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Look at that! – The effect pictures have on consumer preferences for in ovo gender determination as an alternative to culling male chicks

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Abstract

Gender determination in incubated eggs (in ovo) has the potential to substitute the highly discussed practice of culling male layer chicks. The aim of this study is to investigate the effect pictures have on peoples' preferences towards in ovo sexing at different stages of embryonic development as an alternative to chick culling. For this purpose, an online survey was conducted with a representative sample of 482 respondents in Germany. A within-subject design with two choice experiments was used to investigate the influence pictures have on respondents' preferences and willingness to pay (WTP). The first choice experiment contained plain text only; the second contained also pictures of a chick or the incubated eggs at the corresponding stages of development. Findings reveal that in ovo gender determination at each proposed day of incubation (days 1, 4 and 9) was preferred to chick culling. In ovo screening on days 1 and 4 was significantly preferred to day 9. This preference for early gender determination increased significantly as a consequence to the provision of pictures. Results furthermore reveal that a high error rate of gender determination or the lack of a meaningful utilisation of incubated eggs can decrease approval for in ovo gender determination to an extent, where no positive WTP remains. Findings of this study are useful for stakeholders in poultry production when considering the implementation of in ovo gender determination as a morally admissible substitute to chick culling.

Keywords chick; choice experiment; egg; gender determination; in ovo; picture

1. Introduction

Pictures say more than words – besides providing information, they can evoke associations and feelings in the wink of an eye. The "picture-superiority-effect" describes the fact that pictures are remembered longer and better compared to text (Childers & Houston, 1984). Furthermore, pictures are considered to be more credible (Graber, 2016) and to trigger stronger emotions in comparison to written words, especially when they have an unpleasant content (Hajcak & Olvet, 2008).

In an environment of mass media, pictures are readily available and fast moving through digital channels, which makes them drivers of societal debates. This applies especially for the agricultural context, where mass media has become an important source of information (Mayfield et al., 2007; Wunderlich & Gatto, 2015). Debates about farm animal welfare have been shown to be strongly influenced by pictures in the last couple of years. One example is the debate about cage housing for layer hens, which was driven by NGOs who provided pictures and videos of confined hens in cages (Busch & Spiller, 2018). The debate led to the ban of the husbandry system in 2012 (EC, 1999).

A topic which is currently present in the media and debated in a number of western societies, for example the Netherlands and Germany (Woelders et al., 2007; BMEL, 2017) is the culling of millions of male layer chicks. These do not serve an economic purpose and are therefore culled after hatching. The topic is causing public resonance and also the awareness among stakeholders in egg production rose (United Egg Producers, 2016; Unilever, 2018). Alternatives came under consideration. The technical alternative which has the potential to substitute chick culling at an industrial scale is gender determination in incubated eggs, called "in ovo". The technology enables detecting eggs with male chicken embryos during incubation in hatcheries. Eggs with male embryos are then removed from the incubator and can be used as animal feed or in the chemical industry under limitations (EC, 2009).

Two in ovo technologies are expected to reach market maturity in the near future. They are executed at different stages of embryonic development. The first is a method determining the gender on day 4 of incubation by a spectroscopic analysis of extraembryonic blood vessels (Galli et al., 2017). The second method analyses the estradiol content of allantoic fluid on day 9 of incubation (Weissmann et al., 2013). A third possibility is currently under discussion, which is aiming to analyse the gender through magnetic resonance. It might offer the possibility to sex eggs within the first day of incubation, but it is currently not clear on which level of precision or when it will reach market maturity (TUM Press statement, 2018). A technology for gender determination at day 14 has already been developed (Göhler et al., 2017). However, currently it has not been pursued further as the chicken embryo is already at an advanced stage of development.

There is evidence that the societal acceptance for in ovo screening will largely depend on the point of time during embryonic development, when screening is performed (Leenstra et al., 2011; Brunijs et al., 2015). It can be assumed that the moral value given to the chicken embryo increases with embryonic development (for a discussion on moral status of embryos see Strong, 1997). To be a meaningful alternative to the current practice, destruction of embryos should be performed at an early stage of development, before conscious pain perception is possible. It is still under discussion, when this is the case in chicken embryos. Before day 7 of incubation, no synaptic connection with the dorsal horn exists. The possibility to perceive pain is assumed to develop stepwise from day 7 on (Aleksandrowicz & Herr, 2015). At day 13, the brain is fully developed. To which degree pain perception is experienced between day 7 and day 13 is not certain yet (Eide & Glover, 1995; Bjørnstad et al., 2015). Mellor and Diesch (2007) argue that chicks are unconscious, being in a sleep-like state until at least day 17. In contrast the Guidelines of the American Veterinary Association (Leary, 2013) presume consciousness at 50% of incubation time, therefore from day 10.5 on. Based on the aforementioned, it can be assumed that pictures of developing chicken embryos might hold a considerable potential for social resonance, which could have a lasting effect on the public opinion about in ovo gender determination.

The influence of pictures on consumer attitudes and product choices has been analysed in former studies. Hollands et al. (2011) found that communicating "images of energy-dense snack foods paired with aversive images of the potential health consequences of unhealthy eating" significantly decreased respondents' choice probability for corresponding snacks, as a consequence of an adverse effect on consumer attitudes towards these products. Germain et al. (2010) found that brand elements significantly increased adolescents' appeal for cigarette packs, while increasing the size of images with health warnings had the opposite effect. Pearl et al. (2012) analysed the impact of positive or stigmatizing pictures on respondents' attitudes towards obese persons. The authors found that the manner in which the person was portrayed in the pictures had an influence on the participants' desire for social distance towards the depicted person, which stresses the influence pictures have on social attitudes.

While the impacts of pictures were analysed experimentally in different areas, as far as we are aware, the use of pictures in discrete choice experiments (DCE) was very limited. Rizzi et al.

(2012) investigated the impact of written descriptions and images of traffic on the respondents' evaluation of travel time savings in a choice experiment; the authors found a statistically significant difference between the treatment with and without pictures. A similar approach was used by Patterson et al. (2017), comparing two choice experiments with text-only descriptions and virtual reality images in the context of neighborhood choice. Findings reveal that respondents were more focused in the virtual reality setting. Furthermore the relevance of an exact pictorial representation of the alternative is emphasized. To the best of our knowledge, the impact of images on attitudes regarding animal welfare has not been tested before using a DCE.

The objective of this study is to investigate the effect pictures have on consumers' choice behaviour regarding the context of in ovo gender determination and chick culling. Furthermore, consumers' attitudes and WTP for in ovo screening at different stages of embryonic development are analysed. For this purpose, a DCE with 482 consumers was conducted between December 2018 and March 2019 in Germany. A within-subject design with two experiments was used for the purpose of this study.

To the best of our knowledge this study is the first that investigates the influence of pictures in a DCE concerning animal welfare and the context of chick culling. The study provides furthermore comprehensive insights about consumers' attitudes and acceptance of the in ovo technology. As German citizens will likely be among the first to be confronted with poultry products from systems with in ovo gender determination, the study gives valuable insights to consumer attitudes in a market, where the debate about chick culling is highly topical. Findings are beneficial for stakeholders in egg production, as well as politicians.

2. Materials and Methods

Design of the discrete choice experiment

By employing the stated preference approach, DCEs allow for conclusions to be drawn from previously unarticulated preferences about real choice decisions (Louviere et al., 2000). The attribute-based measure of respondents' preferences is thereby possible through a series of hypothetical decision-making situations (List et al., 2006). These decision situations are called choice sets, each consisting of different alternatives. Participants are asked to select one of the given alternatives. Each presented alternative is characterised by pre-defined attributes and their associated levels. By systematically varying the attributes and their levels, the respective influence on the choice decision can be determined (Louviere et al., 2000).

The DCE utilised in this investigation presented the following decision situation to the participating consumers: based on an unlabelled design, the consumers had to choose between two generic alternatives A and B or could decide whether or not to use either of these alternatives (opt-out).[1] The opt-out alternative was included so that the choice for one of the proposed alternatives remained voluntary. A forced choice could lead to inaccuracy and inconsistency with demand theory (Hanley et al., 2001). The attributes and their levels were chosen based on the premises of relevance and complexity of the experiment. Both were addressed by reviewing the literature and seeking expert advice.

The following four attributes were employed to describe the alternatives in the DCE: (1) the day of gender determination, (2) the later use of incubated eggs or – for the current practice – male chicks, (3) the error rate, including incorrect gender determination and lower hatchability, (4) extra cost of in ovo sexing compared to the current practice described as price increase per box of 10 eggs.[2] An overview of attributes and levels used in the experiment is presented in Table 1; furthermore they are described subsequently.

The feasible days of gender determination, as derived from the literature and the current political discussion, are prospectively day 4 of incubation (Galli et al. 2017) or day 9 of incubation (Weissmann et al. 2013). An approach aiming for gender determination at day 1 is furthermore discussed (TUM Press statement, 2018). In the DCE, the in ovo gender determination is compared to the current practice of culling male chicks at the day of hatch (day 21). These four possibilities are defined as the levels of the first attribute.

The later use of incubated eggs depends on the preceding incubation time. Eggs can be used as pet feed, livestock fodder component or in the chemical industry (e.g. for shampoo), whereas male chicks are currently mainly used as pet feed (EC, 2009). Depending on the current market situation, it might occur that male chicks or eggs would also be thrown away as waste. The four levels of the second attribute are defined accordingly.

In ovo gender determination can influence hatchability negatively. Furthermore, an error rate in gender determination remains. In this way, also eggs with female embryos could be sorted

[1] The opt-out option can be chosen by consumers if both other alternatives do not meet their preferences, for instance if they prefer other alternatives for handling male chicks or if the combination of levels does not meet their preferences.

[2] Boxes of 10 eggs are a common package size in Germany.

out by mistake, leading to an increase of incubated eggs and animals needed in layer hen production. These factors are summarised to the attribute “error rate”, its levels are defined in a range between 1% and 15%, according to the gender determination process error rate which was found in the literature (Weissmann et al., 2013; Galli et al., 2017; Krautwald-Junghanns et al., 2018).

The price increase incurred per box of 10 fresh consumption eggs is defined in a range of €0 to €1.70, following the findings of Leenstra et al. (2011). Conducting an online survey, Leenstra et al. (2011) found positive willingness to pay (WTP) for alternatives to chick culling for the majority of respondents, ranging from the statement to be willing to pay an additional €0.50 - €1.00 per box of 10 eggs to “double the price or more”.[3] The study derives the levels of the price attribute on the basis of these statements.

Table 1. Attributes and levels of the DCE

Attributes	Levels
Day of gender determination	day 1 | day 4 | day 9 | day 21 (chick)
Usage of eggs or male chicks	waste (no use) | chemical industry | pet food | fodder
Error rate	1% | 5% | 10% | 15%
Price increase per box of 10 fresh eggs	€0 | €0.30 | €1.00 | €1.70

The design of the DCE was comprised of two alternatives and four attributes with four levels each, thus resulting in a full-factorial design of $[(4 \cdot 4 \cdot 4 \cdot 4)_{\text{Alternative A}} \cdot (4 \cdot 4 \cdot 4 \cdot 4))_{\text{Alternative B}} =]$ 65,536 possible choice sets. However, for the sake of practicability, this design was determined to be too extensive and therefore, the number of choice sets was reduced. To minimise the simultaneous and unavoidable loss of information when reducing the full factorial design, a so-called “efficient design” was applied. Efficient designs (Rose & Bliemer, 2009) aim to minimise the standard errors of the utility parameters for the estimation process. These designs therefore require ex-ante information regarding the population’s utility parameters. Thus, a pretest was conducted with 38 consumers in order to obtain the required

[3] The price of a box of fresh eggs in German supermarkets at the time of the study ranged from a minimum of €1.10 for conventional barn eggs to about €5.00 for organic eggs with additional production claims (e.g. DU poultry, regional agriculture, ect.).

information for the final experiment. This pilot study furthermore served to examine the comprehensibility of the questionnaire.

A D-optimal design (Scarpa & Rose, 2008; Rose & Bliemer, 2009) with eight choice sets was found to be appropriate for the purpose of this study and was computed using the software ngene (ChoiceMetrics, 2014). An overview of all choice sets is given in Appendix A.

Data collection

For the empirical analysis, primary data was collected from German consumers. An anonymous online survey was developed and available for participants from December 2018 to March 2019. Consumers were invited to participate in the survey by the data panelist “respondi” (respondi AG, Cologne, Germany). In order to obtain a representative picture of the German population, quotas on the variables age and education (highest educational attainment) were implemented. Furthermore, emphasis was made to achieve a sample which is geographically well distributed over Germany by implementing quotas on participants’ postcode.

The questionnaire was structured as follows: First, consumers were asked to provide socioeconomic data. Furthermore, to understand whether participants were already aware that male chicks were culled, this information was requested through a multiple-choice question. Second, informational texts about the practice of chick culling and the in ovo technique were provided to participants. Participants’ understanding of the information was verified through control questions, which were integrated after the informational texts. If respondents repeatedly failed to give the correct answer, they were excluded from the survey. Informational texts and control questions are provided in Appendix B.

Third, the DCE was conducted. To ensure participants’ understanding of the offered alternatives, a description of the attributes and levels remained available throughout the experiment by placing “mouse over buttons” in each choice set. By moving the cursor over the buttons, information became visible. In order to analyse the effect of pictures in the DCE, all participants were confronted with two DCE rounds. In the first round, the eight choice sets were given as plain text; an example is depicted in Figure 1. Then, four pictures of incubated eggs and a chick were shown to participants, depicting the proposed levels of the attribute “Day of gender determination”. They are presented in Figure 2.

The pictures were then integrated into the choice sets; the picture corresponding to the level of the attribute “Day of gender determination” was added to the former text which was describing the alternative. An example of a choice set with pictures is shown in Figure 3. All choice sets, now with pictures, were presented to participants a second time. A mouse over zoom was integrated so that the details of the pictures became more visible to consumers. In both DCE rounds, the eight choice sets were randomised.

	Alternative 1	Alternative 2	I do not support any of the given alternatives
Day of gender determination ?	Day 4	Day 1	
Price increase per 10 eggs ?	€1,00	€1,00	
Usage of screened out eggs or chicks ?	Processing in the chemical industry	Pet food	
Percentage of wrongly sorted eggs or chicks ?	10%	5%	
Which alternative do you choose?	○	○	○

Figure 1. Example of a choice set (first choice experiment with text only)

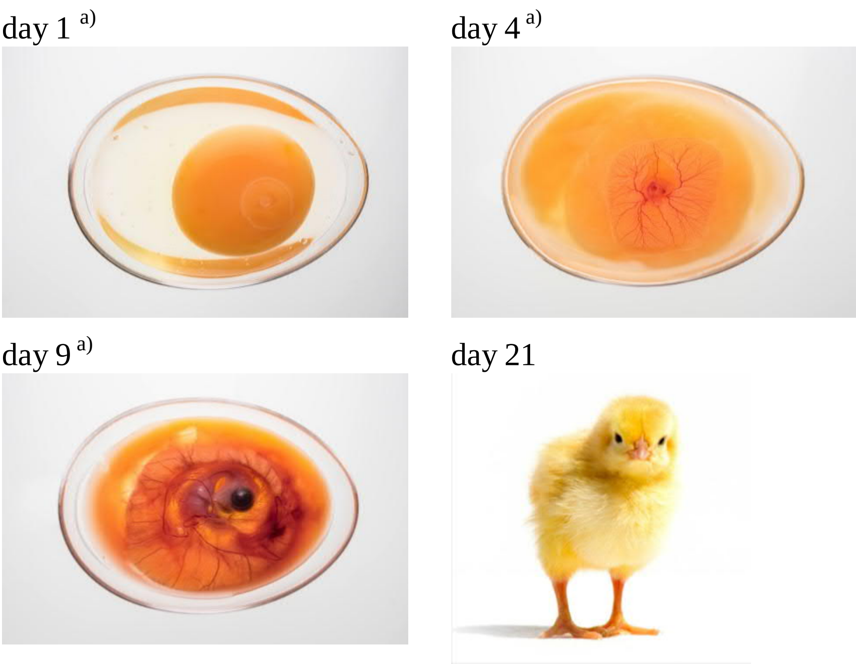

Figure 2. Pictures utilised in the choice sets of the second choice experiment

a) *Source: Agri Advanced Technologies GmbH, Visbeck, Germany.*

	Alternative 1	Alternative 2	I do not support any of the given alternatives
Day of gender determination	 Day 4	 Day 1	
Price increase per 10 eggs	€1,00	€1,00	
Usage of screened out eggs or chicks	Processing in the chemical industry	Pet food	
Percentage of wrongly sorted eggs or chicks	10%	5%	
Which alternative do you choose?	○	○	○

Figure 3. Example of a choice set (second choice experiment with text and pictures)

Econometric approach

In the Random Utility Theory (Luce, 1959; McFadden, 1974; Manski, 1977), which is the underlying framework for DCEs, the estimation of respondents' preferences is based on the assumption that the respondents' choice is dependent on specific attributes which characterise an alternative. Under the assumption of utility maximisation, respondents choose the alternative for which they have the highest utility.

In discrete choice models, the utility of alternative *j* perceived by respondent *n* in the choice situation *t* is denoted U_{ntj}. Moreover, U_{ntj} is divided into two components with a deterministic component V_{ntj} and an unobserved component ε_{ntj}:

$$U_{ntj} = V_{ntj} + \varepsilon_{ntj} \tag{1}$$

Focusing on the estimation of the WTP, the deterministic component can be described by the price component p_{ntj} and the vector of non-price attributes x_{ntj}, which are weighted by the respondent-specific, random parameters α_n and β_n :

$$U_{ntj} = -\alpha_n p_{ntj} + \beta_n' x_{ntj} + \varepsilon_{ntj} \tag{2}$$

Thereby, ε_{ntj} is assumed to be an independent and identically distributed (i.i.d.) error term following an extreme value distribution Type 1. The variance of the error term is respondent-specific and therefore defined as $Var(\varepsilon_{ntj}) = k_n^2(\pi^2/6)$, with k_n as scale parameter of respondent n. Since the utility is ordinal scaled, equation (2) may be divided by k_n without having an impact on U_{ntj} (Train, 2009). This results in:

$$U_{ntj} = -(\alpha_n/k_n)p_{ntj} + (\beta_n/k_n)' x_{ntj} + \varepsilon_{ntj} \tag{3}$$

Thereby, the variance of the error term is identical or rather constant for all respondents. By the standardization of k_n to 1, the variance is therefore redefined as $Var(\varepsilon_{ntj}) = \pi^2/6$. Defining the utility coefficients as $\lambda_n = (\alpha_n/k_n)$ and $\varphi_n = (\beta_n/k_n)$, utility can be written as:

$$U_{ntj} = -\lambda_n p_{ntj} + \varphi'_n x_{ntj} + \varepsilon_{ntj} \tag{4}$$

which is referred to as a model in *preference space*. In preference space, WTP for attribute levels is obtained by calculating the marginal rates of substitution between the attribute levels and the price parameter. Literature indicates that models in preference space seem to be the current standard method for estimating the WTP of individuals (see Sauter et al., 2016).

However, a main assumption of these models is that the price coefficient is fixed across individuals. This is necessary because otherwise the WTP is derived by calculating the ratio of two randomly distributed terms, namely the ratio of the distribution of the non-monetary attribute and the distribution of the price coefficient ($WTP = \omega_n = \varphi_n/\lambda_n = \beta_n/\alpha_n$). Unfortunately, this procedure often results in unrealistic and invalid distributions for the WTP (Scarpa et al., 2008; Hensher and Greene, 2011). Handling the price coefficient to be fixed is an unnecessarily restrictive assumption as it does not allow to account for heterogeneity in the price coefficient, and furthermore assumes that the scale parameter and therefore the variance in the error term is identical for all individuals. Consequently, this unidentified scale heterogeneity can be erroneously attributed to a variation of the WTP (Train and Weeks, 2005). Considering this, models in so-called *WTP space* are able to overcome this problem by directly estimating WTP coefficients through a re-formulation of the model to

$$U_{ntj} = -\lambda_n p_{ntj} + (\lambda_n \omega_n)' x_{ntj} + \varepsilon_{ntj} \tag{5}$$

where ω_n is directly calculated in the estimation process. In this case, assumptions regarding the distributions of the WTP are made directly rather than on the attribute coefficients.

In the case of this study, to test for differences between the single WTP estimates derived from the experiments with and without pictures, two approaches were used. First, the variable "treatment" was designed to describe the DCE round with pictures; interaction terms of all attributes with this variable were then included in the model estimation (Model 1). Second, the two DCE rounds were estimated separately (Model 2 and Model 3) and a complete combinatorial method proposed by Poe et al. (2005) was applied subsequently. This so called Poe test has become a standard for measuring the difference of independent empirical distributions in the context of DCEs in recent years. It is widely applied in the literature (Carlsson et al., 2005; Liebe et al., 2012; Glenk & Colombo, 2013; Colombo et al., 2015; Liebe et al., 2015). In all three models, random parameter logit models (RPL) in WTP space were employed, which were estimated by using 1,000 Halton draws.

3. Results

Socioeconomic characteristics

A total of 544 respondents completed the survey. The average answering time was 26 minutes. Data from respondents who always chose the same alternative in the DCE or attitudinal questions were excluded from the dataset, as inaccurate answering behaviour must be assumed in these cases. Thus, 482 respondents remained in the dataset. The socioeconomic characteristics of the respondents are depicted in Table 2. Through the implementation of quotas, the sample was achieved to be almost representative for the German population regarding the variables average age and education (highest educational attainment). The sample is furthermore representative for the German population regarding respondents' residence (rural or urban) and occupation group, as can also be seen in Table 2.

Evidence shows that participants were already widely aware of the culling of male chicks. A total of 79% of participants chose the correct answer in the multiple-choice question "What happens to male chicks from layer hen production?" (79% "they are culled"; 17% "I do not know"; 4% "they become broilers").

Examination of the impact pictures have

The choice experiment data was analysed using the software Stata 14. First, an effects coded[4] variable "treatment" which is coded as -1 for the DCE without pictures and as 1 for the DCE with pictures was created. Then, interaction terms of this variable with all attributes were

[4] Effects and dummy coding differ in the handling of the attribute level which describes the base level. With dummy coding, all non-omitted levels are coded as 0 when the base level is present. With effects coding, all non-omitted levels are coded as -1 when the base level is present (Hauber et al., 2016). The latter avoids confounding with the opt-out alternative. For a discussion on effects coding in DCE see Bech and Gyrd-Hansen (2005).

included in the model estimation (Model 1). Results of the interaction terms are presented in Table 3.

Table 2. Socioeconomic characteristics of the sample (N=482)

Variable		Mean (SD)	Percentage %
Average age		49 [50][a), b)] (17.6)	
Gender male			44 [50][b)]
Education	Apprenticeship		51 [56][b)]
	University degree		19 [18][b)]
	School leaving certificate or none		30 [26][b)]
Residence	Rural residence (town <20,000 inhabitants)		48 [41][c)]
	Urban residence (town > 500,000 inhabitants)		19 [17][c)]
Occupation	Students		4 [3][d)]
	Employees		50 [50][d)]
	Pensioners		35 [26][d)]
	Other		11 [21]

a) German average given in brackets []
b) Destatis (2017)
c) Destatis (2018)
d) Destatis (2019)

As can be seen in Table 3, statistically significant coefficients of the interaction terms give evidence for differences in respondents' answering behaviour between the with-pictures and without-pictures setting. A statistically significant negative alternative specific constant (ASC) demonstrates that respondents were more inclined to opt out when pictures of incubated eggs and chicks were included in the choice sets, in comparison to plain text. Choice probabilities for the two in ovo alternatives executed on days 1 and 4 of incubation significantly increased when respondents were provided with the pictures of incubated eggs.

In contrast, a statistically significant decrease of choice probability can be observed for in ovo gender determination at day 9. Regarding the attribute "usage", no statistically significant changes in preferences between the two DCEs are observed. Also, regarding the preferences for the attribute "error rate", no statistically significant difference in preferences can be found between the two experimental settings.

In the next step, two separate RPL models in WTP space were estimated for the two DCE rounds with and without pictures. Differences in the distributions of coefficients were subsequently investigated using Poe test. The results of both models are presented in Table 4. Both models reveal statistically significant coefficients for all attribute levels and for the ASC. In ovo gender determination at all of the given days is preferred over the culling of chicks in both models. Wald test was used to test for differences in WTP between the coefficients of the attribute "Day of gender determination". Gender determination at day 1 and at day 4 do both generate a statistically significantly higher WTP compared to day 9 in the without pictures alternative. No statistically significant difference can be found between the coefficients of day 1 and day 4.

Table 3. Model 1: RPL model in WTP space with interaction terms (N=482)[a)]

Variables	Mean	
ASC x treatment	-0.40	***
Day 1 x treatment	0.85	***
Day 4 x treatment	0.19	**
Day 9 x treatment	-0.36	***
Day 21 x treatment	[-0.68]	
Error rate x treatment	-0.01	
Chemical industry x treatment	0.11	
Pet food x treatment	-0.03	
Waste x treatment	0.02	
Fodder x treatment	[-0.10]	

Notes:
[a)]* $p < 0.1$; ** $p < 0.05$; *** $p < 0.001$; Coefficients estimated using 1,000 Halton draws. Base levels of effect coded attributes in brackets []. For clarity, only coefficients for the interactions are shown. Complete results are displayed in Appendix C.

However, Poe test reveals statistically significant differences in the choice behaviour between the two DCE rounds, indicated in bold font in Table 4. Whereas a positive WTP for gender determination at day 9 of incubation is found in the without-pictures model, this changes in the with-pictures setting. Choice probability significantly decreases for day 9, rendering even a negative WTP for this alternative. In opposition, WTP for the two early gender determination points day 1 and 4 increases statistically significantly.

Preferences for the attribute "usage" are similar in both models. The use of the by-products, namely screened out eggs or male chicks as pet food is the preferred utilisation, followed by the use as fodder. Throwing by-products away as waste is the least preferred option and considerably reducing WTP for the associated alternative in both DCE rounds. The use of by-products in the chemical industry is also reducing WTP, though less strongly than the attribute level "waste". For the attribute level "chemical industry" we find a statistically significant change in choice behaviour between the two DCE rounds. The attribute level is evaluated less negatively in the with-pictures scenario. For the other attribute levels, as well as the attribute "error rate", no statistically significant difference in choice behaviour can be found between the two models.

Table 4. Comparison of Models 2 and 3 by means of Poe test (N=482)

	Model 2 - without pictures				Model 3 - with pictures			
Variables	Mean		SD		Mean		SD	
ASC	1.98	***	3.12	***	1.41	***	3.86	***
Day 1	**1.47**[b)]	***	1.48	***	**3.66**	***	1.84	***
Day 4	**1.45**	***	0.54	**	**2.22**	***	0.49	***
Day 9	**0.25**	**	0.28		**-0.81**	***	1.40	***
Day 21	[-3.17]				[-5.07]			
Error rate	-0.17	***	0.09	***	-0.22	***	0.10	***
Chemical industry	**-0.89**	***	0.04		**-0.44**	***	0.16	
Pet food	1.58	***	0.02		1.42	***	0.02	
Waste	-1.69	***	1.69	***	-1.86	***	0.64	***
Fodder	[1.00]				[0.88]			
Log Likelihood	-3,273				-2,883			
AIC	6,581				5,801			
BIC	6,713				5,934			

Notes:
[a)]* p < 0.1; ** p < 0.05; *** p < 0.001; [b)]in bold: differences in mean WTP between the first DCE without pictures and the second DCE with pictures significant at 10% level based on Poe et al. (2005) test; Coefficients estimated using 1,000 Halton draws. Base levels of effect coded attributes in brackets[].

Both approaches, which were used for the comparison between the two experimental settings, show statistically significant changes in WTP for all levels of the attribute "Day of gender determination", whereas preferences for the other attributes remain equal (with exception for the attribute level "chemical industry" of the attribute "usage"). This gives evidence that changes in choice behaviour can be assigned to the treatment, namely the provision of pictures.

The change in WTP for the attribute level “day 9” is particularly interesting. In the setting with pictures, in ovo gender determination is still preferred to chick culling (also when executed at day 9 of incubation). Nonetheless, this attribute level *decreases* choice probability in the with-pictures scenario, whereas it *increases* choice probability in the scenario with plain text. On day 9 of incubation, the shape of the embryo already gives an idea of the future shape of the chick. As well as this, the eyes are already developed. In contrast, on days 1 and 4 of incubation, no shape of a chick is visible yet, only the yolk. The association with a chick might be the reason for the disapproval of the attribute level “day 9” when accompanied with a picture. This could be an open flank of the in ovo technology which determines the gender on day 9, as the images of the embryo are able to trigger emotional resonance.

Findings furthermore reveal that a meaningful utilisation of the by-products of layer-hen production, screened out eggs or male chicks, is considered as a crucial characteristic and almost equally important as the day of gender determination. Surprisingly, the use of screened out eggs in the chemical industry is not considered desirable. In practice, this type of use could represent the main utilisation of eggs. In this study, the use as pet food and fodder were preferred. This could either be due to the fact that these utilisations are more common to consumers, or due to the fact that the utilisation as a nutrient is considered superior to the utilisation as an industry product. However, all three possible utilisations were considered an improvement compared to “waste” / no use. The error rate in gender determination, associated with an increase of animals and incubated eggs needed, is considered a disadvantage and was penalised by respondents through a decrease in WTP. Respondents’ WTP for a box of 10 eggs decreased by €0.17 when the error rate increased by one percent. Therefore, high error rates or the lack of a meaningful utilisation of incubated eggs can decrease approval for in ovo gender determination to an extent, where no positive WTP remains.

4. Conclusion

The presented study provides insights to consumer preferences for a highly topical subject regarding poultry production: gender determination of male layer chicks in incubated eggs. The aim of this study was to investigate consumers’ preferences for in ovo gender determination at different stages of embryonic development as an alternative to chick culling, and to analyse the effect pictures have on these preferences. The study therefore contributes to the limited literature on the effect of pictures in DCE. Using a within-subject design, two identical DCEs were presented to respondents, providing choice situations between egg alternatives with different production attributes. In the first DCE round, alternatives were described through text only. In the second DCE round, pictures of incubated eggs or a chick – depending on the attribute levels given in the choice set's alternatives – were added. Findings reveal that all proposed in ovo alternatives are preferred over the current practice of chick culling. Results show that gender determination at earlier stages of development, namely day 1 and day 4, is statistically significantly preferred over day 9. Pictures influenced respondents' choice behaviour significantly. When respondents were confronted with pictures, gender determination at day 9 of incubation actually decreased choice probability.

Results have important implications for stakeholders in egg production in Germany, and also in other countries where the practice of chick culling is debated due to moral concern. The development of a technology enabling the sexing of chicken embryos at an early stage of development is in line with consumer expectations. Considerable WTP can be found for these in ovo alternatives. This preference becomes clearer, when consumers are confronted with pictures of incubated eggs or a chick. Furthermore, a low rate of failure and meaningful usage of screened out eggs should be communicated clearly to consumers, as they are crucial attributes for the acceptance of in ovo gender determination as a morally admissible alternative to chick culling. The results demonstrate that as long as chick culling remains the industry standard, communication of "in ovo" production claims could be a way for producers to differentiate from the market. Knowledge of societal expectations and a profound communication with consumers is able to increase WTP and acceptance for the in ovo technique significantly. However, gender determination at advanced stages of embryonic development is seen critical, especially when respective pictures of incubated eggs are provided. This offers a potential for social criticism, which should be kept in mind by stakeholders in poultry production when implementing the in ovo technique on a large scale.

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Appendix A

Table A-1. Overview of all choice sets

	Choice Set	1		2		3		4		5		6		7		8	
	Alternative	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Attribute	Level																
Day of gender determination	Day 1		✓	✓						✓		✓					✓
	Day 4	✓			✓				✓							✓	
	Day 9					✓		✓			✓		✓				
	Day 21 (chick)						✓							✓	✓		
Usage	Waste (no use)					✓						✓			✓	✓	
	Chemical industry	✓		✓									✓				
	Pet food		✓				✓		✓					✓			
	Fodder				✓			✓		✓	✓						✓
Error rate (%)		10	5	10	5	5	10	5	10	1	15	15	1	5	10	1	15
Price (€)		1.00	1.00	0.30	0.30	1.70	-	-	1.70	1.00	0.30	-	1.00	1.70	-	0.30	1.70

Appendix B

Information about poultry production

In poultry production, egg and meat production are separated. For the production of chicken meat such as chicken fillets or chicken thighs, there are special breeds that grow very quickly, put on a lot of meat and can be slaughtered after 5-6 weeks. For the production of eggs, specialised breeds are used which lay over 300 eggs per year. They are called layer breeds. The hens and cockerels of these breeds have a narrow, thin physique and put on very little meat, even when they are fully grown.

Only the females of these layer breeds can lay eggs. However, as male and female chicks hatch when breeding the laying hens, there is a problem: Cockerels do not lay eggs and they grow very slowly and put on very little meat. They are therefore neither useful for the production of eggs nor for the production of meat. Therefore, they are killed on the first day of life, shortly after they hatch. This happens in the EU mostly by suffocation with CO2 gas. Slaughtered chicks can partly be used as feed for zoo animals or pets. This practice is very widespread, both in conventional and organic farming. In Germany, between 45 and 50 million male chicks are killed every year on the first day of life.

A technical solution to determine the gender in the egg (1)

Chicken eggs are usually incubated for 21 days. On the 21st day the chick hatches. In laying hen production, the chicks are sorted after hatching by hand into female and male chicks. The male chicks are then killed. Currently, research is underway to develop a technique for determining the gender in the egg. This method is called "in-ovo", i.e. "in the egg". Eggs with male embryos would as a consequence be sorted out before hatching. Male chicks would therefore not have to be killed on the first day of life and eggs with female embryos would be incubated until hatching. The future laying hens hatch from these eggs. Determining the gender of a chick before hatching is technically complex. Alternatives include the examination of the egg on days 1, 4 or 9 of incubation. On the 1st and 4th day of incubation the pain sensation of the chick embryo is not yet developed. On the 9th day of incubation, perception of pain might already be present to a certain degree.

Control question

Why should the ovo technique be introduced?

- The eggs can already be sorted into future broilers and laying hens during incubation
- The health of the chicks can be determined before hatching, so that unhealthy embryos can be sorted out.
- Male chicks from layer hen production can be identified and sorted out during incubation. This prevents the killing of male chicks after hatching.

A technical solution to determine the gender in the egg (2)

Half of the fertilised eggs in the incubator contain male embryos, the other half is female. It is possible that the gender is not determined correctly in all eggs with the in ovo technique. It can happen that eggs with female embryos are destroyed by mistake.

Due to different errors, to obtain 100 healthy laying hens, more than 200 fertilised eggs must therefore be incubated.

Control question

Due to errors in gender determination, it is possible that eggs with female embryos are also unintentionally rejected.

- True
- False

Appendix C

Table A-2. Interaction model, full table of results[a)]

Variables	Mean	statistical significance
ASC [b)]	1.55	***
Day 1	2.34	***
Day 4	1.69	***
Day 9	-0.24	**
Day 21	[-3.79]	
Error rate	-0.20	***
Chemical industry	-0.72	***
Pet food	1.53	***
Waste	-1.74	***
Fodder	[0.93]	
Price	-0.22	**
ASC x treatment	-0.40	***
Day 1 x treatment	0.85	***
Day 4 x treatment	0.19	**
Day 9 x treatment	-0.36	***
Day 21 x treatment	[-0.68]	
Error rate x treatment	-0.01	
Chemical industry x treatment	0.11	
Pet food x treatment	-0.03	
Waste x treatment	0.02	
Fodder x treatment	[-0.10]	

Notes:
[a)]* $p < 0.1$; ** $p < 0.05$; *** $p < 0.001$; Coefficients estimated using 1,000 Halton draws. Base levels of effect coded attributes in [brackets].
[b)]Alternative specific constant (ASC)

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