1.8 Ear, tail and body postures

Ear, tail and body postures have been studied as indicators of positive emotions in various domestic animals. Six literature results were retrieved regarding ear and tail postures as potential positive welfare indicators of the pig. Three of them (Camerlink & Ursinus, 2020; Keeling, 2019; Lawrence, Newberry & Špinka, 2018) are theoretical studies. Camerlink and Ursinus (2020) and Lawrence, Newberry and Špinka. (2018) describe these indicator specifically for the domestic pig. Keeling (2019) analyzes these indicators in general for all domestic animals. The other results (Marcet-Rius et al, 2018a; 2018b; 2019) are experimental studies. Marcet-Rius et al. (2018a) studied tail movement on mini-pigs. Marcet-Rius et al. (2018b; 2019) studied both tail and ear movement on the domestic pig. All results agree on that tail and ear movements are promising positive welfare indicators for the on-farm welfare assessment. Marcet-Rius et al. (2018b) support that tail movements are more effective as positive welfare indicators compared to ear movements. Keeling (2019) and Lawrence, Newberry and Špinka (2018) highlight the importance of combining them also with other behavioral indicators in order to assess welfare and that more studies are needed in order to understand ear and tail postures in various behavioral contexts of the domestic pig. Body postures have been mentioned in two literature findings but not analyzed deeply as positive welfare indicators (Keeling, 2019; Marcet-Rius et al., 2018b). They have been proposed as a direction for future studies.

A pig’s tail can vary in posture, movement and frequency of postural changes. Camerlink and Ursinus (2020) allocated the tail postures to the four quadrants of the circumplex model of affect. They concluded that a curled tail can be allocated to the quadrant of positive valence and high arousal. A tucked and motionless tail to the quadrant of negative valence and low arousal when tucked, or to the quadrant of negative valence and high arousal as a response to a threat. A relaxed hanging and loosely wagging tail can be allocated to the quadrant of positive valence and low arousal. So, they concluded that the pig’s tail can give significant information about the animal’s emotional state.

Increased tail movement in pigs is linked to positive emotions (Lawrence, Newberry & Špinka, 2018). Marcet-Rius et al. (2018a) observed a positive correlation between the frequency of object play and the duration of tail movement in mini-pigs that were introduced to toys, compared to a control group that was raised and housed under the same conditions but not been introduced to play sessions. A positive correlation was also observed between the duration of social play and the duration of tail movement. Based on these findings, Marcet-Rius et al. (2019) continued by studying tail and ear movements as potential behavioral indicators of positive emotions in fattening tail-docked pigs in experimental farm conditions. The scientists wanted to investigate if tail and ear movements could be used as potential indicators for the on-farm evaluation of positive welfare. Some animals were housed
with access to enrichment material that allowed exploratory behavior (straw in a rank, wooden locks or chains). It was observed again that both duration and frequency of tail movement were increased in the animals that were offered the environment enrichment, compared to the control group that was not offered any enrichment. It was suggested that the more the pigs play, the more they use their tails. As a result, it was concluded that the duration and frequency of tail movement should be studied as an indicator of positive emotions in pigs for the on-farm evaluation of positive welfare.

Ear postures and movements have also been studied as indicators of emotions, although less than tail movements. Increased ear movement is linked to negative emotions (Lawrence, Newberry & Špinka, 2018). Marcet-Rius et al. (2018b) observed decrease of the frequency of ear movement in the mini-pigs that were introduced to play sessions, compared to the control group that was not introduced to play sessions. It was observed that the animals during play move their ears less frequently. It was suggested that decrease in ear movements can indicate decrease in positive emotions, but not necessary the presence of neutral or negative states. On the contrary, while studying fattening pigs in experimental farm conditions, the scientists found no significant differences regarding change of ear movements due to play and environmental enrichment. This observation was in contrast to the observations regarding tail movement that showed significant differences due to enrichment and play (Marcet-Rius et al., 2019). Therefore, it can be concluded that tail postures may be a stronger candidate as positive welfare indicator compared to ear postures for the pig.

Body postures have been proposed as a potential positive welfare indicator for the future. They have the advantage of being feasible, non-invasive and reasonable in time and cost indicators for the on-farm assessment of positive welfare (Marcet-Rius et al., 2018b). Nonetheless, they have the disadvantage of being influenced by the personal arousal of the animal. In addition, the same body posture can be observed in different emotional states and so it is important to observe a specific part of the body not separately but in the whole body posture (Keeling, 2019).

### 4.1.9 Vocalizations

Vocalizations have been studied as indicators of emotions in various animals, especially in the domestic pig that has a rich repertoire of vocal expressions. Three literature results describe vocalizations as potential positive welfare indicator for the pig, two on theoretical base (Keeling, 2019; Laurijs et al., 2021) and one on experimental base (Leliveld et al. 2016). All three agree that although vocalizations should be combined with other indicators of emotions and more studies are needed, they are promising as positive welfare indicators and could be used also during the on-farm welfare evaluation. Keeling (2019) mentions in addition a concern that vocalizations cannot be reliable in all situations and should be examined each time in the whole context of the situation.

The domestic pig’s vocal expressions include grunts, barks, squeals and screams (Laurijs et al., 2021). Grunts are produced in various negative and positive situations. Barks are common during alarm call and play behavior. Squeals and screams are higher in frequency and are produced mostly in negative situations, especially screams. An example is the screams that piglets emit during castration or when they are trapped under the sow (Laurijs et al., 2021). Lower frequency vocalizations are produced more in positive situation, however within grunts higher frequencies indicate positive situations.

Vocalizations have also been studied as a mean of measuring emotional valence in pigs and not only strongly negative and positive emotions. Leliveld et al. (2016) studied if subtle variations of emotional...
valence, like those often caused by moderate differences in husbandry conditions, could affect the welfare and mood of animals when they occur consistently, and if this emotional valence could be indicated by the vocalizations of animals. They conditioned young weaned pigs to a repeated startling or rewarding procedure for some sessions. The startling procedure was sudden noise or appearance of objects and the rewarding procedure applesauce, toys or straw. Through detailed acoustic analysis, they observed that the positively conditioned pigs produced in general fewer vocalizations, fewer low-frequency grunts, but more high-frequency grunts compared to the pigs that were conditioned startling. They concluded that vocalization patterns can be useful for the examination of emotional valence and could be used as indicators in pigs, especially if they are combined with other physiological and ethological indicators.

A combination of vocalizations and other indicators of emotions could be a promising direction for the on-farm assessment of welfare. It is a non-invasive way of assessing positive welfare and can be observed by using microphones or automated vocalization detection systems (Laurijs et al., 2021). Among all farm animals, experimental research has been carried mostly on pigs. Still, much more research is needed. A disadvantage of using vocalizations as emotional indicators is that the same vocalization cannot be a reliable indicator in all situations, since its meaning can vary. Thus, each time a vocalization has to be examined and interpreted judging by the whole context of the situation (Keeling, 2019). In addition, another disadvantage it that a vocalization reflects the welfare at the moment that it is expressed by the animal because of its very short duration, and not the general state of an animal. Finally, in intensive systems it is difficult to detect only one animal that deviates from the group by its vocalizations, it is easier to use the vocal indicators for the whole group instead (Laurijs et al., 2021). So, vocalizations may be more suitable as positive welfare indicators for a whole group of animals instead of an individual, although welfare is a characteristic of an individual and not of a group (Keeling, 2019).

4.2 Positive welfare indicators used at the farm level

In this second subchapter, I am going to analyze the behavioral positive welfare indicators that are already being used for the on-farm evaluation of pig’s positive welfare. I am going also to describe some positive welfare indicators that have been used in the welfare assessment of the pig in pilot studies. The results were limited, only four articles were retrieved. Two of them (Temple et al., 2011a; 2013) refer to the Welfare Quality assessment protocol for pigs (Welfare Quality, 2009). Due to this the protocol was studied further. The third article (Vitali et al., 2020) refers to a pilot study of a proposed welfare assessment protocol for suckling piglets. The fourth literature finding (Rice et al., 2013) is a report conducted for the Co-operative Research Center for High Integrity Australian Pork (Pork CRC). The project evaluated an assessment tool to monitor and benchmark the welfare of animals in research housing and husbandry systems under study in Pork CRC projects. I have included it in the results since the Pork CRC studies housing, managing and husbandry systems that aim to improve the Australian pig industry and be applied in practice. Criteria of the Welfare Quality protocol for pigs regarding positive welfare were incorporated both in the pilot study of Vitali et al. (2020) and the assessment tool of Pork CRC. Actually, most of the general welfare criteria that are proposed and used in these two pilot projects, are criteria of the Welfare Quality protocol for pigs (2009). This highlights the importance of the Welfare Quality protocol for the on-farm welfare assessment of the pig. As far as the literature results have shown, the Welfare Quality protocol for pigs (2009) is the only on farm welfare assessment protocol that evaluates officially the positive welfare of the pig by measuring positive welfare indicators. The literature results have also shown
that play is the positive welfare indicator that is mostly used/proposed to be used for the on-farm evaluation of pig’s welfare, followed by exploratory behavior and positive social behaviors, which include among other measures of play and social affiliative behaviors. In addition to the use of these positive welfare indicators, the Welfare Quality protocol evaluates the positive emotions of the pig.

4.2.1 The Welfare Quality protocol for pigs

All the below information have been retrieved by studying the Welfare quality assessment protocol for pigs (sows and piglets, growing and finishing pigs) (2009).

The Welfare Quality project is a European project that has developed standardized ways and scientific tools of assessing animal welfare and providing feedback on the welfare status of food production animals. It has been used extensively not only in Europe, but also globally. For the domestic pig, the welfare of sows, piglets and growing pigs is evaluated on the farm level and the welfare of finishing pigs is evaluated on the slaughterhouse. Measures are collected and then a bottom-up approach is used for integrating the collected measures to an overall assessment of the animal unit. The measures are first turned to twelve welfare criteria, which are then turned to four welfare principles: good feeding, good housing, good health and appropriate behavior. The principles-scores are used to assign the unit to one of the four welfare categories: excellent, enhanced, acceptable welfare and not classified farms (farms that do not reach the minimum standards).

The key welfare question that the welfare principle appropriate behavior wants to answer is: Does the behavior of the animals reflect optimized emotional states? This is where aspects of positive welfare are evaluated. The four welfare criteria that are comprised in this welfare principle are: expression of social behaviors (criterion number 9), expression of other behaviors (criterion number 10), good human-animal relationship (criterion number 11) and positive emotional state (criterion number 12).

The protocol states that the criterion of expression of social behaviors is defined as “animals should be able to express normal, not harmful social behaviors”. Regarding sows, piglets and growing pigs both positive and negative social behaviors are being recorded. The observations take place in the morning when animals are more active. The negative social behaviors that are being recorded are aggressive behaviors or aggressive social behavior with a response from the disturbed animal. The positive social behaviors that are observed are defined as “sniffing, nosing, licking and moving slowly from the animal without aggressive or flight reaction from this individual”. The positive social behaviors include social affiliative behaviors as positive welfare indicators. The recording of these spontaneous behaviors is performed by using five scan samples made at two minutes interval. After this, a summary is calculated at the scoring sheet. By this summary the social behavior is scored as positive, negative or neutral. The criterion of expression of social behavior is not evaluated for finishing pigs in slaughterhouses.

The criterion expression of other behaviors is defined as “animals should be able to express normal species-specific natural behaviors such as foraging or exploring”. For the evaluation of this criterion two welfare indicators are measured: stereotypies as negative welfare indicator and exploratory behavior as positive welfare indicator. Regarding the exploratory behavior, the measuring is made again via scan sampling of spontaneous behaviors. The observations and recordings are made simultaneously with the positive and negative social behaviors. Two behaviors are being recorded as exploratory behavioral indicators: investigation of the pen and exploring of the enrichment materials. The investigation of the pen is defined as “sniffing, nosing, licking or chewing features within the pen”. The exploration of enrichment materials is defined as “play or investigation towards straw or any other enrichment material”. So, not only exploratory, but also play behavior is evaluated as
positive welfare indicator. Play is actually noted as a separate indicator in the scoring sheet. As for the social behaviors criterion, the criterion of exploratory behaviors is not used for the welfare assessment of finishing pigs in slaughterhouses.

The criterion good human-animal relationship is not assessed via positive welfare indicators. It is simply observed if the animal allows the assessor to touch it or withdraws or approaches the assessor.

Finally, the criterion of positive emotional states is the one that evaluates the most the animals’ positive welfare. The protocol states that negative emotions such as distress or fear should be avoided whereas positive emotions such as contentment or security should be promoted. Positive emotional states are measured with Qualitative behavioral assessment (QBA). Animals’ interaction with each other and the environment is observed and described by using a 125 mm visual analogue scale. Terms of positive emotions that are used and measured via QBA are: calm, content, happy, enjoying, playful, positively occupied, active, relaxed, lively and sociable. In total, twenty positive and negative emotions are scored for the total emotional state calculation. Not all have the same weight in the total calculation. Content, positively occupied, active and happy have the highest positive weight and frustrated and listless the highest negative weight. For finishing pigs, the positive emotional state principle is scored via QBA during unloading. It is observed if animals are reluctant to move or turn back during the unloading.

So, the Welfare Quality protocol for pigs (2009) uses as positive welfare indicators the social affiliative behaviors, exploratory behavior and play behavior. In addition, it evaluates and measures positive emotional states of the animals. Social behaviors, exploratory behavior and play are measured via scan sampling of spontaneous occurring behaviors. Emotions are measured via QBA. The four welfare criteria are equally taken into consideration for the calculation of the appropriate behavior principle that wants to investigate and answer if the behavior of animals reflects an optimized emotional state. It is just one of the four welfare principles that the total welfare calculation comprise, still, it can be concluded that positive welfare has a significant role in the calculation of the total welfare score during the on-farm assessment. In addition to the above indicators, the Welfare Quality protocol uses high pitched vocalizations for scoring the good-human animal relationship criterion for finishing pigs in slaughterhouses. Squeals and screams are noted, but in this case, the vocalizations are used as a negative welfare indicator.

The focus of the protocol is on animal-based measures. All indicators should be valid, reliable and feasible (Welfare Quality, 2009). Temple et al. (2011a) have studied the application of the Welfare Quality protocol to assess growing pigs kept under intensive conditions in thirty conventional farms in Spain. The aim was to study the validity and sensitivity of the protocol and its capacity to discriminate among conventional farms. Regarding positive social and exploratory behaviors, the variability was high between farms, which means that the methodology is sensitive to between farm factors. For exploratory behavior, variability was noticed not only between farms, but also between the rooms of the same farm. It was concluded that the methodology of assessing exploratory behavior is sensitive not only to between-farm but also within-farm factors. The QBA showed variability between farms for all descriptors except “distressed” but no statistical analysis for evaluation of the variability was made. It was concluded that all the behavioral measures, and so the behavioral indicators of the protocol were effective and sensitive when it comes to intensive farms, but further studies should be made. In the same year, Temple et al. (2011b) applied also the behavioral measures of the protocol on Iberian pigs of eleven extensive and ten intensive farm units in order to evaluate the changes in the occurrence of behaviors and in the qualitative measures between these two different types of systems. They concluded that negative, positive social behaviors and QBA are sensitive to changes in the housing and the management. On the other hand, no differences were observed in the
expression of exploratory behavior between extensive and intensive Iberian pigs. Temple et al. (2011b) concluded that high negative social interactions in intensive system clearly indicate poor welfare, but the results of positive interactions and exploratory behavior can create misconceptions and so behavioral observational measures of the protocol should be questioned as useful tool to discriminate among farms of different rearing systems. QBA gave good variability between intensive and extensive farms (Temple et al., 2011b). So, by the two studies of Temple et al. (2011a, 2011b) it was concluded that behavioral measures of the protocol have good validity between farms of the same rearing system but their validity should be questioned when it comes to farms of different rearing systems. On the contrary, QBA is sensitive as a mean to discriminate both among farms of the same and different rearing systems.

Czycholl et al (2017) observed specifically the reliability of QBA as included in the protocol for growing pigs. They evaluated the inter-, intra-observer and test-retest reliability. QBA observation was performed by two observers on-farm or via video recording. Twenty-four farm systems were studied. For the evaluation of inter-observer reliability, the two trained observers watched video sequences separately. For the intra-observer reliability each observer watched the video twice with an interval of six months. For test-retest reliability the assessment were compared between two growing periods, for animals of similar weight. Principal component analysis showed that test-retest and inter-observer reliability of QBA was insufficient when on-farm assessed, in contrast to when assessed via video recording. So, QBA should be questioned as the best way for the on-farm assessment of positive emotions. It was suggested that other methods like evaluation of play behavior and novel object test should be studied as alternatives. On the contrary, Czycholl et al. (2016) support that behavioral observations have good reliability as positive welfare measure in the protocol via instantaneous scan sampling. Observations were done again in twenty-four farms. It is not clarified in the two papers if the twenty-four farms that were studied are the same as in Czycholl et al. (2017), but judging by the description they should be the same. Temple et al. (2013) have also studied the test-retest reliability of QBA and behavioral measures of the Welfare Quality protocol. The protocol was applied to fifteen intensive commercial pig units of growing pigs with an interval of twelve months. During this period no changes in management and housing were made. In contrast to Czycholl et al. (2016), this study of Temple et al. (2013) showed that the measures of social and exploratory behaviors were not constant between the two visits, and so the test-retest reliability was low. A difference is that Czycholl et al. (2017) applied an interval of six months between the observations and exploratory and social behaviors were expressed as a percentage of the total behavior, as described in the protocol. On the other hand Temple et al. (2013) applied an interval of twelve months and expressed social and exploratory behavior as a total of the active behavior. In accordance to Czycholl et al. (2016), the study of Temple et al. (2013) showed also that test-retest reliability of the QBA was insufficient, since the QBA scores were not stable over time. So, although QBA has good validity (Temple et al. 2011a; 2011b) it does not have good reliability as measure (Czycholl et al 2016; Temple et al. 2013). On the other hand the behavioral observations have good reliability according to Czycholl et al. (2016) but low test-retest reliability according to Temple et al. (2013) and their sensitivity should be questioned when discriminating between farms of different rearing systems (Temple et al., 2011b).

4.2.2 Other studies of pig’s on-farm welfare assessment

According to the literature findings, the Welfare Quality protocol for pigs (2009) is the only applied protocol that uses positive welfare indicators during the on-farm welfare assessment. Social affiliative
behaviors, exploratory and play behavior are used as indicators for the evaluation of positive welfare. In addition, the protocol evaluates the positive emotional states of the animals by QBA. Apart from the Welfare Quality protocol, two additional pilot studies were retrieved that have integrated animal-based measures of the Welfare Quality protocol, including the above behavioral positive welfare indicators: a pilot protocol for suckling piglets by Vitali et al. (2020) and a proposed protocol in a two questionnaire form applied on the research animals of Pork CRC in Australia where husbandry systems and improvements of the pork industry are being researched (Rice et al., 2013). As explained above, although applied on research facilities, it is included in the results because these facilities research housing and husbandry conditions that will be applied in the pig industry of Australia. It is not an on-farm welfare assessment but has similarities and evaluates the welfare outcome of using the research husbandry, managing and housing systems in practice in commercial units.

Vitali et al. (2020) have proposed a protocol for the on-farm welfare assessment of suckling piglets. A pilot study has been done on litters reared on two conventional Italian farms. Data collection was carried out on two groups, tail docked (TD) and tail undocked (TU) piglets. The data were collected two times: at seven days of age (T1) and at twenty days of age, just one day before weaning (T2). So, all data were collected during the nursing period and none post-weaning. The welfare parameters that were used in this protocol were parameters of the Welfare Quality (2009) and AssureWell (2020) protocols. They were used as is or slightly modified. Additionally, a few parameters were introduced ex novo by the scientists after literature research. The parameters were divided into four categories: QBA, behavioral measures, lesions and health measures. In total, twenty-one animal-based welfare parameters were used in the study. Most of these parameters were measures of the Welfare Quality protocol. Only one parameter was a measure of the AssureWell protocol: further care, a lesion and health parameter that identifies animals that have been removed from the pen, needing additional care or being emergently culled. All the behavioral measures of the welfare principle appropriate behavior of the Welfare Quality protocol were applied in this pilot study. Both positive and negative social behaviors were used as parameters, but slightly modified. Positive social behaviors were defined as “sniffing, licking, playing and moving away from the other animal without an aggressive or fighting reaction from this individual”. In this case, the behavior was expressed as the percentage of social behavior (positive or negative) to the percentage of total active behavior and not as the percentage of social behavior (positive or negative) to the percentage of total behavior as in the Welfare Quality protocol. Exploratory behavior was also used as positive welfare indicator, both pen and enrichment directed, and was expressed in the same way as social behaviors. Play was another positive indicator that was used and was defined as “piglets playing with one or more pen mates”. Finally, this pilot protocol integrated and assessed the positive emotional states parameter, defined and applied by QBA exactly as in the Welfare Quality protocol. All the positive welfare indicators in this pilot study were retrieved exclusively by the Welfare Quality protocol (2009).

This pilot study of welfare assessment protocol for suckling piglets by Vitali et al. (2020) has shown that negative social behavior was more frequent than positive social behavior. The only positive social behavior that was observed was play. The behavioral measurements demonstrated also that the most frequent active behavior was pen exploratory behavior. According to Vitali et al. (2020), this behavior cannot always be considered as a positive welfare indicator because piglets since their birth have a strong need for exploration which becomes even stronger in barren environments without enrichment as the ones that were studied. So, exploratory behavior can be a negative welfare indicator of piglets in some cases, which can also turn to a stereotypic behavior. Regarding QBA, different scores were found between the two farms, which can be explained by small management differences. Pigs of T1
gave also higher scores compared to T2. Furthermore, TU piglets gave a higher QBA score compared to TD piglets. Especially the T2 piglets of the second farm were strongly associated with negative valence and high arousal. Tense, aimless, frustrated and indifferent gave the highest scores. It can be concluded in general that tail undocked pigs showed higher scores of negative emotional states. Still, this may be due to the fact that tail docked pigs cannot use their tails to show their emotions so clearly. Vitali et al. (2020) have concluded that this protocol and the indicators mentioned in it are a promising tool for the on-farm welfare assessment of suckling piglets. In this protocol, tail postures were also used, but as negative welfare indicators. More hanging and tucked down tails were observed when the nest temperature was low. Tail postures were proposed as a promising negative welfare indicators for future studies.

The second pilot study that has been retrieved contains parameters and assessment methods of the Welfare Quality protocol for pigs (2009) and is a project prepared for the Pork CRC in Australia. The report and study were contacted by the Animal Welfare Science Center of the University of Melbourne and were established and supported under the Australian Government’s Cooperative Research Centers Program. The aim of this project was to evaluate an assessment tool, practical, reliable and repeatable, to monitor the welfare status of pigs in the husbandry and housing systems under study in Pork CRC projects. These report and proposed measures apply to animals in research centers under Pork CRC evaluation, still the report is based on measures of protocols that apply to commercial pig units and aims on categorizing the probability of a good welfare outcome when the methods under study will be applied on-farm level (Rice et al., 2013). In addition, the researches propose that although the suggested welfare assessment tool applies on research animals, it could be used as a base for future studies and adapted as a welfare assessment system for commercial farm units. Although research facilities of the Pork CRC have fewer animals, they examine new husbandry conditions and husbandry conditions for the pork industry. According to the report, it is important to recognize the welfare consequences before results of new developments are extended out in the industry.

Firstly, a comprehensive review of the literature and current assessment protocols was conducted. Indicators that could applied in the Pork CRC research animals were chosen. Based on the findings, two questionnaires were developed and sent to the research facilities and answered by the researches. Based on these results the questionnaires were refined further and two standard questionnaires were proposed: one that assesses the welfare risks at the proposal stage and contains resource based measures and one that evaluates the final outcome of the research and contains animal based measures (Rice et al., 2013). The questionnaires apply to research animals, nonetheless they are designed to be scored in order to assess the welfare of the pigs according to the industries welfare standards. They categorize the probability of a good satisfactory welfare outcome. This will help Pork CRC to evaluate the actual impact of its research on the animals and the pig industry.

The Welfare Quality protocol for pigs was used as a base to choose the indicators and design the questionnaires. In total, forty animal-based and resource-based measures of the general literature and various assessment protocols were examined and information were gathered on their validity, reliability, feasibility and potential advantages and issues. Still, during the selection process the welfare principles and criteria of the Welfare Quality protocol were being followed as a base and it was ensured that all the selected measures were relatively spread across the four principles (Rice et al., 2013). Finally, nine animal based measures were judged as adequate to be used in research animals and intergraded in the questionnaires. Regarding behavioral parameters fear of humans and play behavior were chosen. Play was integrated in the animal based measures of the second questionnaire.
as a positive welfare indicator. Its validity and feasibility were determined as medium level according to the literature. Its reliability as low to medium. The definition was more detailed in the questionnaire than in the Welfare Quality protocol. Play was defined as “an activity started by hop, scamper, pivot, paw, flop or head toss, involving chasing without biting and being piglet to piglet, sow to piglet or individual behavior”. It was recorded as spontaneous behaviors under one minute observations. The questionnaires included also other measures of the Welfare Quality but play was the only selected positive welfare indicator. Although the questionnaires applied on animals in research facilities of husbandry practices their outcome could recognize welfare risks before they would be extended to farm practices.

5. Discussion

5.1 Discussion of the results

The positive welfare indicators that have given the most results are play behavior, followed by ear and tail postures, followed by social affiliative behaviors and vocalizations. The first question analyses the positive welfare indicators that could be used theoretically for pig’s welfare evaluation. It does not take into consideration if these indicators could actually be applied in practice. The indicators that are being used in welfare assessment programs should be valid so that they clearly indicate an impact on pig’s welfare, reliable by giving consistency on the results, and on the same time feasible. They should require short time and low effort by the assessor, and have an application method that is easily understood. The cost-efficiency is also important for their widespread application (Sørensen & Fraser, 2010). The results of the second question have shown that play is mainly the indicator that has been used for the positive welfare on-farm evaluation, followed by exploratory behavior and social affiliative behaviors. This means that these three indicators are in total more valid, feasible and reliable for application on the field, at least until today.

The domestic pig is considered a playful species. Piglets play from the first day of their life and the behavior increases until three weeks of age. After this age the behavior declines, but is still expressed in the adult life (Śpinka, 2017). Pigs perform both solitary and social play. The animals that play feel good and cope with stress and future challenges (Held & Śpinka, 2011). The behavior helps to reduce aggression and is contagious among the group, so some pigs that are more playful can be used to spread the behavior in the whole group. This behavioral indicator is feasible and can be measured easily by behavioral observations and spontaneous occurring behaviors. Although it is also supported that sometimes play can be increased due to stress and environmental challenges, it is accepted that even in this situations it has a buffering effect, so that its impact on welfare is positive. Play as positive welfare indicator is used in the Welfare Quality protocol, in the pilot welfare assessment study of Vitali et al. (2020) and the report regarding welfare assessment of Pork CRC (Rice et al., 2013). In the last study, it was actually the only positive welfare indicator that was used. Furthermore, the relationship of play with environmental enrichment should be emphasized, especially with litter, toys and rooting materials. Environmental enrichment is easy to be applied in practice, does not require much work from the farmer and has various welfare benefits.

Exploratory behavior and social affiliative behaviors are also connected with play. In the Welfare Quality protocol for pigs play is noted in the scoring sheet of exploratory and positive social behavior for object and peer play respectfully. Exploratory and social affiliative behaviors are easy to promote on the field, among other means by environmental and social enrichment. In nature pigs spend half
of their time on feeding and rooting, so exploratory behavior is a natural, strongly motivated behavior of the pig. Pigs do not engage in social grooming and do not perform strong individual affiliations, although they perform other social interactions like social play and their behaviors are synchronized (Śpinka, 2017). In addition, pigs perform social nosing, a gentle pig-directed nosing behavior with massage effect that is unrelated to harmful behaviors (Camerlink & Turner, 2013; Lawrence, Newberry & Śpinka, 2018). Pigs create close social associations not only with related peers, but also with unrelated, especially if they have been reared together (Śpinka, 2017). Social affiliative behaviors are strong candidates as positive welfare indicators. Still, applying them on the farm level can be complex. Determining both the social connectedness of individual pigs and overall group cohesiveness through network analysis can be a direction for future studies (Lawrence, Newberry & Śpinka, 2018).

Vocalizations have also been studied a lot in pigs, but in order to be valid as positive welfare indicators and feasible, more research is needed. Screams indicate always negative emotions (Laurijs et al., 2021) and are used in the Welfare Quality protocol for the measurement of fear via QBA in slaughterhouses. But the other types of vocalizations are not always clear, nonetheless they could be used in combination with other positive welfare indicators (Laurijs et al., 2021; Śpinka, 2017). Using automatic systems and microphones is an advantage, but an extra cost. Regarding ear and tail movements, more research is needed. A future direction could also be the use of tail lateralization as positive welfare indicator, since there is a right hemisphere dominance of positive emotions (Camerlink & Ursinus, 2020; Keeling, 2019). Not only tail lateralization, but lateralization in general could be used for the assessment of both positive and negative emotions in animals (Mendl & Nikol, 2017). Future studies should combine posture, motion and lateralization of the tail alongside with other behaviors of the pig in order to better understand the emotional states of the animal (Camerlink & Ursinus, 2020). Still, tail movement and lateralization may not be feasibly as positive welfare indicator for tail-docked pigs. Tail-docking is still permitted and used as a practice in some European countries since the European legislation allows it under conditions. The European Council Directive 2008/120/EC of 20 July 2008 about laying down minimum standards for the protection of pigs states in Annex I, chapter 1, general conditions 6 that tail docking must be carried out routinely only where there is evidence that injuries to other pigs’ tails and ears have occurred and only after other measures have already been taken to prevent tail-biting, taken also into account stocking density. Although Marcet-Rius et al. (2019) have studied ear and tail movements as indicators of emotions in tail docked pigs and have noticed higher duration and frequency of tail movement while pigs played, maybe observing the tail of a tail docked pig can be difficult in practice. In addition Vitali et al. (2020) during the on-farm assessment of their pilot protocol for suckling pigs observed higher QBA scores in tail undocked pigs compared to tail docked pigs, possibly due to the fact that tail-docked pigs cannot use their tail to show their emotions so clearly.

Regarding maternal care, mother-young bonding and sexual and mating behavior, these are behaviors that the pigs do not express or have time to experience in their short lives in the pig industry. In nature, the wild boar breeds only once a year, after building a nest, and weans its litters at about four months of age. In livestock on the contrary, a sow breeds 3-4 times per year and weans its litters at 3-5 weeks age (Śpinka, 2017). The mating behavior is not usually expressed and the sows do not have the ability to build a nest, which is a strong motivated behavior. 4-5 days after weaning, a sow is usually kept under boar contact, so that oestrus can be encouraged. Sometimes the sow is kept under boar contact even at the end of the lactation period to accelerate the coming of the oestus. In most cases artificial insemination is used and rarely a mixture of artificial insemination and mating. So, the animals do not have the time to experience neither long mother-young bonding nor sexual and mating behavior. In
addition, in some countries the sow is still kept confined in narrow metal crates in order to prevent and reduce the mortality of the piglets due to crushing, although the European Council Directive 2008/120/EC states in paragraph 10 that sows prefer to have social interactions with other pigs when they are provided with freedom to move and environmental complexity. This allows very limited sow-piglet interaction. Especially mother-young bonding is a behavior that could be promoted, since it would create also peer-bonding. This could reduce aggression in the future and post-weaning stress and is important because aggression is a problem both for the farmer and the animals. The difficulty is that this would also mean significant changes in the pig production and higher work and cost, so it would not be considered feasible from a farmer’s point of view.

In addition to the indicators analyzed in the results, other indicators that have been proposed for future studies and have been retrieved with the search method are facial expressions and behavioral diversity. Facial expressions have been studied mostly in humans, but have been proposed also for the welfare assessment of mammals. Camerlink et al. (2018) recorded facial metrics of pigs prior and during aggression and during retreat and have concluded that facial metrics can convey information about aggression and fear, so they could be used as indicators of negative emotions. Miller et al. (2020) suggest behavioral diversion as positive welfare indicator in zoo animals. Furthermore, another direction for future studies are physiological indicators. Marcet-Rius et al. (2018a) have proposed oxytocin as positive welfare indicator since they observed that mini pigs that played prior blood sampling had lower oxytocin level during blood sampling compared to mini-pigs that did not play before the sampling. Oxytocin level as positive welfare indicator could be an alternative, but physiological parameters are more difficult to study. Samples from the animals and laboratory testing are required and extra cost and work, so they are not much feasible for the on-farm evaluation of welfare.

So, various indicators have been studied and proposed. One important point, as analyzed above, is thinking the validity, feasibility and reliability of the indicators for their use on the field. The second important point would be to think which behaviors we should chose and promote their expressions to the animals. Livestock species live short lives compared to companion animals. A pig slaughters at around 5-6 months of age, what does it have the time to experience? And after choosing and prioritizing the indicators, we should think, how can we promote the expression of these positive welfare indicators in the domestic pig and by which changes in its environment and the whole production and management system? Taken also into consideration the economical parameter and a sustainable pig industry.

We can definitely start by promoting exploratory, play and social affiliative behaviors and step by step raise the bar higher. Environmental enrichment with toys and rooting materials and a more complex environment can promote these behaviors. It is important, especially for the pre-, post-weaning and fattening pigs. Provision of toys is effective, especially for piglets and during the pre-weaning period. In addition, the legislation requires environmental enrichment. The European Council Directive 2008/120/EC states in paragraph 8 that pigs should benefit from an environment corresponding to their needs for exercise and exploratory behavior. Furthermore, it states in Annex 1, chapter 1, paragraph 4 that pigs should have permanent access to a sufficient quantity of material that enables manipulation and investigation activities. Still, the legislations state the minimum standards. We should ask ourselves, is this enough to create positive experiences and emotions? Clearly more is needed, especially in intensives systems, but promoting play, social affiliative and exploratory behavior could be feasible and a good start.

Another factor is the provision of larger space. This factor is important especially for the growing and finishing pigs (Godyń, Nowicki & Herbut, 2019). Larger space and less stocking density will lead
also to less stress for the animals, less competition for resources and less aggression. Nonetheless, in intensive systems we have for example a finishing pig kept in a group and the minimum space that corresponds to it is only 1 m² when it weighs 110 kilos and more. We should ask ourselves, how complex can we make this environment? Could it play, explore and feel group bonding and pleasure instead of frustration and aggression in this space? The space provision factor is determinant for positive welfare, and for an acceptable welfare in general.

Drastic changes are needed. As analyzed above, we could also forbid the confinement of the sow during weaning and maybe extend the weaning period for some days, in order to promote mother-young and peer-bonding. In addition, it is important to study all these suggested indicators and promote them in all groups of pigs and housing systems, because of their different needs. A different approach is needed for extensive and intensive systems and all groups of pigs should be studied separately, organic pigs included. A lot of effort and research is needed since the research at the moments focuses mainly on the piglets, growing and finishing pigs of intensive systems. In all cases, if we will not set higher standards to the environment and the management, we will not improve the quality of lives of animals, their welfare and of course the experience of positive welfare states.

We should also examine the legislation of animal welfare and consider changes, it is another important approach. We should think, do we actually protect our animals both physically and mentally and offer them an acceptable welfare according to the legislation? A representative example for this question is the Iberian pig. The European Council Directive 2008/120/EC states in chapter 1, paragraph 8, that nose-ringing is permitted only when animals are kept outdoors and in compliance with national legislation. The Iberian pig lives in an environment far beyond the minimum standards of space, motion, ability, social interactions, without pain, disease, fear, hunger, thirst and discomfort. Nonetheless, the nose ring does not allow it to root. The alleviation of so many negatives aspects of welfare does not mean that the animal has a good life. This is also why all pig groups and housing and managing systems should be studied separately for the promotion of positive welfare.

Positive welfare goes a step beyond the common welfare approach and focuses on the positive aspects that animals should have in their lives, additionally to the negatives that should be alleviated. But still, work is needed even for the alleviation of the negatives. Positive welfare is a new welfare approach. According to the literature findings, and as far as my own knowledge, the Welfare Quality protocol (2009) is the only welfare assessment protocol that is being used today internationally and uses positive welfare indicators: play, exploratory and social affiliative behaviors. It is also important that it evaluates the positive emotions of the animals, even happiness. The evaluation takes place via QBA, a simple, non-invasive method. The Welfare Quality protocol recognizes the animals as sentient beings, as they have been recognized in the 2009 Lisbon Treaty. It is a misfortune that it is the only applied protocol that assesses positive welfare, still, it is hopeful that a start has been done. It is a significant start since although it is a European project, it is being used and studied globally. The pilot studies that have been retrieved show that changes can be made. In addition, although the literature findings regarding on-farm positive welfare evaluation are limited, on the contrary, the findings regarding positive welfare and positive welfare indicators are broad. This is hopeful, since it indicates a more and more growing interest on positive welfare, not only for the pig, but for all domestic species. This interest is mostly theoretical at the moment, but theory is the first step when trying to make something practice and bring changes.

The citizens’ and farmers’ role is also critical in order to make the application of positive welfare economically realistic. The role of farmers because they should create the positive states, the role of citizens because they determine the wants of the market. If the consumers support this approach, then farmers will apply it. As Vigor and Lawrence (2019) mention, positive welfare approach needs the
support of the scientists, the citizens and the farmers in order to achieve as good results as possible for the animals. Vigor (2019) researched how farmers perceive positive welfare and their attitudes towards it, by using qualitative interviews in dairy, beef, pig, sheep and poultry farms in the UK. The results indicated that farmers emphasize on preventing the negatives, and that they believe that through this approach the positive experiences will arise naturally. In addition, they believe that the high productivity outcome is a proof that their animals experience good well-being and positive affects. When applying a qualitative interview to UK citizens (Vigor & Lawrence, 2019), the answers indicated that they understand positive welfare as free from negative experiences, and so with positive experience. Nonetheless, most citizens had never heard about positive welfare. They answered that positive welfare equals positive experiences just by thinking automatically that positive is the contrast of negative. In another study of Sorensen and Scrader (2019), it was concluded that the aspects of animal welfare that have been promoted by pig labelling focus mostly on resource-based measures instead of animal-based measures. The authors suggest that this is due to the fact that animal-based measures are more difficult to communicate to consumers and not because consumers would not want the evaluation of animal-based measures. The effort of this communication is important in order to have informed and concerned consumers that require labelling in pork products that reflect major animal welfare problems and push the pig industry to better direction. Furthermore, none of the examined labelling programs of the study evaluated positive welfare aspects. Still, it is hopeful that the consumers demand the labelling of resource-based measures like space and outdoor access. With good communication in the future positive welfare aspects could also be labelled.

In addition, according to Broom (2021) consumers today demand sustainability of production methods and for most consumers animal welfare is an important component of the sustainability. Animals are recognized as sentient, cognitive beings, with the capacity of experiencing feelings, like humans. It is not only morally wrong to offer to the farm animals poor welfare, but also unsustainable. The attitude of consumers towards the farm animals has changed and a product is not considered of good quality if the welfare of the production animals is not also good. A sustainable product is judged among others by the ethics of the production and the way that it treats the animals. It is more common to talk about sustainable pork production and focus on the housing systems, the environmental impact and the food and water provision of the animals, but the way that we treat animals is now also important for the consumer. This highlights again how important the role of the consumers is. The high concern about animal welfare and sustainability by the consumers means that the farmers should adapt and be aware of all the impacts of their management and housing practices (Broom, 2021). In addition animals that experience good welfare cope well with the environment and perform well. Good productivity per se is not always associated with good welfare, but low productivity is associated with low welfare (Jensen, 2017).

So, positive welfare is a new concept that should be communicated to both farmers and citizens without implications. It is important that it should be communicated and explained in order to become from theory practice, at least step by step. Constant effort, communication and collaboration is needed between scientist, consumers and farmers in both national and international level. Both consumers and national and international legislations can raise the bar of animal welfare higher and the farmers will have to follow and apply it. The economic impact of applying positive welfare in the pig and livestock production in general is out of the scope of this study, but it is important to say that if consumers understand the concept, and are willing to pay more, this will make the application easier and the farmers will have a competitive product with profit and an economically sustainable pig industry. In addition, if the legislation requires higher minimum standards, the farmers will be obliged to apply them. In that way, the bar will be raised, the animals will experience better lives worth living and positive welfare will become practice. It is important and our ethical obligation to protect the pig
and all animals under human care and give them an acceptable welfare and a good life with positive emotions and experiences.

5.2 Discussion of the method

Together with the discussion of the literature results, some main points that strengthen or limit the research method and so the results should be also taken into consideration.

Regarding the first question that I wanted to answer, "Which are the behavioral positive welfare indicators that can be used for the domestic pig?", a lot of material was retrieved. This means that it is a field that has been studied a lot under the last decade. A strength of the method is that regarding the population of the study not only the keyword pig, but also keywords of other group of pigs were used. This gave broader results and information on specific group of pigs (mostly piglets and sows). The term Sus scrofa instead of Sus scrofa domesticus was used in the search, because the term Sus scrofa would have given results both for the domestic pig and the wild boar. The aim was to compare these results after during the analysis for the domestic pig and its wild ancestor. Nonetheless, no results referring specifically to the wild boar were found. A weakness of the method is that only one search engine was used and that only 600 of the 2,150 literature results were examined. Still, the results were sorted after relevance, and the gathered information was enough to answer the question. I selected only behavioral indicators. Other type of indicators would have given a more holistic approach to the positive welfare of the pig, but it is out of the scope of this thesis. Both experimental and theoretical studies were used and the results were combined. In addition, some articles referred to the domestic animals in general. This was necessary in order to analyze some indicators that have not been studied yet specifically for the pig. Still, these indicators were selected and used in the analysis only if they applied on pig’s ethology.

The second question, "Which of the positive welfare indicators are being used already for the on-farm evaluation of pig’s welfare?", gave limited results. Although different searches were tested the results were limited and the selected articles always the same. Even though even more searches and keywords could have been tried, the estimation is that the results would still be few. It has been concluded that the existing research for the on-farm evaluation of positive welfare is limited until today. Still, the broad range of results regarding positive welfare indicators shows that there is growing interest on positive welfare. The Welfare Quality protocol (2009) for pigs was analyzed further, since it was the main finding. Maybe a more detailed search and examination of selected protocols used locally in different countries would have given more information on the assessment of the positive welfare of the pig globally. In addition to the mentioned searches, only a few other protocols have been examined separately: AssureWell (2020) used in Europe, Pork Quality Assurance (PQA Plus) (2019) used in Canada and Animal Care Assessment (ACA) (2011) used in USA. No positive indicators were retrieved in these protocols.

6. Ethical considerations

This is a literature study, so no animal experiments were involved and no ethical approval was required. No sensitive material with respect to confidentiality or privacy was used. This research is not commissioned or in collaboration with a funding body. There are no interest conflicts. The references indicate clearly the source/ sources of each information and the method describes how the
literature was selected. I indicate which thoughts are mine and which are literature data retrieved through my search. In case of misconception of the literature, the reader can trace back my source by my reference and makes his/her personal judgment.

7. Conclusion

After analyzing and discussing the results of the literature findings, the answers of the questions of this thesis are the following:

**Which are the behavioral positive welfare indicators that can be used for the domestic pig?**

The positive welfare indicators that have been proposed for the domestic pig are: exploratory and feeding behavior, play, social affiliative behaviors, synchronization, mother-young bonding and maternal care, pro-social behaviors, sexual and mating behavior, ear, tail and body postures and vocalizations. Play has been studied the most. Exploratory and social affiliative behaviors are the most promising positive welfare indicators together with play. Vocalizations and ear and tail postures are also promising, non-invasive indicators, but more research is needed, especially for ear and tail postures.

**Which of the positive welfare indicators are being used already for the on-farm evaluation of pig’s welfare?**

The positive welfare indicators that are being used already on the farm level are play, exploratory behavior and social affiliative behaviors. The only official protocol of on-farm welfare assessment of the pig that evaluates positive welfare and uses these indicators is the Welfare Quality protocol for pigs. Exploratory and social affiliative behaviors are measured simultaneously by behavioral observations. Social affiliative behaviors are observed while both positive and negative social interactions are being evaluated. Play behavior is noted as exploratory or positive social behavior. In addition, the positive emotions of the animals are being evaluated via QBA. Playful is one positive emotion that is measured. Other pilot studies propose also the use of the above indicators, mostly play. The evaluation of positive welfare on the farm level is limited at present. Still, the studies of positive welfare indicators both theoretically and experimentally are broad.

8. List of references

Assessment of positive emotions in animals to improve their welfare. *Physiology & Behavior*, 92, pp. 375-397. doi:10.1016/j.physbeh.2007.02.003


Appendix 1: Glossary

**Animal Welfare**

A state of complete mental and physical health, where the animal is in harmony with its environment (Hughes, 1976). The state of an animal regarding its attempt to cope with its environment (Broom, 1986). How the animals feel (Duncan, 1993). An animal’s capacity to avoid suffering while sustaining its fitness (Webster, 1994). A balance between positive (reward, satisfaction) and negative (stress) experience of affective states (Spruijt, Van den Bos & Pijlman, 2001). The World Organization for Animal Health in its Terrestrial Code Chapter 7, Article 7.1.1, defines Animal Welfare as the mental and physical state of an animal in relation to the conditions in which it lives or dies (World Organization for Animal Health, 2019).

**Animal-based measures**

A response by an animal, or an effect on an animal, used to assess its welfare. It can be taken directly on the animal or indirectly, and includes the use of animal records (Keeling, 2019).

**Circumplex model of affect**

It was initially used in human psychology but has also been adopted in animal welfare science for the study of emotion and mood of animals (Camerlink & Ursinus, 2020). Emotions are placed on a graphic map of two dimensions. One axel describes valence (positively or negatively loaded affective state) and the other axel describes arousal (high or low activity or energy) (Mendl et al., 2010 see Camerlink & Ursinus, 2020).

**Five Domains**

The Five Domains model was designed by Mellor and Reid in 1994 for assessing animal welfare. It was initially applied to animals used in research and teaching, but now is used also for farm animals. Compared to Five Freedoms, it differentiates between physical and affective states. The model firstly evaluates particular physical/functional disruptions and restrictions on behavioral expressions of the animal and then identifies the negative aspects that these disruptions and restrictions generate. The model has four physical domains: nutrition, environment, health and behavior and a fifth mental domain that focuses on the overall impact on welfare of all the identified individual negative aspects. This affective outcome on the mental domain represents the animal’s overall welfare state (Mellor, 2016). Since 1994 the model is being updated to incorporate developments in animal welfare thinking like positive affects.

**Five Freedoms**

They were developed as we know them today in 1992 by the Farm Animal Welfare Council (FAWC). The Five Freedoms are freedom from hunger and thirst, freedom from discomfort, freedom from pain,
injury and disease, freedom to express normal behavior and freedom from fear and distress. They were first developed in the Brambell report, in 1979. The report was conducted by order of the UK government to Roger Brambell due to the book Animal Machines. This book was written by Ruth Harrison in 1964 and raised high concerns about the farm animal husbandry systems. It described the suffering of animals in intensive farm systems in the UK (Webster, 2013). The Five Freedoms have been the base of animal welfare ever since. They have been the guiding principles of OIE and animal legislation internationally (Mellor, 2016).

**Instantaneous sampling**

The observer examines the individual, or all the animals in a group, at pre-selected times and records what each animal is doing (Rees, 2015). A sample of states is selected, and then these data are used to calculate the percentage of time spent on activities.

**Lateralization**

Localization of function on one side of the body in preference to another (Mendl & Nikol, 2017). In this thesis, we refer to brain lateralization where cognitive processes are specialized to one of the two hemispheres of the brain. Lately there has been growing interest in that lateralization of brain processes may reflect emotional states (Śpinka, 2017).

**Porcine**

Adjective that indicates relating to swine. Here it is used as a synonym to “of swine”, “of pork”, “of pig”.

**Play behavior**

A behavior that i) is “not fully functional” which means that it contains elements “that do not contribute in the current survival of an individual” ii) is “autotelic”, self-rewarding for the individual and performed for its own sake rather than to achieve some other goal iii) differs in structure or timing from its adult “serious” form of the behavior iv) is performed repeatedly but not stereotypically and v) is expressed when the animal is in “relaxed field”, with no immediate threats to its fitness (Burghardt, 2005 se Held & Śpinka, 2011).

**Pro-social behaviors**

Behaviors in which an individual engages in order to benefit others (Rault, 2019). Behaviors “explored to produce or maintain the physical and psychological well-being and integrity of others” (Wispé, 1972 se Rault, 2019).

**Qualitative behavioral assessment (QBA)**
Observers judge an animal’s behavioral state using one-word descriptors (Wemelsfelder et al., 2001). The method considers the expressive quality of how animals behave and interact with each other and the environment, which is indicated by their body language (Welfare Quality, 2009). The method was initially developed to be used through video recording observations (Wemelsfelder et al., 2001), but the Welfare Quality protocol for pigs describes it for on-field direct observations (Welfare Quality, 2009).

**Reliability of a set of measures**

A set of measures is considered reliable if there is little variation within it. It indicates that the measures are consistent. It is a particular concern especially when more than one researcher is making measurements that may be pooled or compared at a later stage (Rees, 2015). Intra-observer reliability indicates the consistency of the measures taken by the same observer, by using the same method, but in different time periods. Inter-observer reliability indicates the consistency of the measures taken independently, at the same time, and by using the same method by different observers. Test-retest reliability indicates the consistency of measures, by using the same method, on the same sample, on different times.

**Scan sampling**

The observer looks at a whole group of animals and records what each animal is doing at a specific point in time and at regular intervals (Rees, 2015). This method works well if a relatively small number of easily identified behaviors is recorded, because the time spent for each animal is short.

**Validity of a set of measures**

A set of measures is considered valid when it is accurate (Rees, 2015). Regarding the welfare assessment, when it is relevant and it represents an impact on the animal’s welfare.

**Visual analogue scale**

In this thesis, it is used as in the Welfare Quality protocol for pigs (2009). It is a 125 mm scale, defined by a left “minimum” and a right “maximum” point. Minimum means that the expressive quality indicated by the visual analogue scale is entirely absent by any of the observed animals. Contrary, maximum means that the expressive quality is dominant across all observed animals. To score a specific term, the observer draws a line across the 125mm scale at the appropriate point. The measure for the term is the distance in mm from the minimum point to the point where the line crosses the scale (Welfare Quality, 2009).

**Welfare indicator**

An observation, method or measurement used to obtain information on an animal’s welfare (Keeling, 2019).
Appendix 2: Animal Welfare

Animal Welfare definitions

Animal welfare is a multidimensional concept. It has been difficult to define not only animal welfare but welfare in general. The broadest definition of animal welfare should include the comprehensive state of an organism, body and mind together along with everything that links and affects them (Carenzi & Verga, 2009). Although difficult to define, a definition is needed for a scientific approach and studying of welfare. In addition, the definition should reflect a clear concept which can be used by the scientific community and be incorporated in laws so that it can be applied in practice and protect the animals (Broom, 1991).

Fraser (2008) suggests that there are different scientific approaches of animal welfare, because scientists, as humans, have different values. Although animal welfare is a concept that can be studied scientifically, our understanding of animal welfare and the science that we use to assess this understanding are influenced by our values. So, animal welfare is a concept not only science-based, but also value-based. According to Fraser (1995), science is limited in its ability to determine the overall welfare of an animal in disparate environment and so the role of science should be to identify and prevent welfare problems instead of attempting to measure and define welfare.

For the above reasons, defining animal welfare has long been a debate with different approaches. There have been mainly three approaches: the functional approach that focuses on the biological functioning, health and behavior, the feelings approach that focuses on how animals feel and the natural behavior approach that emphasizes the importance of performing natural behaviors (Carenzi & Verga, 2009; Marchant-Forde, 2008). The functional approach and the feelings approach were the first to be developed and were developed under the same period. The focus on natural behavior mainly arise later as a concept, although for many years some scientists had been supporting that it is important for the animals to express their natural behaviors (Carenzi & Verga, 2009).

Broom (1986) defines animal welfare “as the state of an animal regarding its attempt to cope with its environment”. This definition is representative of the functional approach. It focuses on the idea that the welfare of an animal is highly concerned with its adaptive response to stress and the impact that this may have on the biological functioning of the animal (Marchant-Forde, 2008). Chronic and acute stress can cause alterations in the behavior and physiology of an animal and this can be used as means to assess its welfare. According to Broom (1986), poor welfare arises mainly when the animal feels that it lacks control over interacting with its environment. Broom (1991) supports that poor welfare and suffering usually occur together, but this is not always necessary since an animal can also experience poor welfare without experiencing suffering. This definition of Broom (1986) indicates that welfare is quantifiable as a state by a total amount of measures (Marchant-Forde, 2008).

On the other hand, Hughes (1976) defines animal welfare as “a state of complete mental and physical health, where the animal is in harmony with its environment”. This approach focuses not only on the physiological but also on the psychological aspects of welfare and supports that an animal needs to feel in harmony with its environment in order to have a good welfare. Duncan (1993) supports that welfare is all about how animals feel. This concept of welfare emphasizes that vertebrae are sentient beings with emotions. It was raised as a criticism towards the functional approach, since in some cases the physiological and psychological aspects of welfare do not agree. A problem with this approach is that it is difficult to measure the subjective experiences and feelings of an animal and to avoid an anthropomorphic approach (Carenzi & Verga, 2009). In addition, according to Fraser (1995), both...
definitions of Hughes (1976) and Broom (1986) specify very little about what processes contribute to welfare and how they can be measured in practice for the welfare evaluation of an animal.

In the following years, the definitions incorporated a correlation of the two above approaches of Broom (1986) and Duncan (1993) (Marchant-Forde, 2008). Webster (1994) defines animal welfare as “an animal’s state regarding its capacity to avoid suffering and maintaining fitness”, a definition with a more holistic approach to welfare.

The third approach emphasizes the natural living of the animals and that we should allow animals to adapt to their environment through their natural behaviors. Bracke and Hopster (2006) define as natural behavior a behavior that the animal tends to perform under natural conditions because it is pleasurable and promotes the biological functioning. This definition includes behaviors like feeding, playing and grooming, but excludes behaviors like sickness, or aggression. This approach has received a lot of criticism, because today the domestic animals vary from their wild ancestors due to the domestication process. Still, it is accepted that animals today have the same strongly motivated behaviors with their wild ancestors and that the expression of these behaviors vary only in intensity and quantity. So, the expression of natural behaviors is necessary for a good welfare (Jensen, 2017).

In addition to the above three approaches, animal welfare has also been defined through the anticipation and reward approach and the wanting and liking of the animals. Spruijt, Van den Bos and Pijlman (2001) define animal welfare as “a balance between positive (reward, satisfaction) and negative (stress) experience of affective states”. This balance can range from positive to negative and so welfare can also vary from good to bad. According to Spruijt, Van den Bos and Pijlman (2001), good welfare arises when the actual and expected state are in line. Reduced difference between the actual and the expected means a good emotional state for the animals.

A more recent and holistic approach of welfare is that of Dockès and Kling-Eveillard (2006). They suggest that animal welfare should be viewed and defined according to four main issues: biological and technical definitions that focus on the fundamental needs of animals, regulation approaches so that animal welfare can be translated into laws, philosophical approaches that focus on the ethical part of animal welfare and the role of animals in the society and communication between man and animal that focuses mainly on the farmer-animal interaction.

Today, the World Organization for Animal Health in Chapter 7, Article 7.1.1 of its Terrestrial code, defines Animal Welfare as the mental and physical state of an animal in relation to the conditions in which it lives or dies (World Organization for Animal Health, 2019). It states that animal welfare is a multi-faceted subject, with scientific, ethical, political and cultural dimensions. In 2017 all the 182 Member Countries adopted the OIE Global Animal Welfare Strategy with the vision of “a world where the welfare of animals is respected, promoted and advanced”. Among the four pillars of this strategy, is the development of animal welfare standards and the implementation of animal welfare policies.

Important milestones in Animal Welfare history

In 1992 the FAWC developed the Five Freedoms: freedom from hunger and thirst, freedom from pain, injury and disease, freedom from fear and distress, freedom from discomfort and freedom to express normal behavior. The Five freedoms have influenced animal legislation and assurance schemes of animal welfare internationally and have contributed to an improved life not only for farm animals but for all animals under human care (Lawrence, Newberry & Špinka, 2018). The Five Freedoms and the five provisions aligned with them incorporate subjective states and behaviors as welfare parameters in addition to physical health and have defined the minimum standards for
acceptable welfare (Mellor, 2016). For the first time they were introduced in the Brambell report in 1979 in the UK. This report was conducted due to the book Animal Machines of Ruth Harrison, published in 1964 (Webster, 2013). In this book, Harrison revealed and described the suffering of animals kept in intensive farm systems. The book created reaction by the public, not only in the UK but in whole Europe, and became the reason that the UK government commissioned Roger Brambell to investigate the intensive farming systems. With this report it became clear that farm animals are sentient beings able to experience emotional states and the Five Freedoms were born. The report emphasized also for the first time the need of a scientific approach to animal welfare (Mellor, 2016).

The Five Freedoms were also the base for the Five Domains model of animal welfare, developed by Mellor and Reid in 1994. This model incorporated both functional/physical and affective states of welfare and differentiated these two types of states. The model was designed in order to provide a more systematic and thorough mean to assess negative welfare impacts compared to the Five Freedoms approach (Mellor, 2016). It incorporated four functional/physical domains (nutrition, environment, health and behavior) and a fifth mental domain. The negative outcomes of the physical domains have an affective outcome in the mental domain. This overall outcome in the mental domain is the overall welfare of an animal. This model aligns the biological functioning with the affective states. It has been updated constantly and has also incorporated positive affective states and how they are generated. In addition, the physical/functional domains were later used as foundations for the outcome-based measures of the European Welfare Quality Assessment Protocol (Mellor, 2016).

Regarding legislations, an important milestone of animal welfare is that in 1998 The European Commission developed the Council Directive 98/58/EC concerning the protection of animals kept for farming purposes. The Council Directive 98/58/EC reflects the Five Freedoms approach of animal welfare. In addition, in 2009 Lisbon Treaty came into force and amended the “Treaty of the Functioning of the European Union 2007/C 306/01”. Article 13 of title II recognizes that animals are sentient beings. It states that the Union and all the member States should pay full regard to the welfare requirements of animals. The Lisbon Treaty has set down the minimum standards concerning the welfare conditions of farm animals, by taking into account that farm animals are sentient beings that should be protected. National governments are allowed to adopt more strict rules for higher welfare standards but the least that they are obliged to do is respect the Lisbon Treaty.
Appendix 3: Welfare Quality protocol score calculation

The Welfare Quality assessment protocol for pigs (sows and piglets, growing and finishing pigs) (2009) has developed scientifically based tools in order to assess the welfare status of the animals in pig production units. Today the protocol is officially used in thirteen countries in Europe and four in Latin America. It has combined analyses of consumers’ perceptions and the existing knowledge from animal welfare science and identified twelve welfare criteria that should be covered equally in the assessment systems (Welfare Quality, 2009). The same approach has been followed also for other food production animals apart from the pig: poultry, laying hens and cattle without veal calves (Welfare Quality Network, 2021). The aim of the protocol is not only to give information about the welfare status of each unit but also to generate knowledge on particular strategies about how to improve the welfare of the animals both on-farm and at slaughter.

Since the aim of the protocol is the welfare evaluation of the animals, mostly animal-based measures are being applied. Management- and husbandry-based measures are also being used, but they are closely correlated to animal-based measures (Welfare Quality, 2009). Animal-based measures have also been chosen because welfare is a characteristic of the individual animal. Mostly health and behavior related measures have been used. All measures have been chosen by taking into consideration their feasibility, validity and reliability. In addition, the assessor trains to classify the animals in categories on the farm level according to categories illustrated by images or video. If the training of the assessor for a measure is not feasible in this way, the measure is being rejected. This approach is being followed so at personal value judgments are minimized. Since the research of animal welfare is constant, the measures of the protocol are also constantly being updated.

Regarding the welfare assessment of the pig, measures are being gathered during three periods: the rearing period, the production period and the end of life, which includes both transportation to the slaughterhouse and the slaughterhouse. Data are not collected during the transportation, but some measures that are taken at the slaughterhouse after the arrival of the animals to the unit indirectly allow assessment of the welfare during transportation. Regarding piglets measurements are collected during the rearing period, regarding sows and growing pigs during the producing period, and regarding finishing pigs at the slaughterhouse (Welfare Quality, 2009).

According to the overall structure of the protocol, measures are being gathered both at the farm level and at slaughter. These measures are then turned to twelve welfare criteria. Then these criteria are split into four welfare principles which are finally used for the overall welfare status calculation of the unit (Welfare Quality, 2009). In summary, a bottom-up approach is being used and the unit is finally classified in one of four welfare categories: excellent (welfare of highest level), enhanced (good welfare), acceptable (welfare above or meets the minimum standards) or not classified (low welfare). The last welfare category is considered unacceptable.

According to Welfare Quality (2009), a bottom-up approach is being used for the overall welfare calculation, but a top-down approach has been used to design the protocol. Welfare is a multidimensional concept, and the whole design is based on identifying the four main welfare principles that reflect and approach in a holistic way the welfare of the animals. Each welfare principle has been designed in a way to answer a key welfare question:

- Good feeding: Are the animals properly fed and supplied with water?
- Good housing: Are the animals properly housed?
- Good health: Are the animals healthy?
Summary of the welfare criteria, welfare principles and welfare categories of The Welfare Quality assessment protocol for pigs (sows and piglets, growing and finishing pigs) (2009). A bottom-up approach is being used for the classification of a unit in one of the four welfare categories. Measurements are being collected on the farm level and at slaughter. By these measurements twelve welfare criteria-scores are being calculated, and by these scores four welfare principle-scores. The four welfare principle-scores are used for the overall welfare classification of the unit.

<table>
<thead>
<tr>
<th>Welfare categories</th>
<th>Welfare principles</th>
<th>Welfare criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Excellent welfare</td>
<td>Good feeding</td>
<td>1 Absence of prolonged hunger</td>
</tr>
<tr>
<td>• Enhanced welfare</td>
<td></td>
<td>2 Absence of prolonged thirst</td>
</tr>
<tr>
<td>• Acceptable welfare</td>
<td>Good housing</td>
<td>3 Comfort around resting</td>
</tr>
<tr>
<td>• Not classified farm</td>
<td></td>
<td>4 Thermal comfort</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 Ease of movement</td>
</tr>
<tr>
<td></td>
<td>Good health</td>
<td>6 Absence of injuries</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 Absence of disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 Absence of pain induced by management procedures</td>
</tr>
<tr>
<td></td>
<td>Appropriate behavior</td>
<td>9 Expression of social behaviors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 Expression of other behaviors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11 Good human-animal relationship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 Positive emotional states</td>
</tr>
</tbody>
</table>

Regarding the calculation of criterion-scores, all measures and criteria are considered independent of each other. Each measure has been allocated only to one criterion although it can be related to several criteria, in order to avoid double counting (Welfare Quality, 2009). The measures taken on the farm level and at slaughter are mathematically interpreted to criterion-scores. All criterion-scores are expressed in a scale from “0” (corresponding to the worst situation) to “100” (corresponding to the best situation). This expression of criterion-scores is done by one of the four following ways: a decision tree, a weighted sum with weights increasing with severity, an alarm threshold that represents the limit between what is considered normal and abnormal or by using as measure-score the worst score obtained at group level as long as it represents at least 15% of the animals. Which tool is used for the expression of each criterion-score varies depending on the species, the group of animals and the severity of each measure that the criterion is calculated from. Not all measures have the same weight in the total criterion-score calculation. Nonetheless, compensation between scores is not allowed. The calculation of principle-scores is done by a specific mathematical operator that is called Choquet integral. All criterion-scores do not have the same weight in the principle-scores calculation.

Finally the overall welfare-score is calculated by taking all principle-scores equally into consideration and by using software analysis. The overall welfare-score is again expressed from “0” to “100”. The threshold for excellent welfare is 80%, for enhanced 55% and for acceptable 20% (Welfare Quality, 2009). Again, there is no compensation between the principle-scores. A farm is classified as excellent if the score is more than 55% for all four principles and more than 80% for two of them. It is classified as enhanced if the score is more than 20% for all four principles and more than 55% for two of them. Farms that score more than 10% in all principles and more than 20% in three principles are classified
as acceptable. Farms with lower scores are not classified and the welfare status of the animals is considered unacceptable.