How do People look at Pictures of Pigs? Analyzing Fixation Duration Depending on Pig Expression and Barn Type using Eye-Tracking

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Abstract

Using eye-tracking, this study investigates fixation duration of students viewing pictures of pigs, which systematically vary in the facial expression of the pig and in the barn setting. The aim of this study is to analyze which picture elements are viewed and for how long, as well as how fixation times vary with a change of the expression of the pig and the barn type. The results show clear effects of picture composition: pig expression and pen type affect fixation durations of different areas of interest with the influence of the pig being considerably larger. Face regions are viewed longer in the "happy" pig, while floor/bedding and the eyes are viewed longer in pictures showing the "unhappy" pig which might be a hint for information search. The power of facial expressions, also for the depiction of farm animals, is a new finding of this paper, which might be of importance when selecting agricultural pictures for different purposes.

Key Words

eye-tracking; pig farming; facial expression; farm animals; bottom-up-influence

1 Introduction

Intensive animal husbandry systems in many industrialized countries has lacked substantial support from the broader public in recent years due to the perceived lack of naturalness and animal welfare (e.g., FREY and PIRSCHER, 2018; MIELE et al., 2011; ROVERS et al., 2018; VANHONACKER and VERBEKE, 2014; WILDRAUT et al., 2018). Thereby, especially intensive pig production systems are perceived very negatively (e.g., BOOGAARD et al., 2011; LASSEN et al., 2006; RYAN et al., 2015).

In order to inform the broader public about livestock farming and to promote it, the agricultural sector heavily relies on mass media communication including the use of pictures. So far, however, only few studies have investigated how agricultural pictures used for communication with the broader public are viewed, or how their content is perceived (SCHRÖTER and MERGENTHALER, 2019).

When looking at a picture, eye-movements are generally guided either by top-down factors such as the viewers' characteristics and interests, or by bottom-up factors, which are related to content and elements within the picture (WEDEL and PIETERS, 2008). Moreover, looking at pictures of animals, it is obvious that not only the picture's background, but the animal itself with its facial expression and body language impacts its perception and evaluation (FRASER, 2008; BUSCH et al., 2019). Housing and floor type that are often the background of pictures of farm animals are regarded as being important for the evaluation of housing systems from a citizen's perspective. Straw bedding is perceived as positively impacting the naturalness and animal welfare and is evaluated much better than the currently dominating slatted floors (BOOGAARD et al., 2011; JANSSEN et al., 2016; KRYSTALLIS et al., 2009; SØRENSEN et al., 2012; VERBEKE et al., 2010).

The manner of expressing emotions in the face is highly species-specific, but humans are sensitive to the emotional expression of non-human animals (SCHIRMER et al., 2013; KUJALA et al., 2017). BUSCH et al. (2017) analyzed people's eye-movements and evaluation of pictures taken in a conventional pig fattening barn and found that especially the bodies and faces of the animals are fixated. In their paper, the authors conclude that faces and bodies of the pigs are of major importance and are fixated longer compared

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to other areas on the pictures. Nevertheless, there was no systematic variation of these elements between the tested pictures. We take up this point and directly build on study design and results from BUSCH et al. (2017) to close this research gap. For the study presented herein, we vary face expression and body language of the pig ("happy"/"unhappy"). Analyzing how different facial expressions influence picture viewing contributes to the profound understanding of how people react to pictures showing farm animals and to analyze how sensitive picture viewing behavior (in this case fixations) is to variations in picture composition.

In addition, it is known that the stable in which a pig is shown has a large effect on pig perception (BUSCH et al., 2019) and therefore presumably on eye movements. We, therefore, also vary the stable in the pictures.

Against this background, the aim of this study is twofold:

1. Describe and compare people's fixation durations on pictures of a pig with systematically varying expressions ("happy" vs. "unhappy")[1] and barn types (slatted floor vs. straw bedding).
2. Measure the influence of pig expression and barn type on people's fixation durations.

Fixation duration has been selected as main variable to analyze, because new information can only be acquired during fixations, whereas during actual eye movement vision is suppressed. Therefore, attention and the information processing is highly linked to the visual attention, manifested in fixations. Important aspects of a scene are typically fixated longer than less important ones (RAYNER and CASTELHANO, 2007) and fixation duration reflects the time needed to process the stimulus at that location (ECKSTEIN et al., 2017), making fixation duration the most interesting variable for our study.

Due to the results from pictures of human faces showing different emotions, the current analysis hypothesizes that for animal pictures, the animals' facial expressions also influences eye-movements. Taking the highly controversial and critical discussions about livestock farming into account, it can further be hypothesized that the husbandry system in which a pig is shown will also influence eye-movements because the system acts as an information cue about the animal's well-being.

When people look at scenes on pictures, the eyes are moved onto those parts of the pictures, that should be processed in detail through fixations that are preceded by attention (RAYNER and CASTELHANO, 2007). This means that the eyes are usually guided to the object of one's thought and reflect engagement of attention (ECKSTEIN et al., 2017). Therefore, using eye-tracking, insights into cognition and information processing can be revealed that cannot be analyzed in surveys due to their unconscious nature.

The results contribute to the literature which analyzes agricultural pictures by systematically investigating how the depiction of an animal, as well as the type of barn, influence picture viewing, revealing insights into cognition and information processing. This might be of interest for any stakeholder using picture based communication about animal husbandry and can help to accurately design communication but also develop housing systems that meet public acceptance. Moreover, future research options are developed.

2 Methods

2.1 Participant Recruitment

A standardized survey was conducted with 187 students at the University of Göttingen and the University of Applied Sciences in Osnabrück in May and June 2016. Participation in the study was voluntary and remunerated with 5 € at University of Göttingen. Students from all disciplines could participate. In Osnabrück, students could participate in the study in course of a lecture on marketing methods.

Seven pictures of pigs were taken in a conventional pig barn by a photographer specializing in agriculture. In order to determine which pictures would be best for the main study, a pretest was conducted with 41 participants that were conveniently sampled via Facebook. The only prerequisite for taking part in the pre-test was having no connection to agriculture. In the pretest, participants were asked to evaluate the seven pictures on a seven-point semantic differential scale using "happy" and "unhappy" as the two extremes for the evaluation of the pigs. The pictures which were rated as showing the "happiest" and the "unhappiest" pig, respectively, were chosen for the main study. Additionally, two pictures, one of an empty straw and one of an empty slatted floor pen were also taken by the photographer. Using Adobe

[1] We point out that these terms are based on participants' evaluations in a pretest and are used to distinguish between both pigs in the course of the study. They do not necessarily reflect the real affective states of the animals which are much harder to assess. Further details are mentioned in the Methods section.

Photoshop, the pictures of the two pigs and the two pens were combined into four pictures showing the "happy" and "unhappy" pig in each of the two barn settings (Figure 1). The same pictures were used in a larger citizen survey analyzing the effects of picture elements on picture perceptions (BUSCH et al., 2019).

From this point forward, the terms "happy" and "unhappy" are used to distinguish between the two pigs; these terms are based on the participants' evaluation in the pretest. Here, it is important to point out that this designation does not necessarily reflect the real affective state of the animal at the moment the picture was taken.

2.2 Survey Design

At the beginning of the survey, respondents were asked about their gender, age and their connection to agriculture, as well as how often they had visited a pig barn in the past. In the main part of the survey, the four pictures of the pig and pen combinations were shown in a randomized order (16 within-subject designs). Each picture was displayed for 15 seconds and eye movements were recorded by an eye-tracker. After viewing the pictures, participants were further asked about their meat consumption.

2.3 Eye-tracker

We used a SMI Red-m remote eye-tracker (120 Hz; SensoMotoric Instruments) for data collection. For data analysis, the SMI Experiment Suite 360° Professional design and analysis software consisting of the two components, Experiment Center 2™ and SMI BeGaze 2™ (analysis and visualization software (version 3.6.52)), respectively, were used. The eye-tracker was mounted on a laptop (iView X™ laptop) and participants sat centrically in front of the monitor. The eye-tracker provided binocular gaze and pupil data. For data analysis, data from right and left eye were averaged.

Figure 1. Combined pictures of pigs and pen settings presented as stimuli to survey participants

A. "Happy" pig in pen with straw bedding

B. "Unhappy" pig in pen with slatted floor

C. "Happy" pig in pen with slatted floor

D. "Unhappy" pig in pen with straw bedding

Source: ©Landpixel (Swen Pförtner)

2.4 Areas of Interest

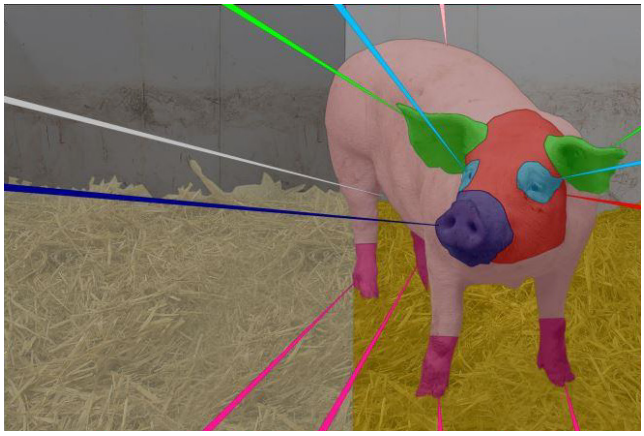
For data analysis, pictures were divided into different areas, called 'areas of interest' (AOI). Eight different AOI were distinguished for the analysis (Figure 2). The left and right side of the walls as well as the left and right side of the slatted floor/straw bedding were condensed into one AOI called "Walls" (displayed in grey) and one AOI "Floor/bedding" (displayed in yellow), respectively. Furthermore, the following AOIs were outlined: AOI "Body" (displayed in light pink), AOI "Upper face" (displayed in red), AOI "Snout" (displayed in purple), AOI "Ears" (data from left and right ear combined, displayed in green), AOI "Eyes" (data from left and right eye combined, displayed in blue) and AOI "Hooves" (data from all four hooves combined, displayed in dark pink). To calculate the ranking of the fixation times of different AOIs, a decision was made to condense the fixation times for the AOI "Upper face" and AOI "Snout" into one AOI "Face". For the comparison of means, the results for all eight AOIs, as well as for the condensed AOI "Face" are shown.

2.5 Data Analysis

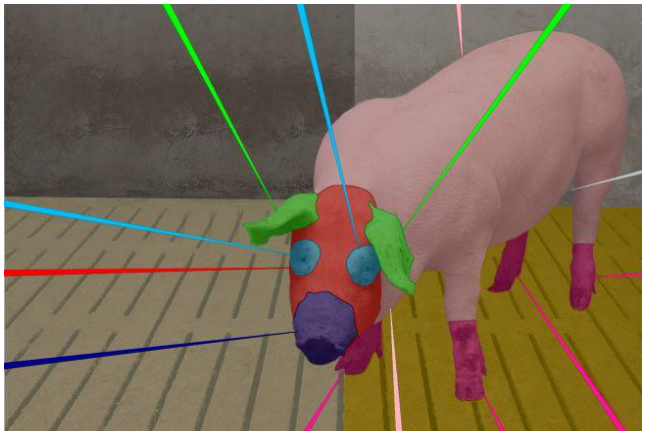
For data analysis, eye-tracking and survey data were merged into one file. IBM SPSS Statistics 23 was used for analyzing the data. Means and standard deviations for fixation times were calculated for each AOI and each picture, and rankings for the fixation times of the different AOIs were calculated for all pictures. An analysis of variance (ANOVA) was used to test for differences between the four pictures. Furthermore, independent t-tests were conducted to analyze differences between the means of fixation durations for the different AOIs in pictures where the "happy" or the "unhappy" pig, and the straw or the slatted floor is depicted.

A General Linear Model (GLM) was used to analyze the effects of the pig and the pen as bottom-up

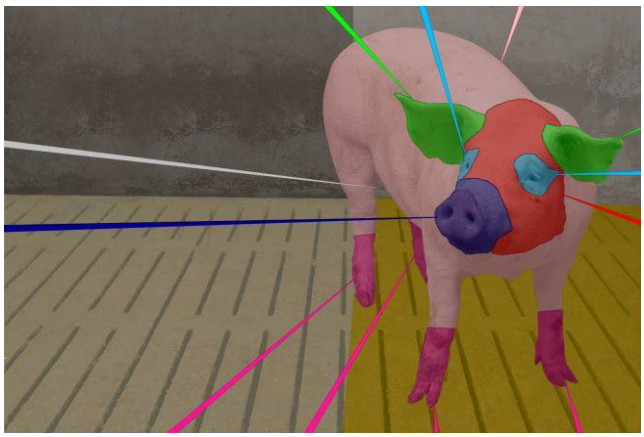
Figure 2. Areas of interest marked by different colors for the four different pictures



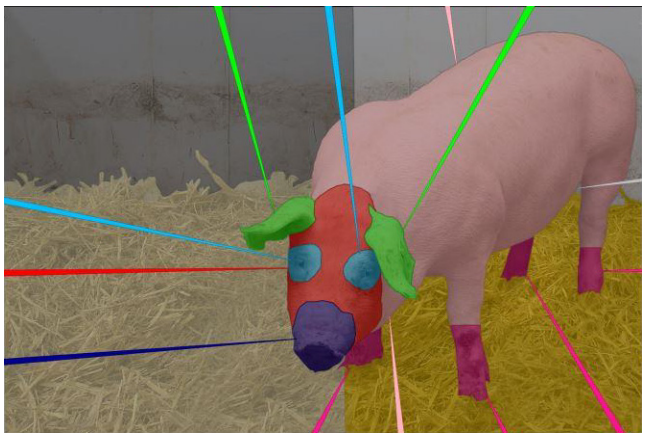
A. "Happy" pig in pen with straw bedding



B. "Unhappy" pig in pen with slatted floor



C. "Happy" pig in pen with slatted floor



D. "Unhappy" pig in pen with straw bedding

The colored lines point at the AOIs of the pig: light pink: body; red: upper face; purple: snout; green: ears; blue: eyes; dark pink: hooves; moreover, the grey areas are showing the AOIs of the walls while the yellow areas show the AOIs of the floor/beddings.
Source: ©Landpixel (Swen Pförtner); own presentation

influences on fixation times. For the model, fixation times for the eight AOIs were introduced as dependent variables, whereas the content of the picture ("happy" or "unhappy" pig/straw or slatted floor pen) and their interaction were introduced as independent variables. The interaction between the main effects of the pig and pen did not show a significant effect and was therefore excluded, resulting in the following statistical model:

$$Y_{ijk} = \mu + Pig_i + Pen_j + e_{ijkl}$$

where **Y** = Fixation Time for each AOI, μ = overall mean, $\mathbf{Pig_i}$ = fixed effect of pig ($_i$ = [1]("happy"), [2]("unhappy")), $\mathbf{Pen_j}$ = fixed effect of pen ($_j$ = [1](straw), [2](slatted floor)), and $\mathbf{e_{ijkl}}$ = residual error.

Although the assumption of homogeneity of covariance matrices was violated, it was possible to calculate a GLM since the sample sizes were large enough and roughly balanced. We report Partial Eta Squared as a measure of effect size, where 0.01 is considered to be a small, 0.06 a medium and 0.14 a large effect (COHEN, 1992).

3 Results

3.1 Sample Description

In the sample, 64% of participants are female and 36% are male. The average age of respondents is 24 years. Regarding participants' connection to agriculture, 46.5% state that they have no connection to agriculture. In contrast, 20% study or have studied agriculture or achieved an agricultural education and 4% of respondents work in agriculture. Regarding participants' familiarity with having been in a pig barn, 20% of respondents have never been in a pig barn before, 25% have visited a pig barn once, 43% a few times and 12% frequently. With respect to meat consumption, 16% eat meat on a daily basis, 51% several times per week, 16% two to four times per month, 1% once a month or less and 16% are vegetarian.

3.2 Ranking of Fixation Times for the AOIs

Analyzing the fixation times of the AOIs in the four pictures, it can be determined that in the two pictures showing the "happy" pig (Pictures A and C), the face of the pig is viewed for the longest time (Table 1). The rankings for the other AOIs regarding fixation times are almost identical for both pictures showing the "happy" pig: the slatted floor/straw bedding is looked at for the second longest time, followed by the walls, body and eyes (or eyes and body, respectively), hooves and ears. When the "unhappy" pig is displayed, the floor is viewed for the longest time, followed by the face and eyes of the pig (Picture B), or eyes and face of the pig (Picture D), respectively. For the "unhappy" pig on the slatted floor, the ranking of the remaining AOIs are as follows, starting with the longest fixation time: walls, hooves, body and ears. In the picture of the "unhappy" pig on straw, the eyes and face are viewed the second and third longest, followed by the body, walls, hooves and ears. The ears are viewed for the shortest amount of time in all pictures.

3.3 Fixation Durations Dependent on the Depiction of the Pig

In line with the rankings of the different AOIs, it can be observed that the fixation times of the AOIs differ between the pictures with the "happy" and the "unhappy" pig (Table 2). The fixation times of the face,

Table 1. Rankings of fixation times of the AOIs in the four pictures

AOI	Ranking "happy" straw (a)	Ranking "unhappy" slatted floor (b)	Ranking "happy" slatted floor (c)	Ranking "unhappy" straw (d)	F-value
[1]Floor/bedding (slatted floor/straw)	$2^{b,d}$	$1^{a,c}$	2^{b}	1^{a}	8.97***
[2]Walls	3	4	3	5	0.28
[1]Face	$1^{b,c}$	$2^{a,c}$	$1^{b,d}$	$3^{a,c}$	53.85***
[1]Eyes	$5^{b,d}$	$3^{a,c}$	$4^{b,d}$	$2^{a,c}$	14.32***
[1]Ears	7^{b}	$7^{a,c}$	7^{b}	7	5.74**
[1]Hooves	6^{b}	$5^{a,c,d}$	6^{b}	6^{b}	16.00***
[2]Body	4^{b}	$6^{a,d}$	5	4^{b}	4.49**

AOI = Area of interest. Rankings of the fixation times [ms] of the different AOIs in each picture are based on the calculated means. Results of ANOVA and post-hoc tests show significant differences between the fixation times of AOIs in the four pictures. F-values are displayed; [1]Variance heterogeneity is assumed; Tamhane-T2 post-hoc test is used; [2]Variance homogeneity is assumed; Scheffé post-hoc test is used; ^{a,b,c,d}Letters indicate significant post-hoc tests between the fixation times of pictures; **p ≤ 0.01; ***= p ≤ 0.001.
Source: own calculations

and more precisely the snout, are longer when the "happy" pig is presented. This finding is independent of the barn setting. The same can be found for the fixation time of the upper part of the face when the pig is presented on straw. However, the difference is not significant for the pig displayed on the slatted floor. The ears are generally fixated longer in the "happy" pig, and this is true for both barn settings.

In comparison to the rest of the face, the eyes are viewed considerably longer when the "unhappy" pig is presented. Furthermore, the floor/bedding gains more attention and is viewed longer when the "unhappy" pig is shown; moreover, the hooves of the pig are looked at for a longer period of time. When presented on the slatted floor, the "happy" pig's body is viewed longer with no difference being found for the straw barn. Fixation times of the walls do not differ between the pictures with the "happy" and the "unhappy" pig.

3.4 Fixation Durations Dependent on the Barn Setting

Regarding the fixation times of different AOIs, fewer differences are found with regard to barn setting (Table 3). The hooves of both the "happy" and the "unhappy" pig are viewed longer when the pig is depicted on the slatted floor, whereas the eyes and body

Table 2. Comparison of fixation durations (in ms) of different AOIs dependent on the depiction of the pig in the straw and slatted floor pen.

AOI	Pen	Means for FD of different AOIs (SD)		t-value
		"happy" pig	"unhappy" pig	
Floor/bedding (slatted floor/straw)	[1]Straw	2111.82 (1223.67)	2568.96 (1608.36)	-3.08**
	[2]Slatted floor	2357.39 (1644.94)	2902.57 (1556.06)	-3.28**
Walls	[2]Straw	1753.55 (1311.16)	1850.23 (1326.11)	-0.70
	[2]Slatted floor	1738.60 (1305.28)	1775.61 (1168.14)	-0.29
Face (2)	[2]Straw	3752.22 (1675.68)	2164.93 (1434.56)	9.81***
	[1]Slatted floor	3390.60 (1620.66)	2236.83 (1217.37)	7.76***
Upper face (1)	[2]Straw	2018.91 (1216.15)	1606.14 (1187.68)	3.30**
	[1]Slatted floor	1769.37 (1238.77)	1626.95 (1028.13)	1.21
Snout (2)	[1]Straw	1854.74 (1184.73)	781.46 (598.74)	10.39***
	[1]Slatted floor	1704.14 (962.63)	731.07 (618.50)	11.07***
Eyes	[2]Straw	1719.02 (1341.46)	2553.41 (1524.66)	-5.40***
	[1]Slatted floor	1680.98 (1288.33)	2137.71 (1505.90)	-3.04**
Ears	[2]Straw	886.70 (619.09)	707.43 (774.58)	2.26*
	[1]Slatted floor	920.53 (779.25)	644.65 (579.24)	3.53***
Hooves	[2]Straw	1017.50 (709.35)	1189.49 (787.52)	-2.07*
	[1]Slatted floor	1230.51 (785.83)	1623.84 (1043.42)	-4.05***
Body	[2]Straw	1739.42 (1063.99)	1731.72 (1022.20)	0.07
	[2]Slatted floor	1636.41 (1034.22)	1401.76 (885.63)	2.32*

AOI = Area of interest; FD = Fixation Duration (in ms). Means and standard deviations (SD) are displayed. Comparison of means by t-test for unpaired samples; t-values and p-levels are presented. *= $p \leq 0.05$; **= $p \leq 0.01$; ***= $p \leq 0.001$;
[1]Variance heterogeneity is assumed; Tamhane-T2 post-hoc test is used; [2]Variance homogeneity is assumed; Scheffé post-hoc test is used.
Source: own calculations

Table 3. Comparison of fixation durations (in ms) of different AOIs dependent on barn type with the "happy" or "unhappy" pig presented

AOI	Pig	Means for FD of different AOIs (SD)		t-value
		Straw pen	Slatted floor pen	
Floor/bedding (slatted floor/straw)	[1]"happy"	2111.82 (1223.67)	2357.39 (1644.94)	-1.62
	[2]"unhappy"	2568.96 (1608.36)	2902.57 (1556.06)	-2.04*
Walls	[2]"happy"	1753.55 (1311.16)	1738.60 (1305.28)	0.11
	[2]"unhappy"	1850.23 (1326.11)	1775.61 (1168.14)	0.57
Face (2)	[2]"happy"	3752.22 (1675.68)	3390.60 (1620.66)	2.11*
	[2]"unhappy"	2164.93 (1434.56)	2236.83 (1217.37)	-0.52
Upper face (1)	[2]"happy"	2018.91 (1216.15)	1769.37 (1238.77)	1.95
	[2]"unhappy"	1606.14 (1187.68)	1626.95 (1028.13)	-0.18
Snout (2)	[2]"happy"	1854.74 (1184.73)	1704.14 (962.63)	1.31
	[2]"unhappy"	781.46 (598.74)	731.07 (618.50)	0.70
Eyes	[2]"happy"	1719.02 (1341.46)	1680.98 (1288.33)	0.26
	[2]"unhappy"	2553.41 (1524.66)	2137.71 (1505.90)	2.60*
Ears	[1]"happy"	886.70 (619.09)	920.53 (779.25)	-0.44
	[2]"unhappy"	707.43 (774.58)	644.65 (579.24)	0.77
Hooves	[2]"happy"	1017.50 (709.35)	1230.51 (785.83)	-2.61**
	[1]"unhappy"	1189.49 (787.52)	1623.84 (1043.42)	-4.40***
Body	[2]"happy"	1739.42 (1063.99)	1636.41 (1034.22)	0.94
	[2]"unhappy"	1731.72 (1022.20)	1401.76 (885.63)	3.30**

AOI = Area of interest; FD = Fixation Duration (in ms). Means and standard deviations (SD) are displayed. Comparison of means by t-test for unpaired samples; t-values and p-levels are presented. *= $p \leq 0.05$; **= $p \leq 0.01$; ***= $p \leq 0.001$;
[1]Variance heterogeneity is assumed. [2]Variance homogeneity is assumed.
Source: own calculations

of the "unhappy" pig gain less attention in the context of the slatted floor. The face of the "happy" pig is viewed longer in the straw setting and people fixate on the slatted floor for a longer amount of time than the straw bedding when the "unhappy" pig is shown. No further differences can be found regarding the two barn settings.

3.5 Bottom-up Influences on Fixation Durations of Different AOIs

A GLM was used to evaluate the bottom-up influences of the pig and the pen on the fixation times of the different AOIs. The results of the model show that the pig has the largest influence on the fixation times of the AOIs (Table 4), whereas the pen shows a substantial, but smaller effect.

Table 4. Results of the GLM showing the effects of the pig and pen on fixation times.

Effect	F-value	Partial Eta Squared
Intercept	3912.05***	0.986
Pig	25.10***	0.314
Pen	5.87***	0.097

F-values and p-levels are presented; ***= $p \leq 0.001$.
Source: own calculations

The between-subject-effects reveal that the depiction of the pig affects the fixation duration of all AOIs except for the AOIs "Walls" and "Body". In contrast, the depiction of the pen influences only half of the fixation times of the AOIs, namely the fixation time of the floor/bedding, hooves, eyes and body of the pig.

4 Discussion

Our study is the first to analyze people's fixation durations when looking at pictures of farm animals that vary systematically in bottom-up-factors of picture composition. We confirm the findings of facial dominance in picture viewing (e.g., BUSCH et al., 2017; KANO and TOMONAGA, 2009; YARBUS, 1967) also for the case of pigs in different husbandry systems. Moreover, we demonstrate that the facial expression of the pig influences the fixation duration of different areas within the picture and is presumably guiding the observers' view. The depiction of the pig ("happy" or "unhappy") affects the fixation durations of all AOIs except for the walls and body of the pig. Thus, the facial expression of the pig plays a prominent role in picture viewing and therefore likely affects picture processing, because participants might need more time to process the information given by the faces and therefore fixate longer on these areas (ECKSTEIN et al., 2017). This finding is consistent with the fact that faces have been found to be visually preferred in pictures showing farm animals (BUSCH et al., 2017). The body, ears and hooves of the pig are viewed less in comparison to the face in all pictures, supporting the hypothesis of retreiving information about the pig from the faces.

Regarding fixation durations of the face of the pig, clear differences can be observed dependent on the depiction of the pig, with the face region being viewed significantly longer when the "happy" pig is presented. It is known that happy faces are more easily recognized than other facial expressions (CALVO and LUNDQUVIST, 2008; CALVO and NUMMENMAA, 2009), which is referred to as the 'happy-face-advantage' (CALVO and NUMMENMAA, 2009). This has also been demonstrated specifically when comparing happy and sad human faces (KIRITA and ENDO, 1995). It might be assumed that if happy faces are more easily recognized, they are viewed for a shorter time because viewers need less time to decode the facial expression. Interestingly, however, the opposite can be observed in our study. Further, fixation times of different regions within the face of the pig change with different facial expressions: specifically, differences were found between the fixation times of the snout and the eyes. The eyes were fixated much longer in the "unhappy" pig, while the snout of the pig was viewed significantly longer in the "happy" pig.

We assume that the way humans fixate faces of animals is similar to how they fixate faces of humans, because people's ratings of animal expressions also follow similar patterns like those for human facial expressions (KONO et al., 2015; KUJALA et al., 2017; SCHIRMER et al., 2013). When humans view pictures of other humans, different parts of the face contribute to the interpretation of facial expressions (e.g., BASSILI, 1979; BLAIS et al., 2012; NUSSECK et al., 2008) and people may search for hints to decode the facial expression. Thus, some areas are especially useful for discriminating between different expressions (BLAIS et al., 2012). In this way, the eyes, nose and mouth are viewed most frequently in faces (e.g., CALVO and FERNÁNDEZ-MARTÍN, 2013; EISENBARTH and ALPERS, 2011; HENDERSON et al., 2005; YARBUS, 1967). The eyes have been shown to be important for the detection and communication of emotional expressions (e.g., CALVO and FERNÁNDEZ-MARTÍN, 2013; GRAHAM and LABAR, 2007; SMITH et al., 2005). Moreover, BLAIS et al. (2012) discovered the mouth to be the most important cue for facial expressions in humans, while CALVO and FERNÁNDEZ-MARTÍN (2013) found that an expressive mouth (such as a smile) biases the evaluation of the eyes (CALVO and FERNÁNDEZ-MARTÍN, 2013). Similarly to our results, EISENBARTH and ALPERS (2011) found for humans viewing different human facial expressions, that the mouth region is fixated on longer in happy faces, while eyes are fixated on longer in sad and angry faces, forming the assumption that these regions are most characteristic for these emotions (EISENBARTH and ALPERS, 2011). Thus, longer fixation times of the eyes in the "unhappy" pig might be reasoned by people wanting to evaluate the pig's emotions based on the sadness in the eyes.

When the "unhappy" pig is shown, the floor is looked at for the longest time and is viewed even longer than the face. Also, in the pictures displaying the "happy" pig, the slatted floor/straw is viewed for a considerable amount of time (second in ranking). However, the significantly longer fixation time of the flooring in the picture depicting the "unhappy" pig might be due to that people try to search for hints in the pig's environment that may explain why it looks "unhappy". Thereby, especially the slatted floors are

viewed longer than straw for the "unhappy" pig, which may be because most people clearly reject slatted floors in pig farming (ROOSEN et al., 2016) and prefer straw bedding with respect to animals' well-being (BOOGAARD et al., 2011; JANSSEN et al., 2016; KRYSTALLIS et al., 2009; SØRENSEN et al., 2012; VERBEKE et al., 2010). Furthermore, the housing and floor type have generally been shown to play an important role in the evaluation of husbandry systems for pigs by the public, (JANSSEN et al., 2016; KRYSTALLIS et al., 2009; VERBEKE et al., 2010) and may therefore be viewed longer. Additionally, it is known from studies with zoo animals, that different environments influence how an animal is perceived and what characteristics are ascribed to the animal (FINLAY et al., 1988; MAPLE, 1983; RHOADS and GOLDSWORTHY, 1979). Thus, the background of the picture is likely viewed for a longer time in order to obtain more information about the animals' situation.

Interestingly, the barn setting is shown to have less influence on picture viewing than the pig. This becomes further evident when comparing the fixation durations of different AOIs in the straw and the slatted floor pens. Therefore, it can be assumed that for the depiction of farm animals in pictures the facial expression determines which elements of the picture are viewed for the longest amount of time, with "unhappy" animals tending to guide the viewers' eyes to the environmental context and eyes of the animal, whereas with "happy" animals, views are typically guided to the face, specifically the mouth region.

5 Limitations

This study has some limitations that might have impacted the results. In this section we are discussing the main limitations and we are giving guidance to future studies using eye-tracking methodology in the agricultural context.

First of all, the sample of this study is a convenient student sample and is therefore not representative neither for the German population, nor for students at German Universities. The higher proportion of females as well as the high share of agricultural students limits the transferability of results. Differences between agricultural and non-agricultural students could be of interest for further investigations. Nevertheless, due to its innovational characteristics, the results give first insights into human fixation behavior on pictures showing a farm animal in different environments. In order to make the results significant for a broader population, future studies should aim at more representative samples.

In addition, the pictures used in this study show some disadvantages that should be improved and controlled for in future studies. The picture editing should be improved to make the pictures look more realistic than in our study. Further, the walls on both pictures have different colors and show different levels of dirt, which might have impacted fixation behavior. In future studies using pictures, more effort should be put on keeping pictures even more similar and realistic than in the study presented herein.

Overall, we are not able to tell with 100% what led to the longer fixation times of the face and snout of the "happy" pig and the longer fixation times of the eyes of the "unhappy" pig. It might have been that, besides the reasons we discussed above, picture quality has impacted fixation duration.

Different sizes of the AOI on both pictures might also have impacted fixation duration, with longer fixations on the larger AOI. Since the differences in size are rather small and due to bottom-up effects guiding fixations, we assume this effect to be comparably small, if at all present. Nevertheless, sizes of AOIs should be kept the same in future studies aiming at comparing different pictures. This requirement is not easy to fulfill if animals are pictured and body parts vary in size when the animals move and might challenge future studies.

In addition to fixation durations, times to first fixations could be reported in future studies.

6 Conclusion

We found that bottom-up influences (content and elements within the picture) of picture composition have effects on the fixation times of different areas in pictures which show farm animals in different barn settings. Thereby, the facial expression of the animal seems to play a role, while the influence of the barn setting on fixations is comparably small. This underlines the importance of faces, especially of the mouth and eye regions, when people view pictures of farm animals. These regions may act as information chunks about picture content. In further studies, top-down influences should also be investigated, especially having in mind that laypeople and experts evaluate agricultural pictures differently (BUSCH et al., 2017). Our results contribute to the literature analyzing public perception and viewing of agricultural pictures, and thereby help towards understanding the underlying

processes. The fact that contemporary societies are increasingly based on images (e.g., VAN WOERKUM and AARTS, 2009) makes it necessary to understand perception and mental image processing. The power of facial expressions, also for the depiction of farm animals, is a new finding, which might be of importance when selecting agricultural pictures for different purposes.

Finally, this paper calls for a deeper analysis of the relationship of perceived emotions by humans, the emotional state of animals and the implications for the design of animal husbandry systems in order to achieve more for all involved through combining approaches of eye-tracking, neuro-economics, marketing, animal science and agriculture.

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