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Review

Positive Welfare Indicators and Their Association with Sustainable Management Systems in Poultry

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Abstract: Animal welfare is a key and distinct component of sustainable agriculture and food security. People, both as citizens and consumers, have become more concerned about the husbandry of livestock species. Positive welfare goes a step further than the common welfare approach, supporting that a good life for animals is not only the alleviation of negative aspects, but also the promotion of positive affectivities. So, a sustainable management system for any livestock species should promote positive aspects in the lives of animals. Poultry is one of the species whose welfare is most impaired, and numerous concerns are raised by society. For all the above, we reviewed the positive welfare indicators that have been studied in livestock poultry and that can be used to promote positive effects and assess welfare for the most common species, i.e., broilers, laying hens, turkeys, ducks, geese, quails and ostriches. We analyzed the results categorized by species, discussed the connection of the indicators with sustainable management, and made proposals for future studies. Exploration and dustbathing have been extensively studied and seem most promising, especially in broilers and laying hens, followed by nesting and perching, and swimming for waterfowl. Qualitative behavioral assessment (QBA) is already applied in protocols for broilers and laying hens, but the results are not as promising due to the homogeneity of the flock and the difficulty in observations. Play has been studied mostly in broilers but is a behavior difficult to recognize and needs further understanding. The results are limited for all species, except broilers and laying hens.

Keywords: broilers; laying hens; turkeys; geese; ducks; positive welfare evaluation; exploration; dustbathing; pre-laying; qualitative behavioral assessment

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1. Introduction

Animal welfare is a fundamental component of sustainability, agricultural development and food security. In order for a livestock system to be sustainable, it should be sustainable economically, environmentally and ecologically, and at the same time, it should be accepted ethically and socially [1–3]. Today, a product of animal origin is not considered sustainable unless the social demand for welfare of the production animals is satisfied [1]. Animal welfare of livestock species is a common debate that attracts more and more the attention globally [2–4]. It has become one of the scientific issues that is most interesting to the public [4], especially after the United Nations Committee on World Food Safety endorsed, in 2016, animal welfare as a pillar of sustainable agricultural development, food security and nutrition [5]. In addition, animal welfare has been linked to human health, as endorsed with the "One Health" approach by the World Health Organization [6] and the "One Welfare" concept [7]. It is considered a public good, beneficial for the wellbeing of the wider society [8] and an attribute of product quality [1]. People as consumers are willing to pay more for products of higher animal welfare [9,10]. As citizens, they have become

more concerned about the protection of animals and the incorporation of animal welfare in national and international legislation [1–3,8,11].

As a scientific field, animal welfare has flourished during the last two decades [1,12]. Its link to sustainability is a constant debate. Global meat consumption is about to increase by 14% by 2030 compared to the average of the 2018–2020 period [13]. The increase in livestock production is linked to intensification, impacts on the environment and impacts on the welfare of the animals. It is a challenge to satisfy the growing meat demand and simultaneously not to impair the welfare of the animals and the environment. This is why scientific research on sustainable management has a crucial role, together with the consumers' willingness to pay and the policymaking that will determine the acceptable welfare level for the animals [3,4,14,15].

Poultry meat is first in terms of global consumption, and it is expected to increase even more by 2030, representing 41% of the total global meat consumption [13]. In low-income countries, it is a low-cost protein source. In high-income countries, it is perceived as a healthy meat choice. Egg production is about to increase globally by 13% over the next decade [16]. According to OECD Agriculture statistics, the projection of average egg consumption is estimated to increase from 90,513 kt in 2019–2021 to 105,809 kt in 2031 [17]. Broilers and laying hens are highly industrialized species, and their welfare is perceived as being the worst among all farm animals. Poultry is the farming species that raises the highest public concern regarding welfare management practices [9]. Consumers are willing to pay more for eggs from cage-free or free-range systems [18–20] or eggs from more "welfare-friendly" furnished cages [21]. They are also willing to pay an extra cost for organic meat [22], meat from slow-growing chickens [23] or meat from dual-purpose farming systems, where male chickens are reared for their meat and females for their eggs [24]. Nonetheless, price is always an issue [18,19,23,25]. Especially for meat from highly welfare-friendly systems, compared to eggs, since meat is a more expensive product than eggs [24,25]. Thus, a farming system that is sustainable for the animals and the environment, and at the same time economically sustainable and morally approved by society, is a challenge.

Positive welfare (PW) is the newest approach to welfare, which, as analyzed above, is a distinct and necessary pillar of sustainable agriculture and food safety. PW promotes the experience of positive affective states in an animal's life in addition to the alleviation of negative experiences [11,26]. It promotes that the life of an animal, without negative experiences, is not necessarily a good life. Good experiences are also necessary [27]. Positive experiences and stimulation are important for a high quality of life [28,29]. The attention and interest for the evaluation of PW is steadily increasing among consumers, especially for intensively farmed animals like poultry [9]. As a result, PW indicators have already been incorporated in welfare evaluation schemes and protocols for laying hens and broilers [30,31].

The aim of the present study is to review all the positive welfare indicators that can be used for the evaluation of positive welfare in poultry, including indicators that have either been tested in practice, experimentally and on the farm level, or studied on a theoretical base. We will emphasize the behavioral indicators since the indicators that are being researched as indicators of positive affective states are mainly behavioral. Furthermore, we will make proposals for future research and for the evaluation of positive welfare on the farm level, as part of sustainable management systems, in the most important poultry species, such as broilers, laying hens, turkeys, geese, ducks, quails and ostriches. To the best of the authors' knowledge, this is the first attempt to review the positive welfare indicators of all livestock poultry species and discuss their association with the sustainable management of poultry farming systems.

2. Materials and Methods

The search was conducted in databases Google Scholar and Web of Science. The search period was 2000–2023 for two reasons: firstly, because the research on PW has

been thriving mainly in recent years, and secondly, because we wanted to include the most recent publications in our review. The starting point was a general search using the following key words separately or in various combinations: "positive welfare", "positive emotion*", "positive affective state*", "positive welfare indicator*", "positive welfare evaluation", "positive welfare" AND sustainability, "positive welfare" AND "sustainable management" OR "sustainable system", broiler* OR chick*, "laying hen*", turkey*, ostrich*, quail*, duck*, geese OR goose, poultry, waterfowl, "*Gallus gallus domesticus*", "*Meleagris*", "*Anser*", "*Anatidae*", "*Anas platyrhynchos domesticus*", "*Coturnix*". The duplicates were removed from the results. For every retrieved PW indicator, a separate search was then performed. The results were also supplemented with articles that were included in the references of our research findings. Moreover, we included in the results some research findings that apply to vertebrae [28,32–35], domestic species [36,37] or livestock species [38] in general and not specifically to poultry. Additionally, we included in the results the Welfare Quality Assessment protocol for poultry [30] and the Welfare Quality Assessment protocol for laying hens, version 2.0 [31]. The whole procedure was conducted by one author.

The used criteria for including a research finding in the results was that it described a positive welfare indicator, based on studies under experimental or commercial circumstances or on theoretical analysis. Physiological studies were excluded. No other review on positive welfare indicators for any poultry species was retrieved. Reviews were included in the results only if the authors marked/concluded that a reviewed trait could indicate positive affectivity.

The above search procedure led to the inclusion of a total of 95 articles in our database. We summarize the search strategy that led to our results in Figure 1.

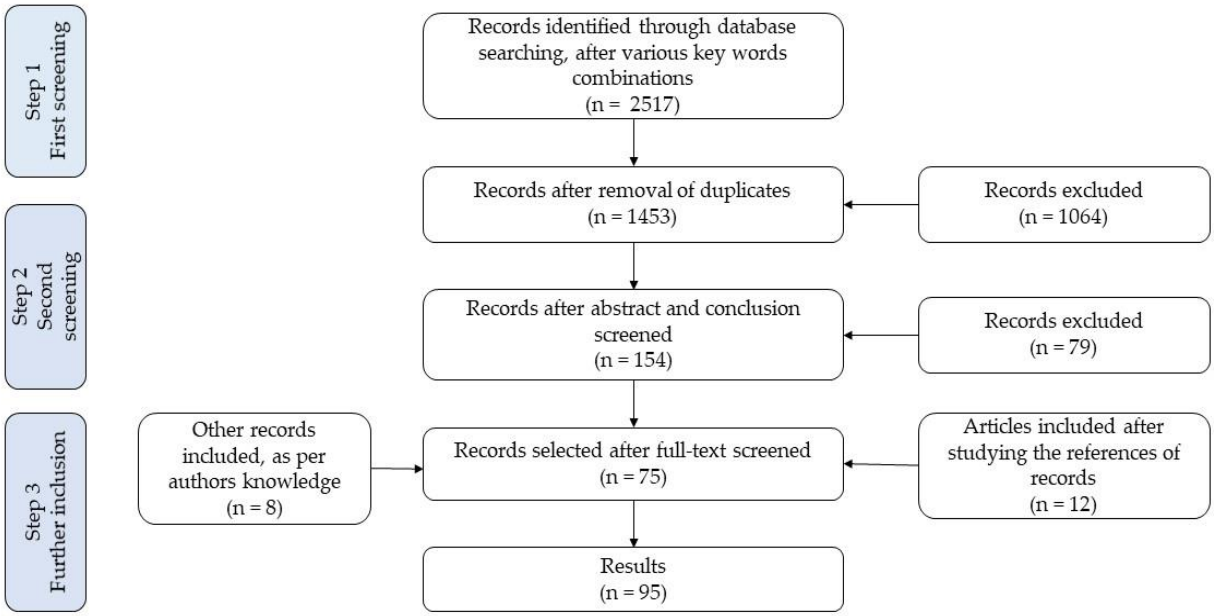

Figure 1. Flow chart of the literature selection strategy, displaying the screening and inclusion process.

3. Results

Thirteen positive welfare indicators, all animal based, were retrieved. The results are summarized in Table 1, classified by indicator, the animals that the indicators correspond to and the research findings that include all the information. The nine positive welfare indicators are summarized in the behavioral group of indicators because they are all referred to as behavioral traits.

Table 1. Positive welfare indicators categorized by poultry species.

Group	Indicator		Species	References
Behavioral parameters	Exploration and foraging		all	[28,33,34]
			broilers	[30,39–50]
			laying hens	[51–53]
			turkeys	[54,55]
			ducks	[56]
			geese	[57]
	Comfort	general	all	[27–29,34]
		dustbathing	broilers	[42,49,58,59]
			laying hens	[31,51,52,60–64]
			quails	[65]
		preening	all	[28,33,34]
			broilers	[40,41,44,58]
			laying hens	[31,52,61,66,67]
			turkeys	[55,68]
			ducks	[56,69,70]
		others	various	[39,40,44,46,48,51,57,59,71,72]
	Play		all	[32–35,73]
			broilers	[30,41,47–49,58,59,74]
			laying hens	[51]
			ducks	[75]
			ostriches	[76]
	Behavioral synchronization		all	[33–35]
			broilers	[77–79]
			laying hens	[80,81]
			ducks	[61,82]
	Swimming and access to water		ducks	[69,70,82]
			geese	[71,83]
	Pre-laying		laying hens	[60,84–87]
			ducks	[88,89]
	Perching		broilers	[40,61]
			laying hens	[51,61,90–92]
	Maternal care		all	[34]
			laying hens	[93–95]
			geese	[57]
			quails	[96,97]
	Anticipatory behavior		laying hens	[72,98–100]
	Vocalizations		all	[33,38]
			laying hens	[38,72,98,101]
	Qualitative behavioral assessment		broilers	[30,47,102]
			laying hens	[31,103–105]
	Positive human–animal interaction		all	[106–108]
			broilers	[30,109,110]
			laying hens	[31,86,111,112]
			quails	[113]
			ostriches	[114]
	Cognitive bias		all	[115,116]
			broilers	[117,118]
			laying hens	[100,119–121]
			quails	[122]

3.1. Behavioral Paremeters

The behavioral indicators that have been retrieved are exploration, comfort, play, synchronization, swimming, pre-laying, perching, maternal care and anticipation. Comfort behavior in poultry is mainly performed as dustbathing and preening, as will be analyzed in Section 3.1.2. All these indicators are animal based, indicative of the behavioral response of the animals to the resources of their environment and/or the management practices. Dustbathing, swimming, pre-laying and perching can be categorized as both resource-based and animal-based indicators, since they are performed under the provision of dustbath, water, nesting and perching substrates, respectively. Nonetheless, they are species-specific behaviors also referred to as behavioral traits, and they indicate the affective states of the animals, as will be described in Sections 3.1.2 and 3.1.5–3.1.7, respectively.

3.1.1. Exploration and Foraging

Exploratory behavior is considered one of the best candidates as a positive welfare indicator in various animals [28,33,34], including livestock species like dairy animals [123,124] and the domestic pig [125]. It is a strongly motivated natural behavior of most livestock species, including poultry, and is correlated to feeding behavior [34]. Animals explore their environment in order to acquire information and feel safe [34]. According to Mellor [34], the animal is performing this behavior repeatedly because it is self-rewarding. The reward is the pleasure of expecting or acquiring the feed, and in addition, the pleasure of tasting it. This is also reinforcing, and so the animal keeps performing the behavior continuously. In addition, exploration indicates the absence of fear or any type of threats to survival [28]. In vertebrae, it is a goal-directed behavior [28] that indicates positive affective states [28,33,34]. Nonetheless, it should be interpreted with caution and by taking into consideration the whole context of the situation, since sometimes it can also indicate fear or uncertainty [33]. There are two types of exploration: inquisitive and inspective exploration [33]. Inquisitive exploration is always performed due to curiosity and is an initiative of the animal. On the contrary, inspective exploration can be driven both by curiosity or fear and is a response of the animal to a change in its environment. So, inquisitive exploration always indicates positive affective states, but inspective exploration can also indicative negative affective states [33].

In poultry, exploration is correlated to foraging and feeding behavior, performed by pecking and scratching on the ground and, sometimes, pecking the environment in general [126]. Slow-growing breeds of broilers explore their environment more compared to fast-growing commercial broilers, are more active, forage more, and use more the provided environmental enrichment [39,41,44,47,48]. Rayner et al. [47] observed that slow-growing broilers ground-scratched more than fast-growing broilers under commercial conditions, and the behavior decreased as stocking density increased or the age of the animals increased. The authors conclude that this finding could be attributed to the fact that higher stocking density leads to worse litter quality and, as a consequence, a worse substrate for pecking behavior. The same observation was reported by Baxter et al. [41], but in farms of higher welfare standards. The reduced available area for scratching, when increased stocking density is applied, may also be responsible for the reduced rate of the scratching behavior by broiler chickens. Abeyesinghe et al. [39] propose exploratory behavior as a positive welfare indicator of slow-growing broilers that should be incorporated in welfare assessment protocols. Moreover, they support that it is also an indicator of better health status, since it is negatively correlated with breast plumage dirtiness, leg weakness and hockburn in commercial conditions. Exploration has been positively linked to environmental enrichment and stimulation in various studies with broilers [40,42,43,46,48–50] and negatively linked to stocking density [42,48–50]. Elevated platforms with ramps [40], pecking stones [42], straw bales [42] and barriers [43,50] are an effective way of promoting exploration and pecking on the ground and the environment. Also, enriching the litter with mealworm can induce the satisfaction of foraging pecking [46]. This enrichment can be combined with outdoor access or access to covered verandas in an attempt to promote

exploration and positive affective states to a greater extent [45]. The Welfare Quality protocol for broilers [30] measures inquisitive exploration as part of the positive emotions criterion. This criterion is measured by QBA, and one on the terms that is used to describe the animals during the evaluation is "inquisitive".

Laying hens display a stronger motivation of foraging explorative behavior compared to broilers due the fact that broilers are more efficient converters of feed, are heavier, grow faster and spend more time resting [126]. Campbell et al. [51] observed that free-range hens reared in a complex environment with navigating and perching structures expressed more foraging and environmental exploration compared to hens reared in a control environment. In this study, both groups had equal quantity of feed indoors, enough to cover their nutritional needs, which indicates that the foraging and explorative behavior was a result of stimulation to explore the environment. Shimmura et al. [52] compared the total pecking behavior of hens kept in single-tiered aviaries with or without access to an outdoor area. The total pecking behavior of the two groups was the same, but the specific types were different. The layers with outdoor access performed more foraging and exploring pecking, while those reared in the aviaries were more aggressive and showed an increased incidence of feather pecking. Furthermore, inquisitive exploration [53] and foraging behavior [127] during the laying period increases when hens are reared in enriched environments as chicks. Environmental enrichment also increases the exploratory behavior of laying chickens in Y-maze tests [128]. Contrary to the Welfare Quality protocol for broilers [30], the respective one for laying hens [31] does not include the term "inquisitive" in the QBA assessment of animals' emotions.

Exploration is also linked with foraging behavior in the domestic turkeys. Animals spend most of their time foraging when raised outdoors [54]. Pecking at the environment is increased when the stocking density decreases [55], but the influence is not as strong as in broilers [41,44,47]. Regarding geese and ducks, exploration is not only correlated to foraging but also to swimming, and it is promoted by the depth and the whole swimming surface area [61]. Ducklings raised in an environment enriched with troughs with water and strings, objects or grain mixture, or just enriched with various types of feed and no water, forage more than ducklings without these provisions and perform less feather pecking [56]. At the same time and interestingly, naturally hatched geese show more foraging behavior compared to artificially hatched geese [57]. Moreover, geese in free-range systems forage and explore the environment more compared to geese kept intensively, although they show more fear to explore [57]. Geese also perform more inquisitive exploration on muddy compared to plastic floor types [71].

3.1.2. Comfort

An animal that displays behaviors associated with comfort is an animal that is presumably experiencing pleasure [27–29]. Comfort behavior is rewarding and accompanied with positive affective states [34]. After reviewing the existing literature, we concluded that two main behaviors indicate comfort in poultry and are proposed as positive welfare indicators: dustbathing and preening. Dustbathing is performed by hens, quails and ostriches [63]. Preening is a comfort behavior performed by all poultry species [61]. These behaviors will be analyzed below separately in Section 3.1.2, respectively.

Comfort behavior is described as preening and dustbathing in most findings concerning domestic hens (e.g., [39–42,48,52]). Preening while dustbathing is defined as dustbathing according to the ethograms in all studies. The Welfare Quality protocol for laying hens evaluates comfort behavior as preening and dustbathing [31], but comfort is not assessed in the respective protocol for broilers [30]. This is likely due to the short lifespan of broiler chickens, i.e., 42 days in an intensive production system. For most of the rearing period, feathers are not fully developed for adequate expression of preening and dustbathing behaviors. In addition to these two main comfort indices, some behaviors that are used as indicators of comfort are: leg stretching [39,40,44,46], wing stretching [39,40,59], wing and tail wagging [48,72] and scratching body [72]. All of these are indicators that

are affected by space allowance and stocking density. Preening [57,71], feather shaking and wing flapping are applied in geese [57], whereas preening and stretching are comfort indicators for ducks [51]. Swimming is also described as comfort behavior for geese in one study [57], but this behavior will be analyzed separately in Section 3.1.5.

Dustbathing

Dustbathing is a complex behavior of domestic hens, quails and ostriches and their wild ancestors, often accompanied with sunbathing when performed in outdoor systems [61,63]. Dustbathing is suggested as a behavior that assists the bird to remove ectoparasites and excess fat from its body and feathers [63]. The full behavioral sequence in hens starts with the bird scratching and bill-raking in the substrate, then it erects the feathers and sits down. The second part consists of vertical wing-shaking, rubbing of the head, bill-raking and scratching using only one leg [63]. Then, the feathers are flattened against the body, and as described by Olsson and Keeling [63], the bird spends some time lying or rubbing on the side. During the last phase, it stands up, shakes out the dust and returns to its activities. According to Nicol et al. [61], the fact that dustbathing is a behavior that returns the motivation to the baseline after being fully performed indicates that it is an indicator of positive welfare. As reviewed by Olsson and Keeling [63] and Hemsworth and Edwards [60], although the motivation towards dustbathing in the domestic hen is well studied, the results are conflicting. The behavior is also influenced by environmental factors, which makes the understanding even more complex [60]. Hens deprived of a dustbathing substrate can perform a behavioral rebound when offered again the chance to dustbathe [60,63]. And, hens kept on wire-floored cages perform sham dustbathing [129]. Although the motivational need of hens to dustbathe is known, the value of this need for the bird compared with other needs is unknown due to conflicting results of various studies, as analyzed by Nicol et al. [61], Olsson and Keeling [63] and Hemsworth and Edwards [60]. Still, it is a motivational and rewarding behavior, often described as comfort. According to Widowski and Duncan [64], dustbathing occurs when the animal is given the opportunity to perform it and elicits positive motivational affecting states, meaning that it is not a need of the animal that leads to suffering if not fulfilled. In the study by Widowski and Duncan [64], most hens strive to obtain a dustbath when they could see one. In other words, the animal is not in need of performing the behavior but has the motivation to do so when it gets the chance and acquires pleasure by it. Another aspect that makes the behavior a good candidate as positive welfare indicator is that it is often synchronized, especially when performed outdoors [62]. According to Campbell et al. [51], chicks reared indoors with structural environmental enrichments exhibit more foraging and dustbathing behavior as adults, indicators of positive welfare according to the authors. Moreover, hens kept in aviaries with outdoor access perform more dustbathing behavior than hens kept indoors [52].

In broilers, dustbathing has been studied as part of environmental enrichment of the birds, in combination with other provisions and a more complex environment in general. Baxter et al. [58] compared the positive effects of an enrichment consisted of platform perches or platform perches and a dustbath, compared to a control environment, in commercially housed broilers. The birds showed the shortest flight distances to humans in the environment with a dustbath, but the amount of play was not altered. In a recent study by Vas et al. [49], increased environmental complexity also promoted dustbathing behavior in broilers, which was used as a positive welfare indicator. The authors defined comfort behavior in their study as vertical wing shaking, also an indicator of dustbathing, according to the analysis of the full behavioral repertoire by Olsson and Keeling [63]. Vasdal et al. [59] also observed that broilers with environmental enrichment including a dustbath were more active compared to commercially housed birds, and they showed more wing flapping, stretching, body shaking and play behavior. Nonetheless, the enrichment used in this study was a combination of peat, bales of hay and elevated platforms, and it cannot be concluded how important the contribution of the peat was in improving welfare compared

to the other types of enrichments. Bergman et al. [42], on the other hand, observed that both fast- and slow-growing broilers in an enriched environment with a complex structure of perches, straw bales, pecking stones and outdoor access spend only a small amount of time dustbathing, but they attributed this to the fact that the litter material was not attractive.

The effects of dustbathing as environment enrichment have also been studied on quails, though again combined with other provisions [65,130], and the results indicate that it is used extensively. Miller and Mench [65] compared the effect of pecking and foraging (ropes, plastic blades, beads and jingle-bells), three-dimensional structural (elevated platform, tubes) enrichment or novel object (naturalistic objects) enrichment on the dustbathing behavior of Japanese quails; the authors observed that in all scenarios, the enrichment that was used most extensively and consistently by quails was the dustbath. Additionally, the birds in the study performed a variety of behaviors in the sand, like preening and pecking, but also egg laying, so the authors concluded that the provision for nest boxes was not adequate. Regarding domestic turkeys, although they perform dustbathing when given the opportunity, and the behavior is usually synchronized [131], no further data have been retrieved.

Preening

Preening behavior is performed by all domesticated birds with the intention of grooming [61]. The bird runs its beak through its feathers in order to maintain good plumage condition and distribute oil from the uropygial glad [132]. The behavior is often performed together with dustbathing, for the removal of the excess oil, but not necessarily. In addition to the hygienic function, this behavior is an indicator of pleasure and comfort, since both grooming and allogrooming are strong candidates as positive welfare indicators [28,33,34]. Still, preening can also be increased in environments with poor hygiene or ectoparasites [132]. In addition to this, due to stress, individuals can perform extensive preening, including self-directed feather-pecking and wounding. Thus, attention is needed when it is used for the assessment of positive welfare [33].

Environmental enrichment has been observed to increase preening in commercial broilers [44,58]. In the study by Baxter et al. [58], the enrichment was a platform and a dustbath. Preening while dustbathing was classified as dustbathing according to the ethogram. In the study by Dawson et al. [44], the enrichment was ropes, ramps and pecking stones. Dustbathing occurred infrequently and could not be analyzed. So, the increase in preening that the authors mention is separate from the preening performed while the birds are dustbathing. In other studies referring to the effects of enrichment on broilers, although dustbathing was used as positive welfare indicator, preening was either not studied at all or not mentioned in the definition of dustbathing in the ethogram [49,59], or it was just studied as part of the dustbathing behavior [42]. Bach et al. [40] have observed increased comfort behavior, as a total of dustbathing, preening and stretching of broilers on elevated platforms, but the percentage of each behavior was low to include in the statistical analysis separately. Both fast- and slow-growing broilers perform more sitting- than standing-preening with age [44], due to the rapid body growth, and the difference is more intense for the fast-growing breeds. But, the total amount of preening behavior is the same for both slow- and fast-growing breeds, and so preening cannot be used as a positive welfare indicator of the slow- compared to the fast-growing broilers [41,44]. As reviewed by Nicol et al. [61] and Freire and Crowling [66], preening behavior is performed at a higher level from laying hens in furnished compared to conventional cages, and so is stretching, although behaviors that require more space, such as wind flapping, can be constrained. According to Widowski et al. [67], preening is also linked to space availability, and it can be restricted below 542–750 cm^2/hen in cage systems, together with wind and leg stretching. So, preening can be both an indicator of positive affectivity and space availability. On the contrary, Shimmura et al. [52] observed that hens kept in aviaries without outdoor access perform more preening compared to hens with provision to outdoor access, although the opposite was observed regarding dustbathing.

Preening is also performed by ducks, including water preening [61]. Mi et al. [69] have observed that ducks with access to water pool perform more general preening and water preening compared to ducks with access only to drinking water. On the contrary, in a study by Riber and Mench [56], preening performance was the same between ducklings kept with access to water and the control group. Nonetheless, in this study, the birds did not have access to a water pool but to troughs with water and cup-type drinkers. Babington and Campbell [70] observed a gentle conspecific-directed behavior, described as allopreening, ignored by the recipient and provoking no response. In turkeys, preening increased on wet compared to dry litter, albeit occurring in a standing position [68]. It has also been found to be increased with increasing stocking density [55]. On the contrary, a linear decrease in this behavior was observed as lighting was increased for fourteen to twenty-three hours per day. So, although the literature results on ducks support its potentiality as positive welfare indicator, the results about turkeys are conflicting.

3.1.3. Play

Play has been studied in various species as positive welfare indicator due to the immediate pleasure that it elicits and, as a result, to its immediate impact on welfare [32–34,73]. It can be pleasurable, exciting and relaxing [34] and has a self-rewarding basis [32,34]. Biological and neurological findings support the opioid-mediated positive affective states that it generates [32]. Furthermore, another aspect that makes it promising as positive welfare indicator, is that it is usually suppressed under threats to fitness [32–34], and for this, it is considered a "luxury behavior" [32]. In addition to the immediate positive affect that is elicits, it also has long-term positive effects on welfare. As a behavior, it has significant functional benefits for the individuals engaging in playing, developing and acquiring somatic skills and competencies that will help the animals adjust to stressful situations in the future [32]. According to Špinka [35], the behavior is "emotionally contagious" and so by using only a few playful individuals, the positive emotions can be spread to the whole group. Nonetheless, it is a complex behavior with high variability between species, sexes, ages and even individuals, performed mostly by young animals and declining with age [32–34], so attention is needed for the observation, interpretation and association of the behavior to positive welfare.

All of the aforementioned benefits also apply to domesticated poultry, although the behavior has been studied mostly in mammals and is more easily recognized when performed in mammalian species [45]. As recently reviewed by Jacobs et al. [45], there are four types of spontaneously occurring behaviors that can be characterized as play in poultry: worm or food running (object play), sparring (solitary play), frolicking and jumping (locomotory play).

According to the existing literature, these behaviors have mostly been studied in broilers. Baxter et al. [58] observed that enrichment with perches and a dustbath did not have an effect on the total play behavior of broiler chicks, compared to birds housed in non-enriched environment. But, it was observed that when the observer was walking and creating space between the birds, this extra space stimulated play, especially frolicking and sparring. In accordance with the findings of Baxter et al. [58], Liu et al. [74] did not observe an increase in spontaneous play behavior in broiler chicks enriched with a ramp, platform, weighing scale, peak stone and feeder with wood shavings, compared to the control group. Additionally, in the study by Liu et al. [74], the enriched birds were less responsive during the tests that aimed at stimulating play behavior. The authors suggested that this was observed due to the fact that enriched birds were kept under an already stimulating environment and thus showed less interest. Only one study [49] mentions a positive effect of environmental enrichment on play behavior. A positive correlation was observed between the extent of provided means of environmental enrichment and the occurrence of play fighting. Furthermore, running and jumping were positively correlated with the increase in space allowance. Vasdal et al. [59] observed that play fighting increases in enriched chicks with wooden boxes for dustbathing, platforms, ramp and bales. Worm

running, i.e., running while carrying a small object in the beak, also increased at young age, due to bales, but decreased with age. Baxter et al. [41], van der Eijk et al. [48] and Rayner et al. [47] compared welfare parameters between fast- and slow-growing breeds in commercial farms. In all studies, slow-growing chicks displayed more play behavior. In the studies of van der Eijk et al. [48] and Rayner et al. [47], play behavior was more frequent in the groups of chicks with less stocking density. Play is also used as indicator of positive emotions in the Welfare Quality protocol for broilers. The term "playful" is used as one of the terms that describe an animal in positive state during the QBA assessment [30].

In laying chickens, Campbell et al. [51] showed no difference in the total play behavior of birds enriched with a structural complex of perches or novel objects, compared to non-enriched birds, with the exception of running, which was more frequent during the first weeks of age of the non-enriched groups. Apart from this, no other research findings were identified. The Welfare Quality protocol for laying hens, in contrast to the one for broilers, does not use the term "playful" in QBA [31], probably because it is a behavior that is positively correlated with the younger age of chickens.

Regarding ducks, Chen et al. [75] observed an increase in play behavior in ducklings reared with enrichment (perches, colored balloons and ribbons). Amado et al. [76] studied the behavior of ostriches, kept according to commercial standards in Brasil, from ten days to five months of age. The authors proposed that the running and dancing behavior of the birds is presumably a play-like behavior, and it was also observed that it decreased with age.

3.1.4. Behavioral Synchronization

Behavioral synchronization has been proposed as a promising positive welfare indicator for all group-housed social animals [33–35]. An individual that belongs in a group experiences cohesion, companionship and safety, and so behavioral synchronicity is experienced as rewarding for the individual [33]. Multiple individuals perform the same behavior simultaneously and the behavior is spread to the whole group. This behavioral contagion is also an emotional contagion, since social animals can experience empathy and develop affiliative connections to each other [35]. It also has a buffering effect to stress in social species [35]. An advantage of behavioral synchronization is that an individual can be used to spread a positive behavior in the whole group, and so positive welfare can be promoted in a whole group by using just a few individuals [34,35]. A disadvantage is that synchronization is a group phenomenon, although welfare is an aspect of an individual [33].

Domestic poultry species are social group-housed species, and so promoting behavioral synchronization in the flock is a means of promoting positive affectivity. Several of their behaviors are synchronized, due to strong intrinsic motivation, especially behaviors that would make animals more vulnerable to predators in the wild, like feeding, drinking, dustbathing and resting [133]. In a study by Eklund and Jensen [134], White Leghorns were less synchronized during perching and comfort behavior, and they maintained a longer inter-individual distance after the comfort and perching bouts, compared to red junglefowl. Additionally, according to Lopes Carvalho et al. [135], social learning is another factor that contributes to behavioral synchronicity, especially in chickens. Broilers tend to synchronize their resting behavior and have longer resting bouts, when offered artificial brooders as resting place. When resting behavior is less synchronized, the birds have shorter resting bouts and keep changing resting groups [79]. Collins and Sumpter [78] have observed that feeding behavior is synchronized in broilers. The birds cluster at the feeder when kept in low stoking density, indicating that the feeding bursts emerge due to social facilitation. Moreover, the light regime affects broilers' synchronicity. According to Alvino et al. [77], broilers perform higher synchronicity when offered 16 h day of high intensity and 8 h of dark per day, with longer synchronized and uninterrupted resting and sleeping periods. Behavioral synchronization also occurs more in hens of the same cage than hens between different cages, indicating that this behavioral synchronicity is promoted by social factors [80]. But, to a lesser extent, synchronicity also occurs between

birds of different cages [80]. Keeling et al. [81] observed that in laying hens, preening is the most synchronized behavior and daytime perching the least synchronized. Feeding is the more clustered one regarding space. In their study, synchronicity and clustering decreased as the number of birds increased. The authors concluded that it is important to provide adequate space and resources to smaller flocks, since behavioral synchronization is stronger in smaller flocks.

Synchronization also occurs in waterflow, with swimming being a social and synchronized behavior [61]. In a study by Waitt et al. [82], Pekin ducks synchronized their bathing behavior in baths and troughs and especially in showers, where they also had the opportunity to socialize on the wetted area around the bath.

3.1.5. Swimming and Access to Water

Goose and ducks are waterfowl, and many of their natural behaviors like preening, bathing, dabbing, foraging and reproductive behavior are strongly correlated to water and swimming. So, swimming is essential for the expression of a full behavioral repertoire [61]. Providing access to open water, in a depth that allows them not only to wet their feathers and perform head-dipping but also full body immersion, is important for the expression of swimming and all water-related behaviors, including thermoregulation and feather cleanness, and promotes positive affective states [70]. Liao et al. [71] observed that geese with access to a swimming pool in addition to swimming increased exploratory preening and moving and reduced feather pecking and sitting. In a study by Fattah et al. [83], Egyptian geese performed more feeding, locomotion, preening and flaying in an environment enriched with a swimming pool. The results of swimming in ducks are in accordance with those of geese. Sanshui White ducks with access to a swimming pool perform more preening behavior compared to control group [69]. Additionally, swimming is a synchronized behavior in ducks, and so it enables animals to experience social interactions, safety and cohesion. Waitt et al. [82] observed that swimming in Pekin ducks was synchronized in baths, showers and troughs, and ducks tended to swim more when other ducks were also performing the behavior simultaneously, especially in showers. On the contrary, the provision of water to Pekin ducks via misting does not seem to importantly affect their general behavior [136].

3.1.6. Pre-Laying (Nesting)

Pre-laying behavior of hens is a strong natural behavior linked to ovulation. Hours before the ovulation, the bird becomes restless and active while searching for the adequate place for nest-building [101,126]. Laying hens deprived of nesting vocalize more frequently and produce mostly gakels, i.e., vocalizations that express frustration and generally negative emotions [101]. They also perform stereotypic pacing, indicating stress [137]. The absence of nest boxes or the prevention of hens from expressing pre-laying behavior, and the negative behavioral impact that this has on behavior, has been studied extensively, as reviewed by Hemsworth and Edwards [60] and Cronin et al. [84]. Hens strive to access a nest box, and this motivation is the most studied one in different types of housing systems [60,138]. Pre-laying behavior is affected by the rearing system, the environment and the location of the nests. Hens kept in aviary systems find the nest less attractive than birds kept in cages, but they experience more active and aggressive pre-laying behavior [87]. Higher stocking density also induces competition for access to nests [139]. According to Engel et al. [140], hens kept in cage systems choose a nest compared to feed, in maze preference testing. In the same study, two groups of animals were studied: one kept in cages with provision to nests after sixteen weeks of age as adults, and one that was trained and exposed to the nests only during the training before the maze testing. Hens kept as adults with access to nest boxes choose the nest over food more frequently than hens kept without access. Still, hens kept without access to boxes also chose the nest box over feed, albeit infrequently. These findings are an indication that nesting behavior presumably induces positive affective states in hens [60,86].

Apart from these two references [60,86], no other research mentions directly nesting as a possible positive welfare indicator, although, as described above, the motivation and the preference of the hens for nests in various systems has been widely studied. In addition, studies on stress physiology, as reviewed by Hemsworth and Edwards [60] and Cronin et al. [84] do not indicate that hens housed without next boxes show physiological evidence of short-term or long-term stress, but only behavioral evidence of negative emotions, like frustration. Nonetheless, some results indicate that one function of nesting may be to provide a specific location of laying for hens, where they perform the pre-laying and sitting phase of ovulating undisturbed [84,85]. This means that hens with the pre-laying behavior are looking for a safe and quiet place [84]. Cronin et al. [85] observed that disturbed sitting before egg laying leads to higher corticosteroid levels in blood plasma and egg albumin, possibly indicating disturbance and stress to the hen that is trying to stay calm and ovulate. If a behavior promotes safety, then it promotes positive states and is a good candidate as positive welfare indicator [28,29,33,34]. Moreover, in a study by Hunniford and Widowski [141], nests areas enclosed with plastic curtains induced more settled pre-laying behavior and less aggression, even to hens that were accustomed to lay before the study with no access to the curtain enclosed nests.

Regarding other poultry species, two studies indicate pre-laying behavior as positive welfare indicator for ducks, albeit indirectly [88,89]. Ducks are highly motivated to nesting and prefer the use of manipulatable substrates that can also be used for nest building, as indicated after preference testing [142]. Barrett et al. [88] studied the difference in pre-laying behavior between Pekin ducks that were floor- and nest-layers. It was observed that floor-layers preferred specific floor locations in order to avoid agonistic interactions and lay quietly. When the behavior was performed in the nest, for both groups, the pre-laying behavior was similar. So, the only difference for the two groups is the location. This indicates that in ducks, as in hens [85,141], nesting provides safety to the bird and thus indicates positive affectivity [28,29,33,34]. Moreover, Makagon et al. [89] have observed that Pekin ducks prefer a nest box enclosure, preferably also with a curtain, as has been observed in hens by Hunniford and Widowski [141], also supporting the theory of promotion and safety of the nest to the layers.

3.1.7. Perching

Perching is a strongly intrinsic motivated behavior of the domestic hen, also linked to roosting behavior [61,90]. It is an antipredator-related behavior. Despite the domestication process and the protection from predators, the motivation of the birds to perform this natural behavior is still powerful. Laying hens, with increasing group size and the same stocking density, spend less time perching, are less vigilant while perching and spend more time on the floor preening, as would be estimated by the antipredator hypothesis [92]. Furthermore, although they spend less time preening, they still prefer to occupy the higher perches [92]. Additionally, laying hens prefer the higher perches for night roosting in aviary cages and multi-tier systems [143]. Hens strive to gain access to perches [62,90], especially at night [61,90,144], and experience frustration if the access is prevented [145]. Perching is also common during the day, due to the feeling of security that it promotes [61]. It is a complex behavior to study, because although the motivational need is established, further research is needed to understand which need is of highest priority for the bird: seeking daytime or nighttime elevation, grasping, or using a perch specifically instead of other structures like ramps and platforms [61]. Still, we propose it as an indicator of positive emotional state due to the feeling of safety that it promotes [61,90]. Moreover, access to perches during the rearing period of chicks enhances the spatial cognitive and physical abilities of birds later in life [91] and is thus a positive cognitive enrichment. Structural enrichment with perches and navigation structures on pullets reared indoors increases the positive behaviors of foraging and dustbathing when kept outdoors as free-range laying hens, from 16 weeks of age and on, indicating that perches in chicks can have a long-term effect on positive welfare [51]. In addition, it contributes to the comfort of the hens [146].

Perching behavior is a stronger motivating need in laying hens compared to broilers, due to the fast increase in broilers' body mass and the locomotory and leg issues that they suffer from [61]. This leads to perching decreasing with age as the body weight increases [61,147]. The decreased perch use in broilers can be a result only of limited physical ability of the birds and not motivation [147]. Studies indicate that broilers are highly motivated to use aerial perches and perches of aviary tiers [148]. Slow-growing broilers perch more than fast-growing breeds [39,41,44,47]. The use of perches also increases as the stocking density increases [147,149]. Broilers, in contrast to laying hens, due to impaired physical ability prefer to use other types of perching substrate, rather than common perches, like platforms [147] or straw balls [150]. According to the findings of Bach et al. [40], the comfort behavior of broilers is high on elevated platforms. The design, the material and the structure of the perching substrate is very important. Although no direct data have been shown for the use of perches as a positive welfare indicator for broilers versus laying hens, since they are motivated to use a perching substrate of structures adjusted to their physical ability (as reviewed by Nicol et al. [61]), perching can promote the same positive affective states in broilers as in laying hens. Thus, we also suggest perching as a positive welfare indicator for broilers, although further research is needed.

Ducks, geese, quails and ostriches do not perch, with the exception of Muscovy ducks [61], but no data have been retrieved.

3.1.8. Maternal Care

According to Mellor [34], maternal care is a positive welfare indicator due to the strong bonding that it elicits between the mother and the young. It is based on physiological alterations that induce positive affectivity both in mother and offspring. The promotion of mother–young bonding also means the simultaneous promotion of peer-bonding. Maternal care is not generally promoted in the poultry industry, especially in intensive systems, due to the high number of animals, the short lifespans of the animals and the impact on productivity and profitability that it would cause [95]. Chicks are hatched in incubators and reared artificially. Nonetheless, this positive welfare parameter has important positive effects not only on the mother, but especially on the chicks, as reviewed by Edgar et al. [95], like teaching them food preferences and reducing fearfulness. This is important especially for the chicks that will have outdoor access as adults [151]. The mother also has a social buffering effect on stress for the young, since chickens in the presence of their mother respond with reduced stress to an aversive stimulus [152], indicating that they feel safe and protected. Moreover, mother hens show empathic responsiveness towards their chicks, when the later are subjected to an aversive stimulus in front of the hens [93]. Additionally, brooded chicks show higher behavioral synchronicity, which is also a positive welfare indicator, although in the first days of their lives, this also has thermoregulating properties [95].

Fearfulness is also reduced in geese when naturally hatched and brooded [57]. Geese chicks naturally hatched and reared with their mothers until three days of age displayed less fearfulness compared to artificially hatched geese chicks [57]. In quails, the development of exploratory [97] and social behavior [96] of the chicks is also influenced by the mother, being higher in brooded chicks.

3.1.9. Anticipatory Behavior

The anticipatory behavior of an animal in the expectancy of reward can be used as a mean to evaluate its emotional state. The animal is initially trained to associate a signaling cue to the reward, and then its emotional state is evaluated between the conditioned stimuli of the signaling and the unconditioned stimuli of receiving the expected reward [153]. The less the anticipation, the higher the welfare level, since the lower the difference between the real and the expected level, and there is a balance between the negatives and positives in the animal's life [153]. Anticipatory behavior has been studied in various farm animals to

evaluate emotional states, mostly negative, but also positive [154]. It should be interpreted with attention since it is often a result of frustration of the animal while anticipating a reward and not a result of positive emotions [154]. Anticipatory behaviors can be variable, with behavioral transitions of the animal being the most consistent parameter for the observer [154]. Nonetheless, although anticipation is a bias towards evaluating positive emotional states, it is necessary to examine them also as positive welfare indicator [72].

McGrath et al. [98] trained laying hens to signal sound cues to two different feed rewards, a dustbathing substrate as reward, or no reward at all. The conditioned animals had the ability to associate each cue with the separate reward/no reward. The anticipation for the dustbathing was higher, and the frequency of vocalizations of positive arousal were more frequent compared to the feed rewards. Zimmerman et al. [72] conditioned laying hens to a negative, a positive and a neutral cue. Again, the birds had the ability to discriminate the cues. They showed more locomotion and head movements and vocalizations indicating frustration in the anticipation of the negative event. On the contrary, the prevalence of comfort behavior was specifically associated with the anticipation of the positive event. In a study by Wichman et al. [100], laying hens were conditioned to associate light signaling cues with the arrival of feed or not. There was no difference regarding the anticipatory behavior from enriched and basic pens. According to the authors, this was observed due to the fact that the number of social interactions in the pen influenced the emotional state of the animals and their anticipation. Furthermore, the anticipation of feed reward in hens is combined with a decrease in the comb surface temperature, and as the peripheral temperature decreases, it indicates a change in positive emotional arousal [99].

3.2. Vocalizations

Vocalizations have been proposed as a feasible and non-invasive positive welfare indicator for all farm animals [33,38]. The digitalization of animal farming and automated microphones make their application effective. Still, either by using microphones or evaluating the indicator live on the farm level, it is easier to detect the vocalizations of a group of animals, and not of a specific individual. Vocalizations have long been studied as indicators of emotions in animals, mostly negative emotions, but today, they are also considered strong candidates as positive welfare indicators [33,38]. A vocalization indicates the emotion of the bird at the moment that it is expressed [33], so it is a short-term indicator of emotion. Usually, they are not considered reliable indicators of welfare alone, at least not yet, but they should be used in combination with other positive welfare indicators [33].

As reviewed by Laurijs et al. [38], chickens produce eight types of vocalizations: food calls (produced only by roosters), single, double, fast and gakel clucks, whines, singing and mixed vocalizations that cannot be categorized in the previous types. Fast clucks and food calls are associated with positive emotions [38]. In a study by McGrath et al. [98], laying hens, in the anticipation of food or dustbathing as a reward, after Pavlovian conditioning, produced mostly food calls and fast clucks with the signaling cue. It was concluded that these types could be indicators of emotions of positive valence that could be used for on-farm welfare evaluation. Zimmerman et al. [72], on the other hand, have observed that laying hens, in the anticipation of a negative event, produce mainly gakel clucks. Gakel vocalizations also increase when hens are deprived of food or nesting and expressing frustration [101]. No literature data have been retrieved for vocalizations as positive welfare indicators in other poultry species.

3.3. Qualiative Behavioral Assessment (QBA)

The qualitative assessment of behavior was firstly proposed by Wemelsfelder et al. [155] as a tool to evaluate animal welfare. Until then, it had been widely used in the study of animals' temperament, but no research had been conducted on its use as a measurement of animal welfare. Wemelsfelder et al. [155] applied QBA in the study of spontaneous expressions of growing pigs, using untrained observers. The behavioral expressions were described with high inter-observed reliability. Further studies revealed that the method

also had high intra-observer reliability [156], and so they proposed QBA as a novel method of integrative animal welfare evaluation. QBA has been proposed as a part of the effective implementation of an animal welfare assessment program [157]. As a welfare indicator, it is feasible, easy, and economic to apply. It is also relatively easy to train the assessors, it is widely accepted, and it is not invasive for the animals [158].

For the above reasons, QBA has been incorporated as a both a positive and negative welfare indicator in the Welfare Quality Assessment protocol for poultry [30], for evaluating the welfare of broilers, and in the Welfare Quality Assessment protocol for laying hens, version 2.0 [31]. Both protocols are built on calculating the total welfare score of a farm by answering four main welfare principles, one of which is the appropriate behavior principle, in answer to the question, "Does the behavior of the animals reflect optimized emotional states?" [30,31]. In turn, each welfare principle compromises some welfare criteria, all independent of each other. The principle appropriate behavior compromises the criteria expression of social behaviors, of other behaviors, of good human–animal relationships and of emotional states. The last one is assessed by QBA in free-range hens and novel object test in laying hens in cages [31] and by QBA in broilers [30]. Both protocols define the emotional state criterion as the avoidance of negative emotions, like fear or distress, and the promotion of positive emotions as security or contentment. The assessor observes the interactions of the animals with each other and their environment via scan sampling for a period of time, replicates for different group of animals, and finally scores one-word terms that describe the birds' behavioral repertoire. Ten of these terms indicate positive affective states: calm, content, comfortable, inquisitive, positively occupied, confident, energetic, playful, friendly and active. Additionally, when calculating the total score, not all description terms are of the same weight. Among the positive terms, comfortable and content have the highest weight [30].

Rayner et al. [47] applied QBA as positive welfare indicator to commercial farm systems of slow- and fast-growing breeds of broilers. The slow-growing breeds displayed higher scores of "happy/active" and lower scores of "stressed/flat". QBA has also been applied on broilers by Muri et al. [102]. It was concluded that QBA may be more adequate for larger animals kept in smaller groups, because the homogeneity of the flock makes the observation of the different qualitative behaviors difficult. The authors concluded that it cannot stand as the sole tool for the on-farm welfare assessment of broilers, but it can give important supplementary information together with other measurements. Vasdal et al. [105] used QBA in laying hens and reached the same conclusion. Van Niekerk et al. [104] applied the Welfare Quality protocol for laying hens [31] to 122 flocks and, as was expected, found low scores for caging systems, high scores for aviary organic systems, but surprisingly low scores for conventional floor systems. QBA has also been studied on parent flocks of white and brown laying hens to investigate behavioral differences in birds of different breeds [103]. Again, due to the homogeneity of the flock, only three out the twenty behavioral description terms that were used could be applied by the observers: comfort, distressed and active.

Regarding all other livestock poultry species, no research has been retrieved about the proposal of QBA as a positive welfare indicator. The AWIN welfare assessment protocol for turkeys [159], which is based on the principles and criteria of Welfare Quality, mentions the emotion states criterion, but it states there is yet no available indicator for its assessment.

3.4. Positive Human–Animal Relationship (Positive HAR)

There is a reciprocal relationship between the attitude of the stockperson that handles an animal and the behavioral reaction of the animal towards this person [106]. Farm animals have the ability to discriminate among handlers that treat them differently [106,107]. A positive human–animal interaction is beneficial not only for the animal, due to the positive experiences and effects that it elicits, but also for the caregiver, since it facilitates the response of the animal to handling [37,106,107]. There are also positive effects on productivity, as reviewed by Mota-Rojas et al. [106] and Zulkifli [107]. HAR in farm

animals is usually measured by a station/ passive human-test, when an animal approaches the stationary man voluntarily or by approaching/active human-test, when the human approaches the animal, and the avoidance distance is measured [37,106]. All methods of assessing HAR have been reviewer by Waiblinger et al. [107]. According to Rault et al. [106], the passive human-test is the more adequate indicator for positive HAR, while the human avoidance tests are usually used to measure fear. An animal that voluntarily approaches a human, or in general, an animal that responds positively to human handling, is an animal that experiences comfort, pleasure and anticipation and finds this interaction rewarding [37]. Positive HAR is also an indicator of long-term positive welfare, improved health and resilience for the animals [37,108].

Visual human contact of laying pullets during rearing reduces the avoidance distance to humans during adulthood [86]. In the same study by Edwards et al. [86], adult hens with close proximity to humans show a shorter avoidance distance and lower levels of plasma corticosterone concentration during handling. Avoidance distance and the stationary person test seem valid and with high correlation to each other both for cage [160] and free-range systems [112,160]. The touch test, where the assessor attempts to touch the birds, has also been studied [111,161]. Bertin et al. [111] observed that positive human visual and acoustic contact for three minutes per day and gentle daily stroking for thirty seconds of adult laying hens led to a reduction in human avoidance, compared to hens that experienced negative human contact. Additionally, the fertility of the positive HAR group was higher, yolk hormones levels were modified, and chicks' social skills were improved, with chicks preferring a familiar conspecific to a stranger. There was no transgenerational effect on chicks' avoidance to humans; still, according to the authors, a positive HAR in the hens influenced the filial imprinting. Graml et al. [112] concluded that only fifteen minutes additional human contact twice a day, with positive visual and acoustic stimulation, even touching, decreases the avoidance distance in free-range laying hens and increases the proportion of touched birds, compared to the group of hens that is subjected only to routine daily management. In laying hens, a visual positive HAR is particularly effective compared to other species [86,111,112], and the general positive HAR stimulation can have important effects even if it lasts for a few minutes daily [111,112]. Data reported in the literature are also similar in broilers. Zukifli et al. [110] observed that broiler chicks that had been subjected to ten minutes visual contact twice per day, from the first day of their life until twenty-one days of age, showed less fear of humans, less stress during handling and improved antibody response at forty-two days of age. The same results were also observed by Al-Aqil et al. [109], but in addition, the chicks were stroked for thirty seconds daily. The Welfare Quality protocol for poultry [30] and Welfare Quality Assessment protocol for laying hens, version 2.0 [31], measure both the good human–animal relationship criteria via the avoidance distance test.

Regarding positive HAR as a positive welfare indicator, studies also exist for quails [113] and ostriches [114]. Positive habituation of quails to humans, involving stroking at hand feeding for ten seconds, twice per day, affected the egg hormone level, immunoreactivity and led to heavier, stronger egg shells and heavier offspring [113]. The positive HAR was also transgenerational, with chicks from the different groups performing differently in behavioral tests. Ostriches that receive extensive human care from young age are more docile towards humans and willing to associate with them at later stages of life, compared to ostriches raised with standard commercial practices of foster parents [114]. Furthermore, human-imprinted ostriches present higher survival levels to four weeks of age compared to conventionally reared birds without human or foster parent imprinting [162].

3.5. Cognitive Bias

Cognitive bias tests have been used as an indicator of both positive and negative emotions in animals, based on the fact that changes in cognitive functions can be indicators of emotional states, as in humans [116]. In particular, indicators of change in emotional valence (positivity or negativity) rather than arousal [115,116] can be generalized across

animal species, livestock included [116], and are promising as a tool for the assessment of positive emotions [115,116]. There are two types of cognitive bias test: judgement bias and attention bias [115]. When a judgement bias test is performed, the animal is firstly trained to associate one cue with a positive event and another cue with a negative/less positive event [115,116]. Then, an ambiguous cue is presented to the animal. If the animal is in a positive affective state, it will interpret the ambiguous cue as positive (optimistic response), and if not, as negative (pessimistic response). When an attention bias task is performed, the animal allocates its attention between a positive and a negative stimulus [115]. Judgement biases are more popular, and this approach has mostly been used in livestock animals [115,116].

Witchman et al. [100] trained laying hens on spatial cues, i.e., feed bowls that contained feed or not, depending on their spatial position. Then, the trained birds were subjected to a judgement bias test with bowls in ambiguous positions, and the latency to approach was recorded. The hypothesis of the authors was that birds kept in higher environmental enrichment would perform more optimistic responses, approaching the ambiguous cues faster. Nonetheless, no differences were found, indicating that the emotional states for the two groups did not differ enough to bias the birds' judgement. Still, the same conclusion was also reached via the anticipation test, and so the authors concluded that individual factors of the birds, like motivation to feed and positive social interactions present in both groups, influenced the judgement and the anticipation. Hernandez et al. [120] also observed that stress occurring immediately before a judgment test does not affect the cognitive judgment in laying hens. It was also observed that the birds approached ambiguous cues faster when they were tested immediately after rewarding events, and so the order in which the cues are presented during a judgment bias in hens matters [120]. However, in the studies of Witchman et al. [100] and Hernandez et al. [120], the manipulation of birds' affective state by the authors did not influence the birds' judgement, as was expected, while a study by Deakin et al. [119] concluded the opposite. A novel cognitive bias task was used, namely, a "screen-peck" task. The hens were trained so that when they pecked a high/low saturation orange circle cue, they obtained a feed reward, and when they pecked an oppositely saturated orange circle, they received a negative air puff. Following the training, the authors changed the temperature for some birds to near twenty-nine degrees Celsius, a temperature that, according to the authors, is pleasant for hens and induces a positive affective state. As was expected, the animals tested under higher temperature judged ambiguous cues and orange circles of intermediate saturation more positively. In a study by Zidar et al. [121], the exposure of female young chicks to cold as a stressor did not bias the judgement of the birds, but it was observed that exposure to environmental enrichment maintained the optimistic judgement in a second judgement bias test that followed. Judgement bias tests have also been performed in broilers. In a study by Anderson et al. [119], broilers housed in high-complexity pens judged optimistically and showed shorter latencies to approach ambiguous cues compared to animals housed in a low-complexity environment, indicating that the higher environmental stimulation induces positive affective states. On the contrary, in a study by Lourenco-Silva et al. [118], slow-growing broilers from groups of high and low environmental complexity performed the same in a judgement bias task. The different results in the two studies may be due to the different environmental enrichment used, enough to initiate or not a positive effect to bias the animals' judgement. Additionally, the birds in the study by Lourenco-Silva et al. [118] were tested in pairs during the task. From all the above research findings, both for laying hens and broilers, we conclude that the results in judgement bias tasks can be contradictory and can be affected by various factors. Furthermore, the stimulation that is used to manipulate the animals' emotional state should be significant in order to promote an affect-induced positive judgement. Still, there are studies where cognitive bias can assess positive affective states successfully [118,119].

Regarding the use of judgement bias tests in other poultry species, the results were retrieved only for quails. Japanese quails housed in different housing conditions, wired or

deep-litter pens, were tested in spatial judgement tasks, after discriminating learning of cues associated with feed rewards or noise punishment [122]. The cues differed in shades of grey. When the birds were then presented with ambiguous cues of intermediate shades, there was no difference between the judgement responses of the two housing conditions, although it was expected that the birds kept in deep litter would have responded more optimistically, since they would had been in a more positive state.

4. Discussion

Following our literature review, we referred to thirteen animal-based indicators that have been proposed as indicators of positive affective states in domestic poultry species. The assessment of positive affectivity aims towards the evaluation of positive welfare by finding indicators that can be used as measures and applied on protocols and welfare evaluation schemes. Although a debate on the definition of welfare exists, welfare needs to be measurable so that it can be studied by scientists and used in practice [1]. In order to apply indicators in practice, they should be feasible, valid and reliable [163] and, at the same time, economically applicable. These parameters have not been evaluated in our review. The research on positive welfare is still mostly performed at the experimental level, although it is flourishing [1,12]. Our results are based mainly on experimental studies.

According to our results, explorative and foraging behavior, dustbathing and pre-laying behavior are the PW indicators that have been studied most extensively. Our results include both PW indicators that have been proposed for other species and indicators relating to poultry-specific behaviors. Exploration, foraging/feeding, comfort, play, behavioral synchronization, anticipation, QBA, vocalizations and cognitive bias have also been proposed for the domestic pig [125] and dairy ruminants [123,124,164]. Dustbathing, preening, nesting and perching have been studied specifically for poultry, and so has swimming for waterfowl.

The majority of the literature results refer to broilers (24) and laying hens (38). The results on laying hens outweigh those on broilers. This is because, as can be concluded by Table 1, some indicators have been studied only on laying hens. Comfort has been studied more on layers, while exploration has been studied more on broilers. Additionally, there is limited research on ducks (with the exception of swimming behavior) and quails, and there is even more limited research on geese and ostriches. The number of results, categorized by species, are indicated in Table 2. According to the FAO, in 2020, more than 450 million turkeys and 1.15 billion ducks were kept as production animals around the world [165]. There is a need for more studies about their welfare, their welfare assessment, the development of protocols and the incorporation of indicators in policies and legislation. Moreover, there is a need for research on breeder flocks, either broiler or laying hens. Only one result was retrieved specifically about the PW of breeders [103].

Table 2. Literature results on positive welfare indicators, categorized by poultry species.

Species	Total Number of References	References
all	14	[27,28,32–35,38,73,106–108,115,116]
broilers	25	[30,39–50,58,59,61,74,77–79,102,109,110,117,118]
laying hens	38	[31,38,51–53,60–64,66,67,72,80,81,84–87,90–95,98–101,103–105,111,112,119–121]
turkeys	3	[54,55,68]
ducks	8	[56,61,69,70,75,82,88,89]
geese	3	[57,71,83]
quails	5	[65,96,97,113,122]
ostriches	2	[76,114]

In Table 3, we summarize the positives and the negatives of each retrieved positive welfare indicator, according to our results. We include not only advantages and disadvantages described in our results, but also personal conclusions after analyzing them. Some key

conclusions that can be reached by Table 3 are that the general data on exploration seem to agree on the positive affectivity that it elicits (e.g., [41,44,47,48,51,56,57]). Comfort behavior has mainly been assessed by dustbathing, which is a stronger positive welfare indicator compared to preening. Preening has been found both to be increased with environmental enrichment and space provision in some studies [44,58,61,66,67,69] and to be decreased in others [52,55], or not affected at all [56]. Nesting [84,85,88,89,141] and perching [88] promote security. A better understanding is necessary for play, since it would be a complementary aid for the on-farm welfare assessment of positive welfare compared with other indicators. Moreover, it is important to mention that a difficulty that we have faced while analyzing our results is that there is an inconsistency concerning the definition/description of behaviors in the ethograms of the studies, especially regarding comfort (as analyzed in Section 3.1.2 with details) and play. In some studies, types of play behavior were analyzed separately as running or chasing (e.g., [74]) or running and worm running (e.g., [59]). Furthermore, the fact that QBA has been found difficult to apply in commercial farms, due to the homogeneity of the poultry flock, also indicates the difficulty of observing and recognizing some behaviors in poultry [102,104,105]. Further studies are needed so that QBA can become more reliable and valid. Additionally, regarding swimming, the system of water provision is important, since ducks prefer to be able to deep their head or whole body in the water and perform all the water-related behaviors in addition to swimming, like water preening [70], and they preferably swim synchronized if there is enough space [82].

Table 3. Advantages and disadvantages of each PW indicator.

Indicator	Advantages	Disadvantages
exploration	indicates curiosity and safety [28,33,34] can be observed relatively easily on the field is positively correlated to environmental enrichment in broilers [49,52,59,65,130], laying hens [51,127] and turkeys [55] is negatively correlated to stocking density in broilers [42,48–50] can be assessed by QBA in broilers [30] is positively correlated to swimming [61] is increased in free-range systems in laying hens [51,53] and geese [57]	inspective exploration can also indicate fear [33] different enrichment in each study studied mainly in broilers slow-growing broilers perform less locomotion QBA is difficult to apply in poultry due to flock homogeneity more difficult to be promoted in intensive systems, cages, aviaries
dustbathing	motivational need of laying hens when given the opportunity [64] is positively associated with environmental enrichment in laying hens [51,52], broilers [49,58,59] and quails [65] is positively linked to outdoor access [52] can be synchronized [62]	conflicting results on the value of this need compared to other needs [60,61,63] different environmental enrichment in the results different definitions of dustbathing in the results
preening	grooming is a strong candidate as a positive welfare indicator [28,33,34] positive association to space availability in hens [67] increases seen in furnished compared to conventional cages [61,66] allopreening performed by geese [70]	can increase due to ectoparasites [132] overgrooming indicates stress [33] conflicting results when studied in connection to environmental enrichment in broilers [44,52,55,56,61], hens [66,67] and ducks [69] decreases with outdoor access in hens [52] included in dustbathing definition in some studies [42] preening while dustbathing defined as dustbathing

Table 3. *Cont.*

Indicator	Advantages	Disadvantages
play	immediate and long-term positive effect [32–34,73] emotionally contagious [35] high variability and ontogeny [32] is positively linked to space in broilers [49] can be assessed by QBA in broilers [30]	difficult to observed in poultry [45] wide range of definitions in the ethograms studied mostly in broilers studied mostly in chicks conflicting results in relation to environmental enrichment in broilers [49,51,58,59] QBA is difficult to apply in poultry due to flock homogeneity
behavioral synchronization	indicates group cohesion [33–35] buffering effect on stress [35] various behaviors synchronized in poultry	group phenomenon, difficult to observe an individual [33] not all behaviors equally synchronized [81] enough space is required occurs more frequently in smaller flocks [81]
swimming	increases preening [69,71] and exploration [69] synchronized [82]	the type of water provision system affects the results hygiene is a challenge requires space and labor
pre-laying	motivation well studied in laying hens [60,84,86,89,140] induces safety and undisturbed ovulation [84,85,88,89,141]	more studied needed for other species no stress physiological data when hens thrived access to nests [60,84] the type and place of nest is important and differs between studies
perching	motivation well studied in laying hens [61,90,144,145] promotes safety [61,90], comfort [146] promotes spatial cognitive abilities of chicks [91] slow-growing breeds perch more [39,41,44,47]	rapid decrease with body weight increase in broilers, with specific perching substrate needed [61,147] the perching type, structure, and height differs in the study more studied needed on broilers
maternal care	promotes mother–young and peer-bonding [35] positive social development of the young [57,95–97,151,152]	in commercial circumstances mostly artificial hatching
anticipation	laying hens [72,98–100] can be trained successfully	can be biased [72,154] can be affected by ontogeny and indicate frustration [154] difficult to apply under commercial circumstances since it requires training and time
vocalizations	feasible, no invasive observation [33,38] automatization, digitalization	more studies needed use only in combination with other indicators
QBA	feasible, economic, and easy to train the assessor [158] already incorporated in protocols [30,31]	due to poultry flock homogeneity, difficult to observe the various behaviors [102,104,105] more studies needed under commercial circumstances
positive human–animal interactions	facilitates animal handling [37,106,107] increases productivity [106,107] short daily visual contact effective in chicks [86,111,112]	requires training of the stockpersons and farmers
cognitive bias	laying hens [117,118], broilers [100,119–121], and quails [122] can be trained successfully to discriminate cues	conflicting results as PW indicator difficult to apply under commercial circumstances since it requires training and time

According to the literature, slow-growing broiler breeds are experiencing more positive welfare aspects compared to fast-growing breeds, including exploration [39,41,44,47,48], comfort [41,44], play [41,47,48] and the use of the environmental enrichment [40,41,44]. All

studies mention the higher locomotion of these birds. In other words, they are healthier and experience more positive emotions and experiences.

Various findings also support the promotion of positive behaviors through environmental enrichment such as exploration [42,43,46,48–51,54,56], dustbathing [49,51,58,59,65], preening [44,58,61] and play [49]. Perching is also promoted in more complex environments for laying hens and with provisions like elevated platforms and bales in broilers, as reviewed by Nicol et al. [61]. Although different environmental enrichment is provided to the birds in each study and so a generalization is difficult, and further research is needed, it can be concluded that environmental enrichment can promote PW on the farm level. Moreover, further findings indicate the negative link between increasing stocking density and the promotion of the positive effects of exploration [55], preening [52,66,67], swimming [82], perching [92] and behavioral synchronicity [78]. Applying high standards of environmental enrichment and space availability for the birds would require drastic changes in the production systems, especially in intensive ones. This would also mean management changes and a decrease in productivity and profitability. Thus, it would be simultaneously necessary that the consumer be willing to pay for products of higher cost. Still, providing relatively simple environmental enrichment like perching substrate or enrichment that promotes exploration, play and comfort can be an economical starting point, requiring limited labor and management change. And, step by step, positive welfare can be improved further.

Today, animal welfare is a prerequisite of sustainable development [5]. Positive welfare supports the minimizing of negative aspects in an animal's life and the promotion of positive affective states and experiences so that an animal, being sentient, can have a good life [28,34]. Consumers today are willing to pay more for products from animals kept under higher welfare standards; however, this willingness is affected by various aspects [3,4,9,14,15], such as the type of product, type of species, the price, the demographic and cultural characteristics [9,10]. Consumers' willingness to pay for products of animal origin, especially poultry, would require another literature review, analyzing how strong this willingness is, all the influencing factors and the price that they are willing to pay. Another complex issue is also to interpret this price in higher animal and environmentally friendly management changes that can additionally maintain profitability for farmers. Nonetheless, animal welfare is a crucial component of sustainability, and sustainable livestock management promotes positive welfare, not only for poultry but for all livestock species. Especially regarding broilers and laying hens, the consumer's concern is high, and various studies have shown their willingness to pay more [18,22,23]. Although it is simplistic to say that consumers are willing to pay more, a gradual change towards more sustainable agriculture, including higher welfare standards and positive affective states for the animals, is the ongoing direction, directed by policy making, legislation and consumers, at both national and international levels.

5. Conclusions

Positive welfare indicators are associated with sustainable poultry production systems because animal welfare is a key and distinct component of sustainable agricultural development, which in turn is a part of sustainable development for the environment, society, the economy and humanity as a whole. The positive welfare indicators for poultry that have been studied mostly and seem most promising for both laying hens and broilers are exploration and dustbathing, a poultry-specific behavior indicating comfort. Changes in management that promote pre-laying behaviors are also important for promoting positive affectivity in laying hens. Swimming is indicated as an index of positive welfare in ducks. Most of the positive indicators in poultry are positively affected by environmental enrichment and negatively by high stocking density. Whilst there is research on broilers and laying hens, there are limited studies on the other domestic poultry species. Although research in animal welfare has been thriving in recent years, further research on positive welfare indicators would be beneficial in order to determine reliable and countable indices for a positive welfare assessment scheme.

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