Relations

BEYOND ANTHROPOCENTRISM

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Being There

If the Pairing of the Birdwatchers Affects the Pairing of the Birds

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Abstract

The drives of inter-individual relationships within avian social groups are largely unexplored and relatively poorly understood, including how social landscapes affect the decisions of individuals within these groups. On a modest level, this study undertakes to expand this knowledge with an ornithological observation of temporary groupings among multiple aquatic species in response to the pairing of birdwatchers. More ambitiously, the study presumes the analogy between the social response of an avian community and the subliminal response of the human psyche to spatial stimuli. The number of bird pairs forming in flocks, coverts and rafts was consistently higher when the birds interacted with children teamed up in pairs than when solitary children interacted with the birds. Inadvertent social cues consequential to the extended duration of the focus, vigilance stimulation and subliminal messages affecting the neurological pathways in the brain and the social dynamics pertaining to proxemics are discussed as potential causes of this effect. Lastly, the structure of the paper mimics the lifetime of inventive ideas, which originate from a chaos of amorphous thought, then crystallize into a clarity of logical concepts open to elaboration, and eventually disperse into a similar semantic clutter as that from which they were born.

Keywords: aves; cardinality; children; cognition; community; conceptualism; ethology; ornithology; proxemics; social network analysis.

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1. Introduction

Show me how the sunrise looks
when viewed in two.
Zana 1983

A crossroad. In space. And you and I on it. Crossing the paths. How magical.

And then a thought: if a human were to simply be, as perfectly as she can be, everything that there is would be instantly endued with the bliss of a million suns.

"It matters not what she said; it matters that she called" (*Out 1: Noli Me Tangere* 1971). So says the Prometheus Bound troupe pivot, sending out semantic waves like screams near the river Seine. Seconds later, he goes on to repeat this point, as if he was not loud enough the first time he uttered it, evoking the swish of the dust left in the wake of the desert travelers who'd say or do a thing twice to make sure its mention occurs somewhere in the Cosmos for the third time.

Sometimes, indeed, simply being at a certain time and place is sufficient to change the course of our or someone else's lives and thereby the trajectory along which the Universe as a whole evolves. No words need be said nor gestures made. Being there is all that is needed.

With children, it is like this. They can enlighten the space and time with their mere presence. The lesson they teach guardians that they guard ever so secretly is that these guardians could achieve the same enlightening effect by simply being. By watching the world through the children's eyes, for one, this world could be made a brighter and more enchanting place.

Here, two children, a brother and a sister, aged 6 and 4, stood on the edge of the lake or the ocean shore, facing away from the senior author ambushed as a photographer, and fed various types of aquatic birds breadcrumbs, sometimes alone and sometimes standing side by side. The hypothesis was that when birds perceive couples, they might form similar couples, reduce the personal space and congregate to tighter social groups. Moreover, what if the collective behavior of animals, here, the thinking went, could be a long-stretch model of the subconscious strata of the human psyche? If so, then any observation of the pairing among the birds as induced by the pairing of the feeders could be taken to mean that humans may react similarly, getting closer to each other if they only perceive two human beings holding hands, hugging or walking together, fondly. If this proxemic proposition were to be proven, as the initial research plan deemed, then simply coming nearer to another human being could be noted for its potential to have a healing effect on the ills of alienation that are tearing apart the fabric of humanity as these words are lain here. One such simplistic method of strengthening the social links that keep humanity whole would be essential in today's digital world where virtual contacts serve as vague substitutes for the real human touch, where "dropping in is unheard-of and flaking out is routine" (Miller 2020), and where being engaged in or only witnessing a scene where two human beings come together is more likely to evoke the feelings of discomfort and awkwardness than spark joy and elate.

Birds are noted for forming complex social wholes, whose internal fluctuations in natural habitats and compositional changes under the environmental pressure have been the subjects of numerous studies so far. Sustenance and evolution of societies, including the avian, appears to be inherently dialectical and conditioned by their complexity, that is, the entwinement of competitive and cooperative interactions. This balance between nonconformity and altruism suggests that neither of them alone is sufficient to keep a society sustainable. There are, for example, countless benefits, albeit contextually dependent (Szipl *et al.* 2019), of the separation of organisms from their social groups, one of which is the bird calling. Ravens, for example, were shown to call less when they sat in close proximity to one another or when they exchanged affiliative gestures before feeding (Sierro *et al.* 2020), insinuating that the evolution of birdsongs, be they sung as foraging signals, as territoriality statements or for courtship ends, may have been conditioned by the sufficient separation of individuals from the social cliques that they belonged to. Likewise, the observation of predators by the group is more likely when the spacing between its members is optimal rather than overly tight, just as well as the disease transmission and the unhealthy competition over resources are less likely. Vigilance increases with the grouping of individual organisms, but then rapidly decreases as the flock size becomes excessively large (Beauchamp 2019), meaning that the individuation of birds beyond a certain threshold of the group size comes with a lot of survival benefits and is often dubbed as the dilution effect (Severtsov 2017). Similarly, hierarchically organized flocks often achieve the highest level of navigation accuracy when a minimal number of connections per individual is maintained (Flick *et al.* 2015).

At the same time, however, there are countless documented benefits of birds' coming together and forming social wholes, including increased vigilance (Blackwell *et al.* 2019), higher adaptability (Clary and Kelly

2016), better food accessibility (Thiebault *et al.* 2016), excellence in group navigation (Parikh, Corcoran, and Hedrick 2019), energy conservation in formation flights (Ghommem and Calo 2014) and flapping swims (Oza, Ristroph and Shelley 2019), thermal isolation in colder climate species, such as penguins (Ancel *et al.* 2015), bluebirds (Stanback 1998) and other nighttime roosters (Beauchamp 1999), pecking order formation (Hahn and Bauer 2008) or breakdown (D'Eath and Keeling 2003) with survival benefits, observational learning (Carcean and Froemke 2019), and so on. And because most birds, like people, are gregarious and tend to form social wholes, commonalities at more subliminal levels of the avian and the human psyches pertaining to the drives for social interaction can be expected to exist too. In fact, complexity theory has argued in favor of holistic similarities amongst all natural systems that surpass a sufficient scale, irrespective of whether they are animate or not (Bohm 1980; Laszlo 1996; Anthes 2008). For example, mathematical models capable of predicting the formation of stellar nebulae can be equally effective predictors of the clustering of cells *in vivo* (Anthes 2008), while algorithms used in cognitive science to model neural networks in the brain can be, in turn, equally useful for making astronomical predictions (Reed 2011). This premise of similarity between the behavior of avian and human social groups underlies the objective of this study, which is to assess the pairing and flocking effects of communicating with birds at a primitive, food-related level in pairs or as singulars.

The study presented here is the third in an array of so-called backyard studies (Uskoković *et al.* 2020a, 2020b) carried out by the senior author with his juvenile research group in the absence of the access to a regular scientific lab he had managed once. Excommunicated from the academia, jobless against his will and deprived of the access to mainstream scientific instrumentation, but with the will to continue to do science that is accurate and rigorous and that also touches human hearts, having a lyrical, artistic note to it, this author engaged in a mission to conceive of studies that could be run with meager or no funds at all. To live up to the conceptual science premises intrinsic to his approach to science, according to which the goal of scientific studies is not only to probe the mysteries of Nature, but also to question the actual trends in the conduct of research, the study aspired to be built on superior analytical rigor, but also provide meaningful findings for the field of science to which it belonged, namely ornithology, and, last but not least, ennoble this discipline with artistic senses and expand the literary genre of the scientific paper into entirely new territories. To that end, it is worth noticing that the form taken on by scientific papers does not naturally represent the way in which their core ideas crystallized in the authors' heads over time (Medawar 1963; Uskoković 2009). In contrast to their alluring the reader to the false impression that these ideas formed by reliance on logic and logic alone, creative ideas are born from semantic incoherencies feeding heavily on analogies and on random jigsaws of ideas tossed to the mental coast by the emotional sea splashing across their bearer's being. Streamlined into a coherent whole, when conclusions are reached, these ideas disperse into a similar semantic mess as that from which they were born, thus ending the lifetime of a creative journey. The innovative form of this scientific paper is modeled after this lifecycle of a creative thought process, starting from an incoherent mess of analogically connected figments of imagination, which then rearrange into rational schemes and gain the solidity of a rigorous semantic whole, before dispersing once again, like the birds that have lain at the focal point of this study - into the sky.

2. Experimental section

2.1. *Study sites and bird populations*

The majority of birds were observed and photographed from the shore, the gazebo or the Sunken Treasure Hunt playground pier of the Woodbridge North Lake (33.680729° N, 117.796021° W) in Irvine, California. The skies were sunny or overcast in the hours of photographing and no precipitation was noted on the days of the experiment. The 0.8 km^2 Woodbridge North Lake with a tortuous shoreline was manmade in 1975 by hollowing flat ranchlands that had stood in its place. Since then, the lake has been the habitat to congregations of various migratory and sedentary free-ranging shorebirds, most of which fall into one of the two categories: waterfowls and gulls. Free-ranging waterfowls comprised the majority of birds analyzed in the course of this study. American coots (*Fulica americana*), Canada geese (*Branta canadensis*), Egyptian geese (*Alopochen aegyptiaca*), glossy ibises (*Plegadis falcinellus*) and mallards (*Anas platyrhynchos*) counted among them. A single type of gull, namely the western seagull (*Larus occidentalis*), was observed too on the edge and the surface of the lake as well as on the Pacific Ocean coast of Balboa Peninsula in Newport Beach, California (33.605942° N, 117.925270° W), 9 miles southwest of the Woodbridge Lake. Cormorants and swans are the waterfowl residents of the lake not treated in this study because of their relative scarcity. Occasional sightings of mallards and geese were performed from the edge of the smaller Heritage Community Park Pond (33.700396º N, 117.779679º W) and on the meadows of the Lemongrass Park (33.683942º N, 117.794053º W), respectively, both in Irvine, California. All birds were habituated to the human communities, which allowed for the collection of behavioral, psychologically relevant data without producing effects that would throw the avian social systems out of balance. American coots formed the most sizable flocks and were also birds with the longest migratory range included in the analysis. These migratory birds travel up to 2000 miles northeast in late winter or early spring, where they prepare for the summer breeding season. All birds were challenged outside of their breeding and nesting seasons, during which the formation of permanent pairs or families within the rafts was minimal. Birds were observed for pairing behavior in late winter, in the month of February, with temperatures ranging from 14 to 21 °C on the hours of the feeding. This timeframe was chosen because waterfowls pair most intensely on the wintering grounds and during spring migration, unlike songbirds, which seek mating bonds upon the arrival on breeding grounds in the spring (Barry 2015).

2.2. *Data collection*

The feeding experiments involved taking two children, a brother and a sister, aged 6 and 4, respectively, to the edge of the lake or the ocean shore, from where they would feed various types of aquatic birds with breadcrumbs. Birds were fed during morning or midday hours of the workweek to ensure that no occasional passersby were present during the feeding, the dispersal and the photographing to interfere with the social scene. In some experiments, the children feeders and viewers stood alone on the shore and in some experiments they stood side by side. As the birds noticed the food, they disengaged from the social structure of the flock, the covert or the raft and engaged in a solitary, competitive search for it. After this initial burst of individuality accompanying foraging has passed, the birds would return to their regular doings, at which point photographs of their congregations were taken by the senior author ambushed behind a fence or shrub. Their inter-individual distances and the extent of pairing were subsequently compared and correlated with the pairing of the feeders. The formation of pairs and also the average distances between the birds were compared depending on whether they observed solitary or paired feeders. Birds that appeared to share the trajectory of movement and the direction of the gaze while being separated by less than two feet for coots and mallards and by less than four feet for geese and gulls, as well as birds that were separated by less than a foot for coots and mallards and by less than two feet for geese and gulls were considered temporarily paired. Naturally, the children were laughing, waving and gesturing during feeding, which increased their prominence to the birds' visual and auditory senses. Hallmarks of the avian eyesight are the superior color vision, but also the inferior sensitivity to achromatic contrast as compared to that of humans (Hodos 2012). For this reason, the color of the garments that the children feeders wore was carefully picked to avoid the visual acuity minimum in the blue range of the spectrum and fall near the 580 nm acuity maximum of the avian vision (Hodos and Leibowitz 1977), corresponding to dark yellow. Typically, thus, the clothes worn were yellow, orange, green or red, including white, the combination of all these colors, neglecting the colloquial premise that white is the color birds associate with danger. The pairing correlations are assumed to be proportional to the flock size and before the feeding began, it was ascertained that birds were not overwhelmingly mixed with other species and that they numbered no less than dozen in a flock. Only the experiments for which birds did not consume other sources of food inland before and after the feeding and remained in the water throughout the duration of time needed to take a sufficient number of photographs were taken into account.

2.3. *Data analysis*

Experiments on each bird species were performed in multiples, on 3-5 different days and they each involved taking 5-10 photographs before and after the feeding sessions. The photographs were taken with one minute apart prior to the feeding and also with one minute apart after the feeding and the dispersal of the birds. Photographs were subsequently analyzed by measuring the percentage of the avian pairs on each of them. The following equation was used to derive the average bird pairing percentage, *n*, for the two central sample groups, namely pre-feeding and post-feeding:

$$n = \frac{\sum_{j=1}^{N} \left(\left(\sum_{i=1}^{M} x_i \right) / M \right)_j}{N} \qquad \text{(Eq. 1)}$$

As per Eq. 1, the sum of the pairing percentages, *x*, derived from each of the M number of photographs from a single experiment in the pre-feeding or the post-feeding stage was averaged. These average values were then averaged over the N number of experiments performed on different days and different flocks on the same or different locations. For a typical bird species, M = 7-10 and N = 3-5. Data analyses were performed using Paint Shop Pro 7, Microsoft Excel 2016 and OriginLab OriginPro 2018. GraphPad QuickCalcs unpaired t-test calculator was used to calculate the statistical significance of the difference between the values of individual sample groups. All data points in bar graphs are expressed as means ± standard deviation.

2.4. *The effect of the Covid-19 pandemic*

All the observations except those on flying flocks of seagulls over the ocean shore were completed by March 1, 2020, weeks before the World Health Organization announced the coronavirus (Covid-19) pandemic on March 11 and the March 19 issuance of the statewide closure of the public spaces. The conception of the premises and the design of the study, which focus on the measurement of inter-individual distances, preceded the physical distancing policy implemented due to the given pandemic. The study could be said to have foreseen the upcoming emphasis on social distances, but was in no way influenced by it because of no overlap between the timeline of the study conception and experimentation and the timeline of the Covid-19 pandemic. More than anything, the assumed direct relationship between the closeness between individuals and the state of social harmony is at odds with the social distancing policies adopted during the Covid-19 pandemic and largely spilling over into the post-Covid-19 world. However, in view of how quickly the society adjusted to these distancing policies and how slowly it would have adjusted to the hypothetic social compaction policies, evoking the more intense repulsion between atoms in the crystal lattice than the attraction as per the Morse curve (Uskoković 2010), this study garners a special meaning in the days following this pandemic, when it was first sent out for publication.

3. Results and discussion

The visual acuity of birds is unsurpassed in the animal kingdom (Martin 1994). Compared to humans wherein eyes occupy no more than 5% of the volume of the skull, the eyes use up to 50% or more of the avian skull

(Waldvogel 1990). A range of compensatory eye movement reflexes stabilizing the gaze during the head movement, the large corneal curvature, especially in birds of prey, the annular pad surrounding the central core of the lens, an avascular retina nourished by the pecten oculi, the rod-free foveae in the retina, the tetrachromatic structure of the cone cells and the presence of colored oil droplets in the distal portions of their inner segments are all responsible for endowing birds with high visual resolution, subtle color hue discrimination and superior binocular, depth fixation – save for monocular birds with laterally placed eyes and wide field of view – compared to those in most other vertebrates (Jones, Pierce, and Ward 2007). In addition to being immersed in a world rich in contrast and color thanks to these extraordinary visual features, birds also have proven numerical abilities, which help them distinguish not only the number of items presented simultaneously, as a group, but also the number of events occurring successively or over extended periods of time (Emmerton 2001).

At the same time, birds have highly developed social skills and promptly react to environmental stimuli with the formation, disassembly or reorganization of social congregations. As a result, the relatively simple social aggregate metrics, such as the flock shape, area and rate of expansion, social connectivity typically expressed as the number of nearest neighbors, the nearest-neighbor distance, the flight initiation distance, the synchronicity of feeding, perching and preening, and other, all measured in real time, can provide useful information about the social instincts in these and, by analogy, many other animals, including humans. For example, notwithstanding that clustering helps birds in foraging activities and in spotting the predators in a timely manner, birds respond to the awareness of danger with rapid scattering and an increase in the inter-individual distances (Beauchamp 2015). Although there are birds, especially those dwelling in open habitats, that escape from predatory attacks as a socially coordinated group to a predetermined location, most cover-dependent birds split from their flockmates under attack and head for the nearest refuge alone (Lima and Lee 2020). In contrast, breeding and hatching seasons or congregation around the source of food or a simple absence of alarm signals tend to bring individual organisms together. A number of positive effects result from this clustering of avian individuals within social groups, mostly relating to food supply management (Toth *et al.* 2017) and defense (Zoratto, Santucci, and Alleva 2009). The "multiple eyes" effect, thus, allows for the rapid detection of danger, while foraging is facilitated by the transmission of information pertaining to food location between the members of the social group, with the optimal number of neighbors generally being lower when the birds focus on the capture of the resources than on the protection from the predators (Brush, Leonard, and Levin 2016). The caveat here is that some birds, such as starlings, sparrows and sandpipers, but also robins, juncos, partridges, kestrels and killdeers, space themselves at practically regular intervals within the flock (Gill 1991), and the formation of pairs and other types of clusters within the flock is relatively rare. For other birds, however, including ducks (McKinney 1964; Fischer and Larned 2004; Eadie and Savard 2015) and geese (Prevett and MacInnes 1980; Gill 1991; Carbone *et al.* 2003), this clumping on smaller scales is common, explaining the choice of waterfowls for the study executed here. Waterfowls, such as geese, moreover, are known for their complex social interactions and the formation of pairs and larger groups (Rutschke 1982; Gupte *et al.* 2019). As in humans, their social connectivity declines with age and is also highly variable within the flock, comprising singletons, pairs, families and larger social structures coexisting with one another (Black and Owen 1989; Kortschal, Hemetsberger, and Dittami 1993). Overall, these specific relationships within the avian social wholes are still poorly understood (Rose and Croft 2017), including how social landscapes affect the decisions of individuals within these wholes, which is largely unexplored (Firth and Sheldon 2016). On a more modest level, this study undertakes to expand this knowledge by testing the hypothesis that the pairing of the birdwatchers perceived by the birds will affect the grouping of the birds. More ambitiously, the study presumes the analogy between the social response of an avian community to the pairing of the creatures in interaction with it and the subliminal response of the human psyche to the same type of spatial stimulus.

Different birds were analyzed for their pairing in response to the pairing of their feeders. American coots, Canada geese, mallards and seagulls gave satisfying and statistically reliable results and were the four types of birds that will be discussed in this section. Egyptian geese were analyzed, but they were rarely found in flocks numbering a dozen of birds or more, which was a precondition for the feeding experiment to commence. Because their source of food lies buried in wet and soft soil, glossy ibises were generally unresponsive to the feedings and are left out of the results section too. Illustrative terrestrial photographs of the four different avian species after the feeding and the dispersal are shown in *Figure 1*. The bird pairs are demarcated in these images based on the previously established criteria evoking the Gestalt grouping principles of proximity and common fate (Luria and Vogel 2014) (Sec. 2.2). Specifically, the pair formation was measured based on transient directions of the swim or toddle and distances between neighbors, while the metrics were adjusted to particular avian species. The pairing of all waterfowls observed was fluctuant and subject to the formation of temporary cohorts under the leadership of dominant individuals, for which reason the metrics had to be time-dependent and also arbitrary to some extent. With this high degree of dependence on temporal parameters and chance, the analyses had to be carried out on sizable enough samples so that the statistical levels of confidence become reliable.

Figure 1. – Illustrative raw, unprocessed photographs of birds after their feeding and dispersal: American coots (a), Canada geese (b), mallards (c), and western seagulls (d). Bird pairs as per the classification described in Sec. 2.2 are fitted inside the dashed red rectangles.

Figure 2 presents the results of the comparison of the statistically averaged percentage of birds forming pairs after the feeding depending on whether the feeding was performed by a solitary child or by a pair of children. Feeding *per se* evidently increases the tendency of the birds to form pairs, but with varying levels of statistical significance. Thus, this increase is present in all four avian species for both types of feeding, but the confidence level of $p < 0.05$ was achieved only after feeding the geese ($p < 0.001$), the coots ($p = 0.003$) and the mallards ($p = 0.02$) by children in pairs and after feeding the geese (p = 0.02) and the coots (p = 0.02) by a solitary child. As far as the propensity for pairing among birds depending on whether they were fed by single feeders or by paired feeders is concerned, feeding by the pairs increased the tendency of the birds to form pairs as compared to feeding alone, but the statistical significance of this difference is rather low for all four avian species: p = 0.13 for Canada geese, p = 0.31 for American coots, p = 0.42 for mallards, and p = 0.65 for the western seagulls. Albeit consistent across species, in none of the cases, however, was the difference statistically significant ($p < 0.05$) from the conventional standpoint.

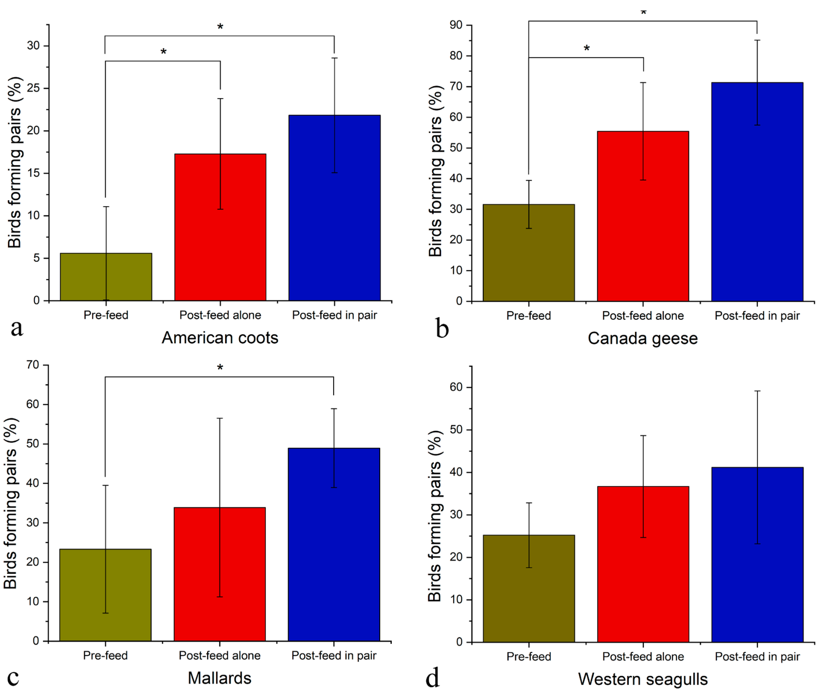

Figure 2. – Percentage of birds in a flock forming pairs prior to the feeding and after the feeding depending on whether the children fed the birds alone or in pairs. Results are presented for American coots (a), Canada geese (b), mallards (c) and western seagulls (d). Data points represent averages (n = 3-5 x 7-10), while error bars represent standard deviations. Data points significantly different from one another as per the unpaired t-test ($p < 0.05$) are connected with an asterisk-topped line.

To figure out whether feeding is a crucial factor defining the observed pairing responses, an experiment was conducted with the objective to compare the pairing rate when the birds were incited to congregate around real food and when they were gathered around the imitation of food in terms of various twigs, pebbles, seeds and dust dropped into the lake. From the results shown in *Figure 3*, it is seen that the pairing rate was higher in the avian sample groups challenged with real food, but the difference was minimal and typified by a comparatively low level of statistical significance. Feeding *per se*, therefore, is likely not a factor inducing their congregation and consequent pairing, but rather the attraction to food. This, however, applies only when the birds were allured to congregate by assuming that food, not imitation thereof, was thrown at them. Very often, they would not pay any attention to these objects, in which cases the correlation provided in *Figure 3* naturally did not apply.

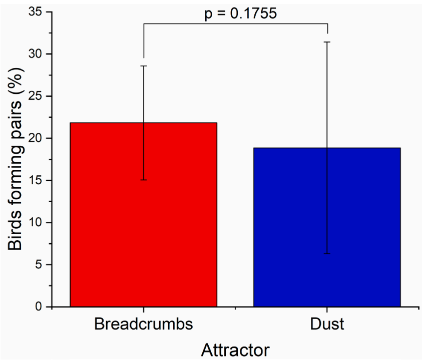

Figure 3. – Percentage of birds in a flock forming pairs after the feeding in pairs depending on whether the children threw real breadcrumbs to the water or their imitation in terms of dust, twigs, pebbles and random seeds. Data points represent averages (n = 3-5 x 7-10), while error bars represent standard deviations. The line connecting the two data points is labeled with the confidence level, p, representing the statistical significance of their difference as per the unpaired t-test.

When interpreting the results presented in *Figure 2*, one possibility was that the higher pairing rates observed in the avian groups fed by children than in the groups fed by a solitary child could be due to the greater degree of congregation of birds in the former groups. To test this correlation, the nearest-neighbor distances were measured for birds before the feeding, during the feeding and after the feeding and the dispersal depending on whether the feeding was performed by a solitary child or by two children as a pair, and the results are presented in *Figure 4*.

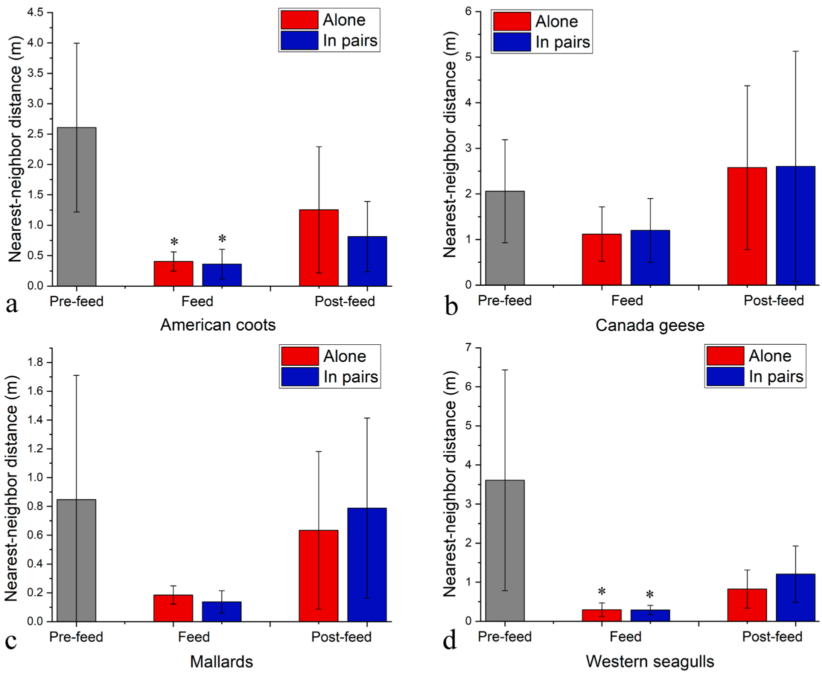

Figure 4. – The nearest-neighbor distance before, during and after the feeding of American coots (a), Canada geese (b), mallards (c) and western seagulls (d) depending on whether the children fed the birds alone or in pairs. Data points represent averages (n = 3-5 x 7-10), while error bars represent standard deviations. Data points significantly different from the pre-feed data point as per the unpaired t-test ($p < 0.05$) are topped with an asterisk.

The nearest-neighbor distances for all four avian species obviously decrease during the feeding, the reason being the dropping of the food within a narrow location, which the birds gather at, engaging in the competition for it. For some species, then, such as coots (*Fig. 4a*) and gulls (*Fig. 4d*), after the feeding is over and the birds disperse, the nearest-neighbor distances get lower than before the feeding, meaning that there is a prolonged tendency for the flock to temporarily get more compact in response to the feeding. For geese (*Fig. 4b*) and mallards (*Fig. 4c*), on the other hand, these distances are practically identical before and after the feeding, and no such tendency can be derived. One way of explaining this effect in coots and gulls is an increased sense of community induced by the comfort of being fed by a stranger. In human social groups too, it is common for sociability and solidarity to increase when the perception of a danger and a panic entailing it transform into the perception of safety. It is possible, however, that the tendency of the birds to cluster together after the feeding session is not driven by an increased sense of communality that food consumption brings about. It is possible that the formation of pairs is driven by an increased vigilance to the unfamiliar source of food, coming from an obvious potential predator, in which case the compaction of the flocks would be indicative of an increased awareness of danger. In any case, no difference in the nearest-neighbor distance was observed in flocks after the feeding and the dispersal depending on whether the birds were fed by a lone child or by two children as a couple (*Fig. 4*). This has refuted the aforementioned possibility that the more prominent pairing among birds fed by children as a couple than by a solitary child is due to the greater degree of congregation of birds in this post-feeding stage.

Overall, the results of this study demonstrate a higher pair formation among individual birds in a flock after they were fed by children in pairs than after they were fed by single children. These results are in agreement with an earlier work that demonstrated that non-predatory disturbances of the flocks of white tits alter the composition of the avian population by increasing the number of potential interaction partners over the following couple of hours of foraging (Voelkl, Firth, and Sheldon 2016). It is uncertain, however, what factors exactly are responsible for the consistently increased pairing rate when the observers fed the flocks in pairs. One possibility, tying back to the hypothesis underlying this study, is that the effect is exerted at the subliminal level, in which case the perception of a pair activates the neural pathways in the brain that drive the organisms to engage in the formation of similar pairs. Albeit primitive, perception of the difference between a single object and a pair thereof is a form of pattern recognition, which in its more complex form underlies the mental processing of virtually all sensory stimuli, from those involved in the individual's navigation through physical space to those involved in the intellectual enrichment of a person. Although such ensemble-coded patterns at higher complexity levels may not be apprehensible to birds, recognition of simpler patterns based on the chaining of contiguous perceptual tokens is within the realm of capacities of both birds and humans (Ravignini *et al.* 2015). For example, pigeons and blue jays reacted differently when presented with pairs and trebles (Lazareva *et al.* 2020), while rats ran faster to a group of small pellets of food than to a single large pellet (Wadhera, Wilkie, and Capaldi-Phillips 2018); in a social milieu, these subtle spatial cues can lead to behavioral signs that modify the dynamics of the group, affecting its degree of cohesion. For instance, stimuli associated with the numbers of higher value tend to be perceived as lasting longer than those related to lower numbers (Oliveri *et al.* 2008; Karsilar and Balci 2019), meaning that the perception of pairs may modify the focus of the avian observer and, with it, its relation with the flockmates. In other words, given the role of such simplistic pattern recognitions in eliciting specific types of behavior in relation to conspecifics, their effects on the social wholes that the individuals comprise, such as those evidenced here, can be expected. Following a *reductio ab absurdum* logic, the demonstrated underuse or low adaptation to numerosity stimuli in children diagnosed with autism spectrum disorder (Turi *et al.* 2015) as well as the fact that infants' competency in enumeration and perception of ordinal relations between quantities arise from a more primitive representation of results of the socially sculpted examination of reality (Simon 1997) can be invoked in support of this fundamental connection between the numerical and the social.

Finally, all the results mentioned so far were obtained by measuring the inter-individual distances between birds on the ground. To assess whether the same correlations between the pairing of the feeders and the pairing of the birds would exist for birds in flight, we headed to the ocean shore and experimented with the seagulls in a setting where their flights are more frequent than on the edge and over the surface of an artificial lake. Because birds normally engage in specific flight formations during the extended flights, the focus was on capturing their interaction soon upon ascending from the ground and photographs were taken in the first 5-10 seconds of their flight. The results shown in *Figure 5a*, however, contrary to the expectation, demonstrate no significant difference between the pairing of the birds depending on whether they were fed by a single child, by two children or simply observed without any prior interaction. The seagulls appeared to have followed their course in the sky independently of the viewers, not responding considerably to feeding, be it performed alone or in pairs. They, as it were, flew as if no world was watching, through an aerial space devoid of danger, suggesting the partial validity of the hypothesis that human feeders may be perceived by the birds as potential predators and that pairing on the ground may be a response to their sensing danger that multiplies with the number of feeders. Pairs were rarely formed in all sample groups and the birds mostly flew independently of one another (*Fig. 5b*). Still, one important observation of these inflight experiments was that the bird pairs forming in the flocks fed by the double feeders were more distinct compared to the bird pairs forming in the flocks fed by the single feeders or in the control, pre-feed cohorts. Compared to the purely transient and rapidly dispersing pairs typically forming in the latter two sample groups, the bird pairs forming after the interaction with the pair of children appeared to have lasted longer in the sky, or so was the impression of the observer. One such pair of birds, flying side by side over long distances and appearing not to want to separate from each other, is shown in *Figure 5c*. These solid avian couples correspond to the upper end of the standard deviation limit, which exceeds 21% in terms of birds forming pairs in the population fed by children in pairs as compared to 17.4 and 15.3% in the single-fed and pre-feed populations, respectively. This may be a reminder that sometimes in outliers the most significant signs for our sciences slumber. Slumbers these are that are golden. Like the sun that the seagulls in this memorable image fly into.

Figure 5. – Percentage of western seagulls in a flock forming inflight pairs over the ocean shore prior to the feeding and after the feeding depending on whether the children fed the birds alone or in pairs. Data points represent averages (n = 3-5 x 7-10), while error bars represent standard deviations. An illustrative raw, unprocessed photograph of seagulls flying over the ocean shore after their feeding and dispersal (b). Birds in these flocks would occasionally form pairs like the one shown in (c), which were rare, but longer lasting and more strongly bonded than the pairs forming in other sample groups.

4. Conclusion

In its broadest connotation, this study has sprung to life from the rather bold assumption of correspondence between the behavior of a flock of birds and the connectome underlying the subliminal levels of the human psyche. More narrowly, it aspired to test if the pairing of the birdwatchers visible to the birds would spontaneously induce their pairing too. To that end, children fed various birds with breadcrumbs to attract their attention and then their pairing was observed in response to this stimulus depending on whether they fed them alone or in pairs. The results demonstrated a consistently higher percentage of pairs in flocks of birds fed by children in pairs than in the flocks fed by a lone child, albeit with low to moderate levels of statistical significance. Feeding *per se* was shown not to be a factor inducing the congregation and consequent pairing of the birds, but rather the attraction to food. The difference between the pairing rates observed in the doubleton-fed vs. the singleton-fed groups was not due to the more compact flocks and rafts, as deduced from the equality of the average nearest-neighbor distances in these two sample groups. Rather, this effect may be tied to vigilance stimulation, to inadvertent social cues consequential to the extended duration of the focus or, as held by the central premise of the study, to the subliminal messages affecting the neurological pathways in the brain and, thereupon, the behavioral aspects falling within the domain of proxemics.

In view of one of the key hypothetic implications of this study, which is to potentially enable bringing people together by the simple sight of two humans coming together, as a pair, we are curious what the more relevant response of human observers, rather than waterfowls and gulls, to the coming together of their viewers would be. This may be the subject of future studies by this or another group of researchers.

But that is not all that there is. An invaluable reward has come from turning the beautiful scene of two children leaning onto one another and feeding birds into a scientific experiment and an insight into the deepest realms of the animal psyche, ours included. It has been a passageway to turning now largely forgotten Paul Dirac's view that "it is more important to have beauty in one's equations than to have them fit experiment" (1963) up on its head and promote the need for conceiving of beautiful experiments long before their rationality and match with the reigning models of reality is even being hinted at. Therefore, this study has been as much about the beauty of an experiment, of its contextual setting and visual scenery, of the overall spirit and zeitgeist woven in it as it has been about the significance of its ornithological findings. This beauty is unexplainable to the very authors of the study, but they imagine an infinitude of potential meanings, both logical and purely aesthetic, that it could gain when squeezed between two discrete interpretative horizons. For now, the idea that the two viewers of the world embracing one another could solicit the affectionate cuddling to occur within the world itself is sufficiently rewarding. It can present a source of invaluable ruminations about the subtle subliminal messages that the actors on the world's stage send forth with their acts.

Finally, like every conceptual work of art, in which form is an equal or oftentimes more significant expression than the content, this work has had an important message inscribed in its form. This form mimicked the lifetime of a creative thought, which, like life itself, is born from chaos and into it disappears at the end.

The end is near and birds have flown. Hands, like words trying to describe the essence, have come too close and the aerial messengers have departed. The coast is lonely, with only a few ripples on the water, a single drooping flower, and an overturned stone.

Plots have untangled and stranded, in the sand, is the word. They came from some faraway skies, shook off a flicker of light from their wings, and sailed away. All has been let out and road is all that is left. No purpose, no destination. A circle and the center on its edge.

This one, thusly, boys and girls, ends with an empty stage. And with the echo of children's chirrups ringing across eternity.

We are still.

We were here.

5. Contributions

As per the CRediT taxonomy, E. Uskoković and T. Uskoković are credited for investigation, while V. Uskoković is credited for conceptualization, methodology, formal analysis, investigation, writing, visualization, supervision, and project administration.

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