

SHORT COMMUNICATION

Presence of a Familiar Odourant Accelerates Acceptance of Novel Food in Domestic Chicks

R. Bryan Jones

Roslin Institute, United Kingdom.

A reluctance to accept unfamiliar foods can damage chickens' welfare and performance. In the present study, chicks were reared on a mash diet presented in hoppers treated with vanillin and acclimatized to a regime of brief food withdrawal and return. At 8 days of age they were presented with the same food in an unfamiliar form (crumbs) when the hoppers had been treated with either vanillin or water. The presence of the familiar odourant accelerated feeding and increased food consumption over a 30 min test. The results are discussed in terms of impaired food recognition, neophobia, and the strategic relevance of olfactory therapy.

A chicken's diet is generally changed at various stages during its development. For example, chicks and adults, respectively, may be fed starter or layer diets differing in protein levels, the form of the food (mash, crumbs, pellets) may also be changed. The consistency, texture, taste, odour or colour of mixed feed may be altered when formulae are changed (Jones, 1987a; Murphy, 1977). Precocial birds like chickens often show fixation of food habits and novelty per se can be frightening (Franchina, Johnson, & Leynes, 1994; Jones, 1996; Kuo, 1967; Marples & Roper, 1996). Not surprisingly therefore, a reluctance to accept an unfamiliar diet is a widely recognized, though rarely documented, phenomenon in chickens (Jones, 1986; Vilarino, Leon, Faure, & Picard, 1998). Such hesitancy to feed may reflect neophobia, i.e., fear-induced avoidance of novel stimuli (Jones, 1996), or simply a temporary failure to recognize the new diet as food (Picard, Plouzeau, & Faure, 1999; Vilarino et al., 1998). Whatever the mechanism, this is an increasingly frequent problem in industry and it can exert undesirable effects on the birds' performance and health. For instance, egg production and eggshell quality may be temporarily compromised and the birds may redirect their pecking towards litter, the drinkers or other birds leading to diarrhoea, wet droppings, reduced litter quality, and feather pecking (Vilarino et al., 1998; M. Macleod & M. Picard, personal communication).

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The present report describes an attempt to identify a practicable method of minimizing the avoidance of novel food. The presence of familiar objects or auditory cues is widely known to reduce chickens' fear of unfamiliar places and objects (Jones, 1977; 1987b; Rovee, Agnello, & Smith, 1973; Zajonc, Markus, & Wilson, 1974) but the use of a sensory cue that could be more closely associated with the food was intuitively considered likely to be more effective in ameliorating food neophobia or aiding feed identification. The present study focused on olfaction. Chickens have a well-developed olfactory sense, they regulate their behaviour in response to a wide range of odourants, and they establish olfactory memories (Burne & Rogers, 1996; Jones & Carmichael, 1999; Jones & Gentle, 1985; Jones & Roper, 1997; Richard & Davies, 2000; Sneddon, Hadden, & Hepper, 1998; Vallortigara & Andrew, 1994). More specifically, chicks are sensitive to odorized food. Firstly, for example, chicks that were reared on food treated with water were hesitant to accept a similar diet that had been rendered unfamiliar by the addition of a aromatic oil, such as limonene (Jones, 1987a). Secondly, chicks readily associated specific food odors (limonene or geraniol) with illness induced by lithium chloride injection and they modified their feeding behaviour accordingly (Porter, Turro-Vincent, & Picard, 1995; Turro, Porter, & Picard 1994). Thirdly, the presence of an unfamiliar odour, such as almond or one of various pyrazines, strengthened chicks' avoidance of food that had been dyed a novel colour (Marples & Roper, 1996).

Chicks from a number of different breeds that had been reared with selected odourants showed strong attraction to these olfactory stimuli when they were subsequently presented in otherwise novel environments. These olfactory stimuli include those associated with soiled substrate taken from the chicks' home cage (Jones & Faure, 1982; Jones & Gentle, 1985) or the nest (Burne & Rogers, 1995) as well as "artificial" odourants such as clove oil, geraniol, limonene, strawberry and vanillin (Jones & Carmichael, 1999; Jones & Gentle, 1985; Sneddon et al., 1998; Vallortigara & Andrew, 1994). Furthermore, the presence of a familiar odourant decreased behavioural inhibition when chicks were tested individually in an unfamiliar open field (Jones & Gentle, 1985) and it increased social dispersal and feeding when pairs of familiar cagemates were tested in an open-field (Jones, Facchin, & McCorquodale, 2002). Since fear inhibits all other behaviour systems (Jones, 1996) and because it is inversely related to social dispersal in a novel environment (Grigor, Hughes, & Appleby, 1995) these findings strongly suggest that fear may be reduced by the presence of a familiar olfactory cue in otherwise unfamiliar surroundings. It is also conceivable that chicks' acceptance of a novel food might be accelerated by presenting it in a familiar olfactory guise, either by reducing the intensity of any neophobic reaction to it or by facilitating its identification as food. Therefore, chicks were reared on a mash diet presented in hoppers that were treated with vanillin and their responses to an unfamiliar food (crumb diet, i.e. same for-

mulation but different texture) were then compared in the presence or absence of the familiar odourant. We chose vanillin because it has no inherent anxiolytic properties (Jones et al., 2002), it is not associated with toxicity in plants, it has no discernible irritating properties, it is relatively inexpensive, and chicks are known to form attachments to it (Jones & Carmichael, 1999).

Sex differences in fear and neophobia have been reported in domestic chicks (see Jones, 1987c). Therefore, since hens far outnumber cockerels in industry, only female chicks were used here.

Method

Eighty female ISA Brown chicks (a brown egg-laying line originally derived from a Rhode Island Red x Rhode Island White cross) were obtained from a commercial supplier at one day of age. Seventy-two of these chicks were allocated at random to pairs immediately upon receipt and housed in both compartments of 18 wooden boxes measuring 72 x 38 x 30 cm (length x width x height). Each of the 36 x 38 x 30 cm compartments held one pair of chicks. The eight remaining chicks were housed in a larger box and kept in reserve to replace any of the test chicks that might have died during the first 2 days of life. As it happened, there were no mortalities so the surplus chicks were not required. The home boxes rested on 1 m high shelves located at both sides of a 9 m long room. The 1 cm wire grid floor of each box was raised 2 cm off the shelving in order to allow the passage of excreta. The photoperiod ran from 05:00 to 19:00 h and a combination of dull emitter heaters suspended above each box and a background convection heater maintained ambient temperature at approximately 27°C. Food and water were provided *ad libitum* in two semi-circular plastic hoppers (food in one, water in the other) suspended on wire grids from the top of one of the 36 cm walls in each compartment. These hoppers could be removed and replaced remotely to minimize visual contact with the experimenter and they were always sited in the same locations. At this stage the food comprised layer starter mash; this type of feed consists of very small particles (Nah & Chung, 1995). Covers consisting of clear plexiglass with two circular holes (2 cm diameter) rested on top of the food in the hopper; these holes allowed sufficient access for the chicks to feed freely while the cover minimized food spillage. A piece of filter paper measuring 4 x 2.5 cm was attached to the back of each food hopper with 2 thin strips of invisible tape (Guilbert, No. 180068); this paper was not visible to the birds and the tape had no discernible odour. Five drops of vanillin (4-hydroxy-3-methoxybenzaldehyde; Supercook, Leeds, UK) were applied to the filter paper at 16:30 h on day 1, i.e. the day on which the chicks were received. Subsequently, the filter paper was treated daily with 5 drops of vanillin at 09:30 and 16:30 h until the chicks were 7 days old.

The chicks were acclimatized to a food deprivation-replacement regime at 6 and 7 days of age, the food hoppers were removed from the chicks' home boxes at 08:30 and 15:30 h and replenished before their return after one hour. Vanillin was again applied to the filter paper immediately before the hoppers were replenished and replaced at 09:30 and 16:30. At 17:00 h on day 7 one "focal" chick was randomly selected from each pair and marked on its head with indelible ink to facilitate subsequent identification. The chicks were also acclimatized to the presence of an overhead camera on each of days 6 and 7. Two Panasonic Industrial Colour CCD micro cameras (WV-KS152, 8 x 2 cm, length x breadth) were suspended from a mobile gantry 75 cm above two home boxes for 30 min (one camera per box); this procedure was repeated until each pair of chicks had been exposed to the micro camera.

The focal bird in each of the 36 pairs of chicks was observed once only when it was 8 days old. The food hoppers were removed from each of the 2 compartments in each of 2 randomly selected boxes at 08:30 h and the water dishes were replenished. The food hoppers were emptied and then refilled with 100 g of an unfamiliar crumb feed. This food is produced by first mechanically reforming small particle mash feed into larger high-density pellets and then breaking these into smaller particles called crumbs (Nahm & Chung, 1995). The composition of the feed remains the same but the appearance differs, i.e. whereas mash consists of very small particles crumbs can be up to 3 mm in diameter. Immediately before the food hoppers were returned one hour later at 09:30 h, the filter papers on each of the food hoppers taken from the two adjoining compartments in one box were treated with 5 drops of vanillin whereas a similar amount of water was applied to those from the other

Table 1
Responses of female domestic chicks to a novel food in the presence or absence of a familiar odourant.

	Test condition		p <
	No odourant	Odourant present	
Lat. approach feeder (s)	23.6 ± 6.9	5.4 ± 1.5	0.02
Lat. feed (s)	33.4 ± 9.2	9.4 ± 3.5	0.002
Pecks at food (no)	311.7 ± 47.6	318.3 ± 41.8	N.S.
Feeding bouts (no)	34.6 ± 4.6	24.9 ± 3.1	N.S.
Food eaten (g)	6.1 ± 1.1	13.6 ± 2.4	0.002

Note. P values derived from analysis by the Mann-Whitney U test (two-tailed). (s) = seconds; (no) = number; (g) = grams; N.S. = not significant; means ± SEMs (N=18).

two-compartment box. Fresh, untreated strips of filter paper were attached to the hoppers before water was applied to them in the control situation. This protocol ensured that adjoining compartments were always allocated to the same treatment, thus minimizing contamination of control boxes with the airborne odourant. Thus, whereas all the chicks had been reared with the odour of vanillin associated with food, half were tested on vanillin- and half on water-treated hoppers on post-hatching day 8. Immediately upon the return of the hoppers, the chicks' responses to the unfamiliar food were recorded onto videotape using the overhead micro cameras for a 30 min period. Both compartments of a box could be filmed simultaneously. The hoppers were then removed and the amount of food remaining in them was weighed; subtraction of this weight from the initial 100 g afforded a measure of food consumption by each pair (these values represent the amount consumed by both members of a pair). At 09:05 h, food hoppers were taken from another 4 compartments; these hoppers were replenished, treated with vanillin or water and then returned at 10:05 for test. This staggered procedure was repeated until 36 pairs of chicks had been tested (18 in each of the vanillin and water groups). Testing was completed by approximately 16:00 h. Upon subsequent analysis of the videotapes we focused only on the behaviour of the marked focal chick because pair-housed chicks generally stay close together and often engage in the same activity (Jones, Carmichael, & Rayner, 2000). We recorded the latencies to approach within 2 cm of the food hopper and to feed as well as the numbers of pecks and pecking bouts directed at the food. Pecking bouts were regarded as discrete events if they were separated by a minimum period of 4 seconds.

The chicks' behavioural responses and their food consumption were compared between treatments using the Mann-Whitney U test, two-tailed (Siegel, 1956).

Results

The chicks approached the food hopper upon its return and began feeding significantly sooner on the novel food when the familiar odour of vanillin was present rather than when the filter paper attached to the food hopper had been treated with water prior to its replacement (Table 1). Furthermore, the presence of the familiar odourant affected consumption, the chicks ate significantly more (+123%) of the novel food when vanillin was present (Table 1). There was no detectable effect of treatment on the numbers of pecks at food, and a numerical tendency for control chicks to show more pecking bouts failed to reach significance ($0.05 < p < 0.1$).

Discussion

Chicks were reared on a mash diet presented in food hoppers treated with vanillin in the present study. When they were subsequently exposed to an unfamiliar crumb diet in hoppers that had been treated with either water or vanillin, the presence of the familiar odourant accelerated their acceptance of the novel food and significantly increased their consumption of it. A reluctance to eat a familiar food treated with a novel odourant is well documented (Jones, 1987a; Marples & Roper, 1996) but, to the best of my knowledge, this is the first time that the present phenomenon has been demonstrated. Interestingly too, although the vanillin chicks ate substantially more than the water controls, chicks in both treatment groups showed similar numbers of pecks and bouts of pecking at the unfamiliar food. These findings suggest that pecking at food in the presence of the familiar odourant was primarily associated with feeding whereas that shown by the control chicks may have reflected exploration rather than or as well as feeding. Similarly, pecking was increased but intake decreased when broiler chicks were suddenly given an unfamiliar pelleted food rather than the mash diet they were accustomed to (Martaresche, Le Fur, Magnusson, Faure, & Picard, 2000). The composition of the food was not changed in either of these two studies, it was only its appearance that was altered. Therefore, these findings suggest that chicks' hesitancy to eat an unfamiliar food may reflect an impaired ability to identify the new diet as food rather than a neophobic response.

The delayed approach to the food hopper shown by control chicks in the present study suggests that they were sensitive to the absence of the familiar odourant at a distance and that this may have been perceived as a novel feature even before they had viewed the unfamiliar food. At first glance this suggestion seems to be inconsistent with a previous report that when chicks that had been reared with orange-scented food were presented with the same diet treated with either orange oil or water the absence of the familiar aromatic oil affected neither their latency to feed nor the amount of food eaten (Jones, 1987a). However, this apparent inconsistency probably reflects the fact that whereas the duration of food deprivation never exceeded 60 min in the present study it ranged from 270 to approximately 500 min in the previous one (Jones, 1987a). The increased feeding motivation that likely accompanied the substantially longer periods of food deprivation used in the earlier study may have diminished the effects of the absence of a familiar olfactory cue.

Regardless of the mechanism(s) underpinning the present findings, it is conceivable that chicks' attraction to familiar or imprinted odourants could be exploited in various ways in order to minimize some of the problems caused by changes to their diet or to their general environment (see Introduction). Such an approach seems particularly practicable because

odourants-flavourants are already routinely incorporated in many livestock feedstuffs, they are not overly expensive and, because of their volatility, they are likely to be perceived by all members of the flock. Hesitancy to feed was apparent in the present study following a relatively modest change to the appearance of the food. It is tempting to speculate that the remedial effect of associating a familiar odourant with an unfamiliar food may be even greater if the novel visual features of that food were more pronounced. Although the present experiment focused solely on identifying an olfactory strategy for overcoming short-term hesitancy to feed on an unfamiliar diet, I would tentatively suggest that once that particular food has been accepted it is unlikely that it would be rejected later in life. Indeed, it is also tempting to speculate that such olfactory therapy may combat the long-term dietary conservatism shown by some household birds, such as canaries (Doherty & Cowie, 1994; Marples & Kelly, 1999). In view of the slight delay in approaching the food shown here by the control chicks it is conceivable that a mild neophobic response might accompany the omission of the familiar odourant from the diet. However, if the feed industry adopted the “olfactory familiarization” strategy suggested here, it is unlikely that the odourant would be omitted from the diet other than by accident.

In conclusion, the present findings strengthen previous suggestions that domestic chickens are capable of chemosensory learning and that they establish olfactory memories. Such olfactory regulation of behaviour may offer opportunities for shaping the birds’ behaviour in order to improve their welfare and productivity (Jones & Carmichael, 1999; Jones & Roper, 1997; Sneddon et al., 1998).

References

- Burne, T.H.J. & Rogers, L.J. (1995). Odors, volatiles and approach-avoidance behavior of the domestic chick (*Gallus gallus domesticus*). *International Journal of Comparative Psychology*, **8**, 99-114.
- Burne, T.H.J. & Rogers, L.J. (1996). Responses to odorants by the domestic chick. *Physiology and Behavior*, **60**, 1441-1447.
- Doherty, S. & Cowie, R.J. (1994). The effects of early feeding experience on long term seed choice by canaries (*Serinus canaria*). *Ethology*, **97**, 177-189.
- Franchina, J.J., Johnson, L.J. & Leynes, P.A. (1994). Roles of visual and taste cues in ingestional neophobia: Response latency effects in chicks (*Gallus domesticus*). *Animal Learning and Behavior*, **22**, 341-350.
- Grigor, P.N., Hughes, B.O. & Appleby, M.C. (1995). Emergence and dispersal behaviour in domestic hens: effects of social rank and novelty of an outdoor area. *Applied Animal Behavior Science*, **45**, 97-108.
- Jones, R.B. (1977). Open-field responses of domestic chicks in the presence or absence of familiar cues. *Behavioural Processes*, **2**, 315-323.
- Jones, R.B. (1986). Responses of domestic chicks to novel food as a function of sex, strain and previous experience. *Behavioural Processes*, **12**, 261-271.
- Jones, R.B. (1987a). Food neophobia and olfaction in domestic chicks. *Bird Behaviour*, **7**, 78-81.
- Jones, R.B. (1987b). The assessment of fear in the domestic fowl. In: R. Zayan, & I.J.H. Duncan (Eds.), *Cognitive aspects of social behaviour in the domestic fowl*. (pp. 40-81). Amsterdam, Elsevier.

- Jones, R.B. (1987c). Social and environmental aspects of fear in the domestic fowl. In: R. Zayan, & I.J.H. Duncan (Eds.), *Cognitive aspects of social behaviour in the domestic fowl*. (pp. 82-149). Amsterdam, Elsevier.
- Jones, R.B. (1996). Fear and adaptability in poultry: insights, implications and imperatives. *World's Poultry Science Journal*, **52**, 131-174.
- Jones, R.B. & Carmichael, N.L. (1999). Domestic chicks are attracted to a familiar odorant in a novel test situation: a brief report. *Applied Animal Behaviour Science*, **61**, 351-356.
- Jones, R.B. & Faure, J.M. (1982). Domestic chicks prefer familiar soiled substrate in an otherwise novel environment. *IRCS Medical Science*, **10**, 847.
- Jones, R.B. & Gentle, M.J. (1985). Olfaction and behavioral modification in domestic chicks (*Gallus domesticus*). *Physiology and Behavior*, **34**, 917-924.
- Jones, R.B. & Roper, T.J. (1997). Olfaction in the domestic fowl: a critical review. *Physiology and Behaviour*, **62**, 1009-1018.
- Jones, R.B., Facchin, L. & McCorquodale, C. (in press). Social dispersal by domestic chicks in a novel environment: reassuring properties of a familiar odourant. *Animal Behaviour*.
- Jones, R.B., Carmichael, N.L. & Rayner, E. (2000). Pecking preferences and predispositions in domestic chicks: implications for the development of environmental enrichment devices. *Applied Animal Behaviour Science*, **69**, 291-312.
- Kuo, Z.Y. (1967). The dynamics of behavior development. An epigenetic view. (esp. pp. 67-72). New York, NY, Random House.
- Marples, N.M. & Kelly, D.J. (1999). Neophobia and dietary conservatism: two distinct processes? *Evolutionary Ecology*, **13**, 641-653.
- Marples, N.M. & Roper, T.J. (1996). Effects of novel colour and smell on the response of naive chicks towards food and water. *Animal Behaviour*, **51**, 1417-1424.
- Martaresche, M., Le Fur, C., Magnusson, M., Faure, J.M. & Picard, M. (2000). Time structure of behavioral patterns related to feed pecking in chicks. *Physiology and Behavior*, **70**, 443-451.
- Murphy, L.B. (1977). Responses of domestic fowl to novel food and objects. *Applied Animal Ethology*, **3**, 335-349.
- Nah, K.H. & Chung, S.B. (1995). *A Textbook of Chicken Production*. MunUn Dang Publishing Company, Seoul, Korea.
- Picard, M., Plouzeau, M. & Faure, J.M. (1999). A behavioural approach to feeding broilers. *Annales de Zootechnie*, **48**, 233-245.
- Porter, R.H., Turro-Vincent, I. & Picard, M. (1995). Role of chemical cues in food choice by 3-day-old chicks. *Chemical Senses*, **20**, 152.
- Richard, S. & Davies, D.C. (2000). Comparison of methyl anthranilate and denatonium benzoate as aversants for learning in chicks. *Physiology and Behavior*, **70**, 521-525.
- Rovee, C.K., Agnello, A.M. & Smith, B. (1973). Environmental influences on tonic immobility in three and seven-day-old chicks (*Gallus gallus*). *The Psychological Record*, **23**, 539-546.
- Siegel, S. (1956). *Nonparametric statistics for the behavioral sciences*. McGraw-Hill, New York, NY. esp. pp. 116-127.
- Sneddon, H., Hadden, R. & Hepper, P.G. (1998). Chemosensory learning in the chicken embryo. *Physiology & Behavior*, **64**, 133-139.
- Turro, I., Porter, R.H. & Picard, M. (1994). Olfactory cues mediate food selection by young chicks. *Physiology and Behavior*, **55**, 761-767.
- Vallortigara, G. & Andrew, R.J. (1994). Olfactory lateralization in the chick. *Neuropsychologia*, **32**, 417-423.
- Vilarino, M., Leon, A., Faure, J.M. & Picard, M. (1998). Ability of broiler chicks to detect hidden food. *Archiv fur Geflugelkunde*, **62**, 156-162.
- Zajonc, R.B., Markus, H. & Wilson, W.R. (1974). Exposure, object preference, and distress in the domestic chick. *Journal of Comparative and Physiological Psychology*, **86**, 581-585.

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