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BRIEF REPORT

Experimental Evidence of Contagious Stretching and Ingroup Bias in Budgerigars (*Melopsittacus undulatus*)

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Previous observational research suggests that stretching is contagious in budgerigars (*Melopsittacus undulatus*). Here we report the first experimental evidence of this response through a reanalysis of a previous experiment testing for contagious yawning in this species. Using a repeated measures design, 16 birds were tested as pairs alongside familiar and unfamiliar conspecifics with and without visual barriers. Our results show that stretching behavior was temporally clustered only when the birds could see one another, corroborating previous observational findings supporting contagion. Additionally, for the first time, we show an ingroup bias in this response. That is, while the overall frequency of stretching did not significantly differ as a function of conspecific familiarity, contagious stretching was only present when cage mates were paired together. These findings are discussed in relation to recent research studying social cognition in this species.

Keywords: avian cognition, collective behavior, empathy, ingroup bias

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Contagion represents the automatic triggering of a reflexive response following the detection of the same response in others (Zentall, 2003). Yawning is a classic example of contagious behavior given its uncontrollable nature. Seeing, hearing, reading or even thinking about yawning can trigger contagious yawning in humans (Massen, Church, & Gallup, 2015; Provine, 2005). Evidence of contagious yawning in other mammalian species is present for chimpanzees (e.g., Anderson, Myowa-Yamakoshi, & Matsuzawa, 2004), bonobos (Demuru & Palagi, 2012), gelada baboons (Palagi, Leone, Mancini, & Ferrari, 2009), wolves (Romero, Ito, Saito, & Hasegawa, 2014), domesticated dogs in response to human yawns (e.g., Joly-Mascheroni, Senju, & Shepherd, 2008), and a strain of high-frequency yawning rats (Moyaho, Rivas-Zamudio, Ugarte, Eguibar, & Valencia, 2015).

The first evidence for contagious yawning in a nonmammalian species came from budgerigars (*Melopsittacus undulatus*), a highly gregarious species of parrot. Through observations of a captive flock, analyses revealed a significant temporal clustering of yawns that were independent of circadian effects (Miller, Gallup, Vogel, Vicario, & Clark, 2012). Given the link between contagious yawning and empathy (e.g., Platek, Critton, Myers, & Gallup, 2003; but see Bartholomew & Cirulli, 2014), and the potential importance of studying this trait comparatively (Amici, Aureli, & Call, 2014; Campbell & de Waal, 2014), two follow-up studies were designed to experimentally test for contagious yawning in this species (Gallup, Swartwood, Militello, & Sackett, 2015). The first study assessed the temporal relationship of yawning between familiar and unfamiliar birds paired in adjacent cages with and without visual access to one another, while the second study displayed videos of previously recorded yawns and control behaviors to small groups of birds to assess how differences in the stimuli altered yawn frequency/expression. Both experiments provided evidence of contagious yawning, and thus future research could explore more direct tests of empathic processing in this species.

Budgerigars are increasingly becoming a model for studies of complex social behavior and cognition (e.g., Ikkatai, Okanoya, & Seki, 2016; Mui, Haselgrove, Pearce, & Heyes, 2008). When considering the presence of other socially contagious behaviors, stretching in budgerigars appears to follow the same reflexive and automatic action pattern. In the aforementioned observational study, temporal analyses suggest that these birds stretch in response to the stretching of nearby birds and even appear to match the type of stretch that initiated the action more often than expected (i.e., stretch-type matching; Miller, Gallup, Vogel, Vicario, et al., 2012). To date, however, experimental evidence of this response has not been documented. Stretching in general has received relatively little attention despite its potential function in collective flocking (Delius, 1969; Miller, Gallup, Vogel, & Clark, 2012). Recent research has confirmed a social component to stretching in budgerigars, as these birds are significantly more likely to stretch when near conspecifics (either live or via video display), in comparison to when they are by themselves (Ikkatai et al., 2016).

Here, we were prompted to further analyze the recordings from a previous experiment focused on yawning (Gallup et al., 2015) to assess whether the expression of stretching is similarly altered

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through access to stretches from conspecifics. Because this experiment paired familiar and unfamiliar birds together (first study referenced above), we could also test for an ingroup bias in this response.

Method

Subjects and Apparatus

The first study within Gallup et al. (2015) tested 16 budgerigars (15 males, three females), which included eight individuals from two aviaries (seven males, one female; six males, two females). The local Institutional Animal Care and Use Committee approved this research (#2014–02). Each testing day, two birds were caught and removed from their main aviaries, taken to a separate testing room, and housed individually in separate cages ($0.305 \times 0.254 \times 0.279$ m) connected to one another. The cage was designed to accommodate a plastic opaque barrier that could be positioned between the two individual cages, thus allowing for conditions with and without visual contact/information transfer.

Procedure

A total of 2 hr of behavioral recordings were taken each day when pairs were tested (1,300 hr): 1 consecutive hr with and 1 consecutive hr without visual access to one another. Each bird was tested twice in this fashion; once paired with a bird from the same home aviary (ingroup member) and once paired with an unfamiliar bird from the other aviary (outgroup member). Although both aviaries were housed in the same room for three months prior to testing (Gallup et al., 2015), a visual barrier separated the two groups and thus the unfamiliar/outgroup pairings represented the first visual contact between these birds. The first time each bird was tested, the composition of the ingroup or outgroup pairing was selected at random. In subsequent pairings, birds were matched based on the number of days that had elapsed since the first testing session to hold the total testing period relatively constant across the sample. The sequence and order of conditions were counterbalanced to account for documented circadian effects of yawning in this species (Miller, Gallup, Vogel, Vicario, et al., 2012), and all four trial orders of testing were evenly dispersed across the sample. For a more detailed description of the subjects and procedures, please see Gallup et al. (2015).

Data Scoring Analysis

Trained researchers scored the 32 hr of recordings for all stretches across conditions. Stretching was characterized by an action pattern in which a bird lifts one or both wings, and then follows with a posteriodorsal extension of one or both legs. When only a single wing and leg were extended from the same side (left or right), the stretch was recorded and characterized as monolateral, but when both legs were extended sequentially, the stretch was bilateral (Miller, Gallup, Vogel, Vicario, et al., 2012). Recent research also noted a third type of stretching in budgerigars (Ikkatai et al., 2016), called wing stretching, in which a bird dorsally extends both wings in tandem with both feet remaining perched. All three stretch-types were scored. Interrater reliability was measured by having two of the researchers go back and independently rescore the same random sample of trials initially scored by the third researcher (which amounted to 12.5% of the total experimental trials). There was significant agreement among the three raters ($k = 0.499$, $p < .001$; Spearman's $\rho = 1.000$, $p < .001$). Although studies often use 5 min (300 s) as a window for contagious transfer (e.g., Ikkatai et al., 2016; Palagi et al., 2009), here, we used a more conservative estimate. Following the same criteria from the original observational study of contagion in this species (Miller, Gallup, Vogel, Vicario, et al., 2012), only stretches that occurred within 30-s of a previous stretch from the adjacent bird were considered contagious. Repeated measures ANOVAs were used to compare total and contagious stretching frequencies as a function of visibility and familiarity conditions. Importantly, the visual attention toward the adjacent bird did not vary as a function of ingroup and outgroup pairings (Gallup et al., 2015). All analyses were performed with IBM SPSS Statistics Version 21 for Mac OS, with α set to 0.05.

Results

A total of 72 stretches were recorded across the experiment (M per bird = 4.500; 95% confidence interval [CI] [1.356, 7.643]). This consisted of 26 monolateral, 11 bilateral, and 35 back wing stretches. Figure 1a shows the overall stretch frequency across conditions (occluded ingroup, $N = 6$; occluded outgroup, $N = 7$; visible ingroup, $N = 37$; visible outgroup, $N = 22$). There was a main effect of visibility condition, in which stretching was more frequent in pairings when the birds could see one another, compared to when they were occluded, $F(1, 15) = 13.247$, $p = .002$, $\eta_p^2 = 0.469$. However, there was no significant difference in the total number of stretches performed across ingroup and outgroup pairings, $F(1, 15) = 3.182$, $p = .095$, $\eta_p^2 = 0.175$, nor was there an interaction effect between visibility and familiarity conditions, $F(1, 15) = 3.636$, $p = .076$, $\eta_p^2 = 0.195$.

A total of 13 stretches occurred within a 30-s window following a stretch from the adjacent bird, and thus were marked as contagious. This response was present only among ingroup pairings when the birds could see one another, resulting in main effects of visibility and familiarity conditions, as well as an interaction between them, $F(1, 15) = 9.639$, $p = .007$, $\eta_p^2 = 0.391$; Figure 1b). In fact, there was not even a single case in which two birds stretched within a 5-min (300-s) window of one another outside of the visible condition of paired ingroup cage mates. The small sample of contagious stretches did not allow for a formal analysis of stretch-type matching, but there was no trend for this effect (six matched, seven unmatched).

Discussion

Although different avian species have been shown to synchronize wing-flapping during mating displays (Southern, 1974; Stevens, 1991), coordinate preening (Palestis & Burger, 1998), and show social facilitation of sitting and dust bathing (Hoppitt, Blackburn, & Laland, 2007), the social nature of stretching has not been closely examined. Following up on an observational study assessing the temporal clumping of stretches in a group (Miller, Gallup, Vogel, Vicario, et al., 2012), we provide the first experimental evidence of contagious stretching in budgerigars. Moreover, in contrast to contagious yawning in this species (Gallup et al., 2015),

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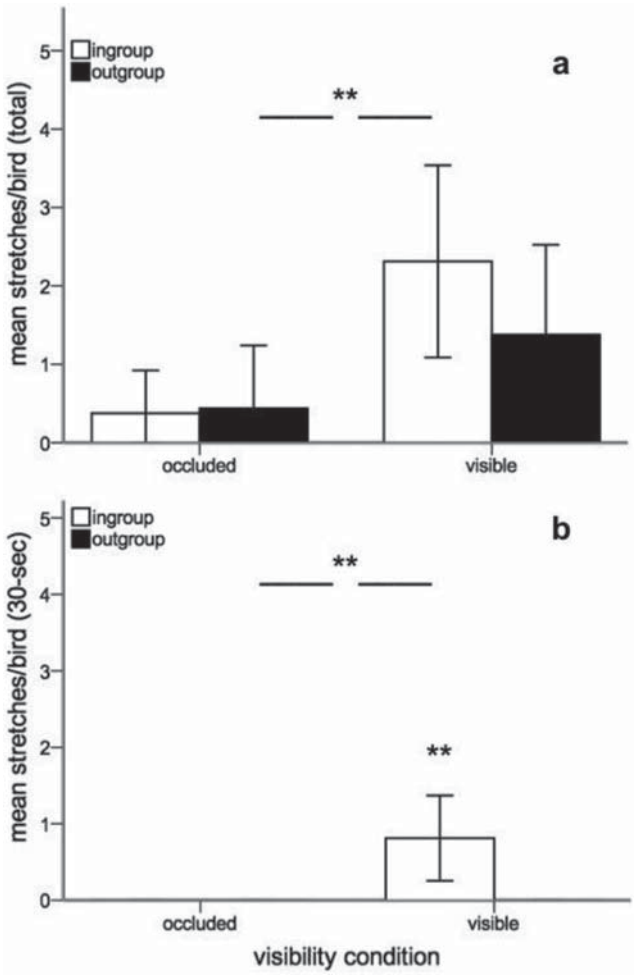


Figure 1. (a) Stretching was significantly more common when birds could see one another, but there was no difference in stretching frequency when comparing birds paired with familiar and unfamiliar conspecifics. (b) Contagious stretching, that is, stretching within a 30-s window of a stretch from the adjacent bird, only occurred within familiar pairs that could see one another. $M \pm 95\%$ confidence interval. ** $p < .01$.

we show an ingroup bias for stretch contagion whereby only birds from the same home aviary would stretch in short succession of one another. Similar to a recent study by Ikkatai, Okanoya, and Seki (2016), we also show that stretching is more frequent with visual access to a conspecific. When taken together, these findings highlight a clear social component to this behavior that may be adaptive.

Stretching has been considered an "associated response" to yawning, as they share similar properties and often co-occur in humans and nonhuman mammals as part of a global motor complex (Provine, 2005). Although budgerigars do not yawn and stretch simultaneously, the frequency of responses tend to be correlated under natural conditions and thus may share analogous functions. However, previous research on budgerigars has shown a decoupling of these behaviors during heat stress (Gallup, Miller, & Clark, 2009, 2010). A similar disassociation between yawning and stretching has also been demonstrated in rats (Gallup, Miller, & Clark, 2011), highlighting a potential difference in functionality and a thermoregulatory component specific to yawning. A decoupling of yawning and stretching also occurs on a circadian cycle in humans, whereby the co-occurrence is greater in the morning hours just after waking than it is in the evening before sleep (Provine, Hamernik, & Curchack, 1987). Although the function of stretching has not been thoroughly investigated, a positive correlation between stretching and flight has been documented in birds (Delius, 1969), suggesting it may prepare animals for takeoff by enhancing blood flow to the wings. Budgerigars show collective flocking in the wild, often forming groups of over 1,000 individuals (Wyndham, 1980), and thus contagious stretching may serve as a mechanism that enhances coordinated movement and departure within familiar members of the group when no external impetus to fly coordinates this. A previous study on budgerigars showed that stretching became more synchronized across group members following environmental disturbances that elicit stress (Miller, Gallup, Vogel, & Clark, 2012), supporting a potential role in coordinated flight. Based on the current and previous findings, future research could investigate whether stretching reduces the latency to take off and/or increases initial flight velocity, and if this transition at the level of the flock is more asynchronous within groups comprised of unfamiliar members.

The current study found no evidence to support the previously reported stretch-type matching within this species (Miller, Gallup, Vogel, Vicario, et al., 2012). However, the number of contagious stretches was quite small for comparison, and a series of factors differed between these studies. For example, in comparison to observations of a larger captive flock housed together and perched alongside one another in rows, the current study paired birds in individualized cages with perches aligned perpendicularly. Thus, it is possible group size and spatial alignments alter the degree of copying in this species, and future research could assess the role of these factors across different socially coordinated or contagious behaviors.

Budgerigars are becoming increasingly utilized as a model organism for studying social cognition (Ikkatai et al., 2016), and the current findings of an ingroup bias for stretch contagion add to the growing literature on the complex social behavior in this species. We hope further comparative research will examine the presence and function of isolated and collective stretching in flocking birds, as well as investigate whether other avian species show similar ingroup biases for behavioral contagion.

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