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Pet dogs exhibit social preference for people who synchronize with them: what does it tell us about the evolution of behavioral synchronization?

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Abstract

Humans show greater affiliation with people who are behaviorally synchronized with them but little is known about the impact of synchronization at an interspecific level. We, therefore, explored whether the synchronization of humans with dogs affects dogs' human preferences. Pet dogs were exposed to two unfamiliar persons: one synchronized her walking behavior with them and one walked randomly. In a preference test, molossoids exhibited a clear social preference for the synchronized person, unlike shepherds. We conclude that pet dogs show a greater affiliation with humans who mimic their walking behavior, although genetic selection modulates this propensity. Behavioral synchronization, therefore, acts as a social glue in dogs too. It is the first time that such a human-like ability has been highlighted in domesticated canids at an interspecific level. Implications for the evolution of behavioral synchronization are discussed.

Keywords Doghuman synchronization · Preference test · Behavioral synchrony · Interspecific synchronization · Dog mimicry

Introduction

Behavioral synchronization is broadly defined as individuals doing the same thing at the same time and in the same place (for a review see Duranton and Gaunet 2016). There are several subcategories of behavioral synchronization, such as activity synchrony (exhibiting the same behavior at the same time) and location synchrony (being in the same place at the same time, depending on the observed scale) (Duranton and Gaunet 2016). Synchronization has been widely studied in humans. Individuals often synchronize their behavior, even without being aware of it (i.e., nonconscious behavioral synchronization, Lakin et al. 2003), for instance when sitting side by side in rocking chairs (Richardson et al. 2007), walking together (van Ulzen et al. 2008), or chatting (Kendon 1970; Richardson et al. 2008). Finally, it is known that the more affiliated two individuals are, the more behavioral synchronization they display (for a review see Duranton and Gaunet 2016).

Nonconscious behavioral synchronization is thus evolutionarily adaptive for humans, as it enhances communication between individuals and fosters social cohesion (Chartrand and Bargh 1999; Duranton and Gaunet 2015; Tunçgenç and Cohen 2016). Neonates move in synchronization with the rhythm of an adult's speech, and it has been suggested that it plays a part in motor preparation for language acquisition (Condon and Sander 1974). A similar phenomenon can also be observed between conversing adults, with the person listnening synchronizing her behavior with the speaker's pace of speech and movements (Kendon 1970). Adults who are synchronized with each other have been demonstrated to have a higher affiliation for each other that with those who are not behaviorally synchronized (Chartrand and Bargh 1999). Additionally, when two individuals exhibit synchronized behaviors, they report that their interactions are smoother (Sanchez-Burks

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et al. 2000). Consequently, being behaviorally synchronized with someone, therefore, leads to prosocial behavior. For instance, individuals leave larger tips and are likely to help people more if the latter behave in a synchronized way with them, even if they are not aware of it (van Baaren et al. 2003; Guéguen et al. 2009; Muller et al. 2012; Jacob and Guéguen 2013).

This observation has now been made at an interspecific level between humans and dogs. Both species have lived together for many thousands of years (Frantz et al. 2016). Owing to both domestication and ontogenic experiences, dogs are very skillful at reading human behavioral communicative cues (for a review see Duranton and Gaunet 2015). Researchers have recently started to investigate human-like nonconscious behavioral synchronization in dogs with regard to humans (walking indoors: Duranton et al. 2017b; exposure to an unfamiliar person: Duranton et al. 2017a), showing that the degree of behavioral synchronization depends on the degree of affiliation between the interacting partners (see Duranton et al. 2017a).

Up to now, however, the effect of human behavioral synchronization on dogs' social preferences has not been studied. Previous studies have demonstrated that dogs are considered to be a good model to understand the evolution of human social cognition (Miklósi et al. 2017). We argue that investigating and defining the existence of such a phenomenon would be relevant to better understanding the evolutionary link between behavioral synchronization and affiliation over the course of human history. We, therefore, examined the effect of movement (walking) and location synchrony of unfamiliar persons on pet dogs (see Paukner et al. 2009 for a similar experiment in capuchin monkeys). Given that dogs are thought to have acquired functionally similar social skills to humans in the course of evolution (Miklósi et al. 2007) and given the existing literature (e.g., Chartrand and Bargh 1999; Sanchez-Burks et al. 2000), we predicted that, like humans (for pre-verbal infants, see Cirelli et al. 2014, 2016; Tunçgenç et al. 2015) and capuchins (Paukner et al. 2009), pet dogs would exhibit social preferences for people who synchronized their behavior with them. To check for an effect of breeding on social cognition, we tested shepherd-type dogs and molossoid dogs. Both groups of dogs originate as working breeds (herding dogs and guard dogs, respectively), forge strong bonds with their owners (Eken Asp et al. 2015) and are more skilled at using human cues than other, nonworking breeds (Mehrkam and Wynne 2014). Based on this literature and on Duranton et al. (2016), who showed that molossoid dogs were more attuned to unfamiliar people than shepherd dogs, we predicted that molossoid dogs would be more sensitive to human synchronization than shepherd dogs.

Methods

Participants

We tested 28 pet dogs (14 molossoids and 14 shepherds; counterbalanced for sex). Sample size was defined beforehand, on the basis of previous research (see Charan and Biswas 2013). The dogs were aged between 1 and 11.5 years (mean ± SE = 4.41 ± 0.51 years) and did not exhibit any signs of age-related disease (e.g., eye or joint problems) that would prevent them from moving freely and comfortably. All were pet dogs and had basic training skills (such as recall, sit, lay down, walking on leash) but no demands were made on them during the test as they were free to move around. All of the participating owners reported that their pet dogs were comfortable with unfamiliar persons visiting their home.

Ethical note

This study was only observational and the dogs were not subjected to any physically or psychologically harm in the course of the study. The study was conducted in accordance to the legal requirements of France (where it was carried out), and the institutional guidelines of the Aix-Marseille Université, France. Each dog was free to move throughout the testing area (their home) without any physical direction nor constraints. No physical manipulation nor sampling was performed on any of the pet dogs participating in the study (e.g., blood or saliva sampling).

Procedure

The pet dogs were individually tested in the living room of their owner's home, in various cities around Paris, France. Three unfamiliar experimenters took part. Before the experiment began, Experimenter E entered the living room and explained the procedure to the owner. To avoid any potential bias in his/her behavior while interacting with their dog, the owners were not made aware of the real aim of the study. The owner was instructed to remain seated on a preassigned chair during the whole test, to look straight ahead, and not to interact with the dog (i.e., no looking, talking, or petting). Once the dogs had become familiar with Experimenter E, and had started to ignore her, the test could start. The dogs were unleashed, and each one underwent the three phases described below. During all three phases, the owner remained seated in the manner described, with Experimenter E standing right behind the chair, filming the dog's behavioral reactions.

Phase S: synchronized

Experimenter S entered the room and remained neutral (no looking at, talking to or petting the dog) while the dog sniffed her. Once the dog stopped exploring S, the testing phase began. S synchronized her Behavior with that of the dog for 3 min i.e., the experimenter went wherever the dog went, looked wherever the dog looked, moved whenever the dog moved, moved in the same direction the dog moved, and stayed still whenever the dog stayed still (see Fig. 1).

Phase R: randomized

Experimenter R entered the room and remained neutral (see above) while the dog sniffed her. Once the dog stopped exploring R, the testing phase began. Experimenter R moved randomly for 3 min, according to a predefined pathway (she had been instructed to alternately walk around the room and cross it along the different diagonals from different sides), without being synchronized with the dog (see Fig. 1).

Phase P: preference test

The dog sat between the owner's legs. The owner was blindfolded, and in turn blindfolded the dog by putting his/her hands over the dog's eyes. Experimenters S and R entered the room and took up predefined positions, 2 m from each other and 3 m from the owner and the dog (see Fig. 1). The owner then uncovered their dog's eyes and set the dog free so that it could go and choose one of the two experimenters (i.e., walking toward an experimenter and remained in close proximity (<1 m) to her for at least 1 s). The dog was filmed until it left the experimenter and went elsewhere (owner, sniffing the ground, etc.).

During Phases S and R, the two experimenters walked at a similar speed. The experimenters moved according to a similarly predefined pathway to respect the same distance from the dogs (<5 m) regardless of the size of the room, and the furniture arrangement. The order of Phases S and R was counterbalanced across dogs, but the experiment always ended with Phase P. The roles of the experimenters (S or R) during Phases S and R, as well as the sides on which they stood during Phase P, were counterbalanced across dogs.

All three phases were separated by a 10-min break. All dogs chose one experimenter.

Behavioral analysis and interobserver agreement

The variables we studied were the dogs' first choice (experimenter toward whom the dogs moved first when released by their owners) for Phase P, and the number of stress-related behaviors (e.g., lip licking, body shaking, yawning; see Deldalle and Gaunet 2014) for Phases S and R. We also controlled for the time spent close to each experimenter in Phase P. To test the reliability of the behavioral coding, in addition to the coding of 100% of the behaviors by the first author (CD), a blind coder (EL)—unaware of the study's aims and hypotheses—was trained to use Solomon Coder. EL then coded the above behaviors for a randomly selected

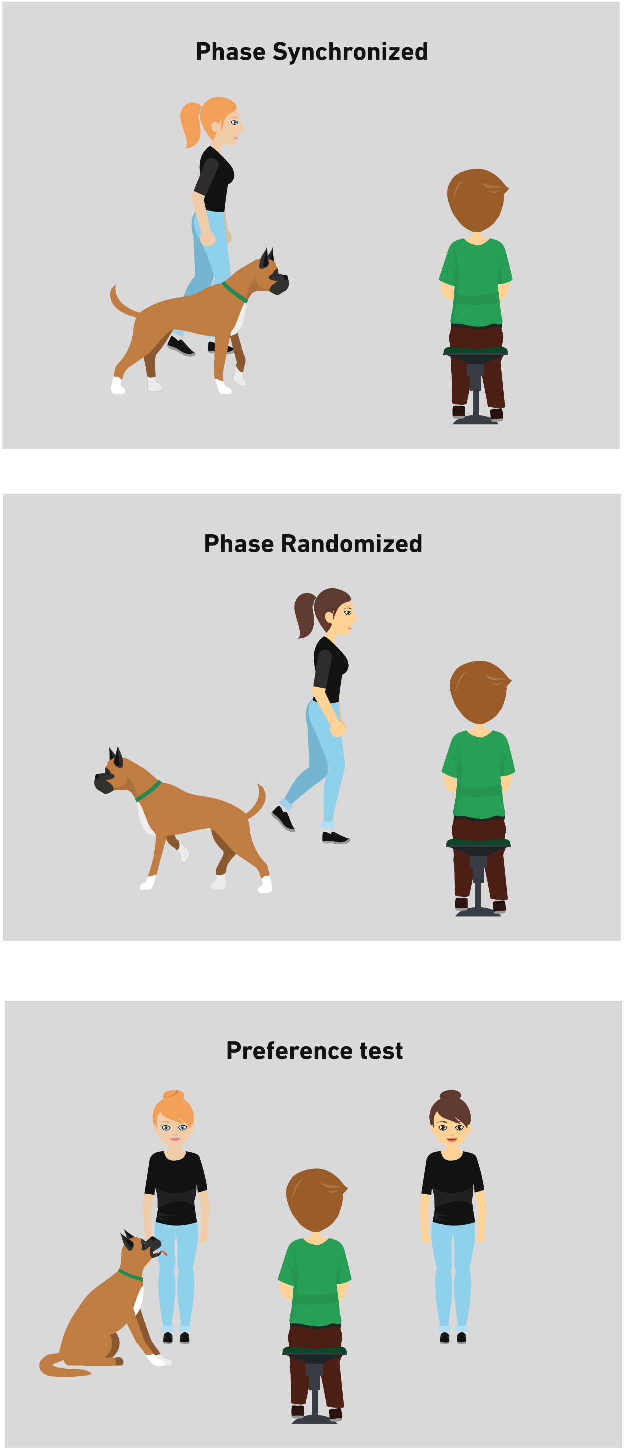

Fig. 1 Experimental setting of the three testing phases

subset of 43% of the data. The resulting Pearson correlation coefficients were good (number of stress-related behaviors: 99% agreement, $p < 0.001$; first choice: 100% agreement, $p < 0.001$; time close to the synchronized experimenter: 99% agreement, $p < 0.001$; time spent close to the randomized experimenter: 99% agreement, $p < 0.001$).

Statistical analysis

Using R software (version 3.2.0), we performed an analysis of variance (ANOVA) to control for the overall effects of the independent variables (order of the phases, role of experimenters, side of experimenters during the preference phase, breed, sex, and age) on our main dependant variable (dogs' first choice in Phase P) as well as for stress-related behaviors. We also performed permutation tests (Ludbrook and Dudley 1998) for 2 × 2 comparisons when comparing breed groups for the first choice as well as to evaluate the difference in performances from chance level when applicable, and when controlling for stress-related behaviors during Phases S and R, as well as time spent close each experimenter in Phase P. For significant results, effect sizes (Cohen's *d*) and 95% confidence intervals (CIs) are provided.

Results

Choice

General

Significantly more pet dogs chose the synchronized experimenter ($n = 18$) rather than the random experimenter ($n = 10$) (ANOVA, $\chi^2 = 1.14$, $df = 1$, $p = 0.033$, Cohen's $d = 0.58$, 95% CI [−0.54, −0.02]).

Controlling for independent variables

However, when we controlled for independent variables, we found a significant effect of breed on the dogs' choice. The analysis of variance (ANOVA) showed that significantly more molossoids ($n = 12$) than shepherd dogs ($n = 6$) chose the synchronized experimenter, $\chi^2 = 1.76$, $df = 1$, $p = 0.0048$, Cohen's $d = 1.25$, 95% CI [−0.83, −0.20]; see Fig. 2. We checked that the choices within each breed group were not due to chance. We found that shepherd dogs appeared to chose randomly between the two experimenters (not significantly different from chance level, permutation test $Z = -0.53$, $p = 0.71$), but molossoid dogs chose the synchronized experimenter significantly above chance level, permutation test $Z = 2.35$, $p = 0.03$, Cohen's $d = 0.80$, 95% CI [0.08–0.75]; see Fig. 2. This was confirmed by the fact that the shepherds did not select the synchronized experimenter

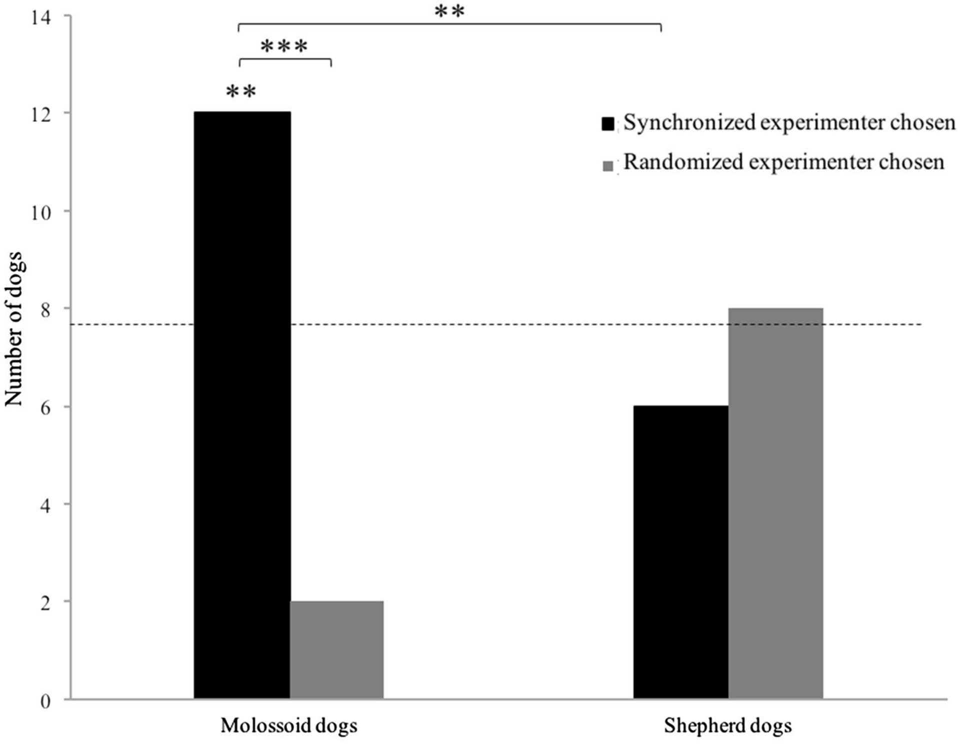

Fig. 2 Number of dogs who selected first the synchronized and the randomized Experimenters during the preference test. Dotted line represents chance level. Stars on the bars represent significant differences between groups. Stars on the graphic represent significant difference with chance level. **$p < 0.01$; ***$p < 0.001$

more than the randomized experimenter (permutation test $Z = -0.53$, $p = 0.71$), whereas the molossoids preferentially chose the synchronized experimenter over the randomized one, permutation test $Z = 2.36$, $p = 0.03$, Cohen's $d = 2.40$, 95% CI [−1.07, −0.62]; see Fig. 2.

The ANOVA failed to reveal effects of the other independent variables (sex: $\chi^2 = 0.07$, $df = 1$, $p = 0.53$; age: $\chi^2 = 0.06$, $df = 1$, $p = 0.56$; order of phases: $\chi^2 = 0.00$, $df = 1$, $p = 0.95$; role of experimenters: $\chi^2 = 0.02$, $df = 1$, $p = 0.78$; side of experimenters during the preference test: $\chi^2 = 0.01$, $df = 1$, $p = 0.81$).

Controlling for stress-associated behaviors

To ensure that the breed difference concerning the choice of experimenter was not due to a difference in stress level during the tests, we controlled for stress-associated behaviors (number and total duration) exhibited by the dogs during Phases S and R (pooled). We found no difference in the number of stress-associated behaviors exhibited by the molossoids (mean = 3.55 ± 0.97) and shepherds (mean = 3.28 ± 0.93; ANOVA, $\chi^2 = 1.14$, $df = 1$, $p > 0.05$). Within each breed group, there was no apparent effect of the condition on the number of stress-associated behaviors (ANOVA: molossoids $\chi^2 = 46.20$, $df = 1$, $p > 0.05$; shepherds $\chi^2 = 20.57$, $df = 1$, $p > 0.05$).

The ANOVA failed to reveal any effect of the independent variables (sex: $\chi^2 = 4.57$, $df = 1$, $p = 0.56$; age: $\chi^2 = 2.71$, $df = 1$, $p = 0.65$; order of phases: $\chi^2 = 12.07$, $df = 1$, $p = 0.34$; role of experimenters: $\chi^2 = 12.07$, $df = 1$, $p = 0.34$) on stress-related behaviors.

Controlling for the time dogs spent close to the experimenter during the preference phase

To ensure that a difference in the dogs' choice was not due to more stress/uncomfort towards one of the two experimenters, we controlled for the time the dog spent close to the experimenters after making their choice and before coming back towards their owners. We found no effect of condition on the amount of time the dogs spent close to the experimenter during the preference phase: each dog spent the same amount of time close to the synchronized experimenter as they did to the randomized experimenter (permutation test, $Z = -0.51$ $p = 0.61$).

Discussion

Our study revealed for the first time that pet dogs exhibit a social preference for people who behave in synchrony with them. Additionally, this preference is modulated by breed: molossoid dogs preferred the person who was synchronized with them, whereas shepherd dogs chose randomly. Our working hypotheses were thus confirmed.

However, after choosing between the synchronized and unsynchronized experimenters, dogs spent the same amount of time close to each experimenter, demonstrating that they were not motivated by fear or stress toward any of the experimenters, and supporting the hypothesis that behavioral synchronization alone influenced their choice. One could also argue that this result reflects a low preference between the synchronized and unsynchronized experimenters. To disentangle this point, a longer testing time could be carried out, to determine if prolonged exposure to synchronization would lead to a greater, longer lasting preference in dogs.

Interestingly, we found a strong breed effect that did not appear to be due to any difference in the dogs' vigilance: (1) both breeds exhibited minimal numbers of stress-associated behaviors; and (2) we visually controlled for activity level/velocity: it did not differ between the breeds, as dogs only stayed still or walked (breed affects dogs' velocity for faster activities such as when trotting or running, see Duranton et al. 2018; Voss et al. 2010). Molossoid dogs clearly preferred the experimenter with the synchronized behavior, whereas shepherd dogs did not. This is in line with previous findings showing that when the owner acts neutral, and does not provide any cues that could influence the dogs' behavior, pet dogs behave according to the temperament for which their breed was selected during the course of domestication and selective breeding (Duranton et al. 2016, Merkham and; Wynne 2014). Shepherd dogs were selected for tending and herding livestock, and for paying attention to their owner for direction during shared activities. Molossoid dogs, by contrast, were originally selected for guarding and attending to strangers. Various studies of dogs' personality have found that guarding breeds, including molossoids, are the boldest breed group (Turcsán et al. 2011; Starling et al. 2013), and are notably bolder than shepherd dogs (Svartberg 2006; Duffy et al. 2008). Molossoid dogs were selected to respond independently to novel and unusual situations (Starling et al. 2013), whereas shepherd dogs were expected to be more focused on their owners and less interested in unfamiliar people than other breeds (Vas et al. 2005; Passalacqua et al. 2011; Duranton et al. 2016). We, therefore, concluded that the molossoid dogs we observed were more interested in and thus more sensitive to the behavior of the unfamiliar person than shepherd dogs were, which would explain why they alone exhibited increased affiliation with the unfamiliar person who mimicked them. Our results are in line with recent findings (Kis et al. 2014; Nagasawa et al. 2015) evidencing that domestication, and thus genetic selection, affect dogs' human-directed social behaviors.

Regarding the mechanisms, although the present paradigm allows us to state that activity (moving or staying still), temporal (changing from move to still or still to move) and local (staying close to) synchronies contribute to increasing dogs' social attunement towards humans, it is prudent to note that the effect of each type of synchrony cannot be disambiguated using this paradigm. By testing the dogs in their natural living environment, we indeed aimed at creating a scenario as ecologically meaningful for the tested dogs as possible; and it is known that in natural settings, the three different nonconscious behavioral synchronizations are often not possible to isolate (see Duranton and Gaunet 2016 for more details). One could argue that the important feature explaining dogs' preference is not behavioral synchronization in the broad sense, but only local synchrony, due to a simple mechanism: the mere exposure effect stating that the repeated, unreinforced exposure is sufficient to enhance attitude toward a stimulus (Zajonc 1968), by increasing positive affects towards it (Harmon-Jones and Allen 2001). Such an effect is known to be at play in preference tests (Bornstein and D'Agostino 1992). We would like to emphasize that we controlled as much as possible to avoid this effect. First, dogs were exposed only once to each experimenter, i.e., without any repetition, and the dogs received the same amount of exposure to the two experimenters as they stayed in a close space around the dogs for the same amount of time in both conditions. Second, tests started only after the dogs first explored the experimenters, to ensure that the dogs became attentive to the experimenters, and allowing them the time to recognize/categorize them as humans (Autier-Dérian et al. 2013). Mere exposure effects produced by stimuli that are clearly recognized are weaker than mere exposure effects produced by exposure to stimuli that are not recognized (Bornstein and D'Agostino 1992). Finally, our setting is evaluating the short-term effect of behavioral synchronization. Dogs were tested in Phase P, the preference test, immediately following completion of the exposure phases, Phase S and Phase R. It has been demonstrated in non-human mammals that mere exposure effect positively affects long-term preference for social companions but decreases the preference for the exposed stimulus in short-term situations (Hill 1978). We, however, did not find such an effect in our setting, allowing us to say that mere exposure effect was likely not at play in our setting.

The present study is the first to demonstrate that pet dogs exhibit social preferences for people who are synchronized with them. These social preferences are similar to those observed in human infants, who are more attuned to individuals who have behaved in synchrony with them (Tunçgenç et al. 2015; Cirelli et al. 2016). Dogs are the third species to display this ability, as behavioral synchronization has already been found to increase affiliation in humans and capuchins (Paukner et al. 2009; Chartrand and Lakin 2013). It has been suggested that the link between behavioral synchronization and increased affiliation was key to human evolution, helping to maintain smooth relationships between individuals (Lakin et al. 2003). We believe that behavioral synchronization, a social glue that helps bind individuals together (Lakin et al. 2003), also exists between dogs and humans. Behavioral synchronization leads to greater affiliation between dogs and humans, thereby increasing dyad/group cohesion and enhancing dogs' integration into human society. In humans, sensitivity to behavioral synchronization is considered a prerequisite for prosociality (Asendorpf et al. 1996; Kirschner and Tomasello 2010; Xavier et al. 2013). Prosociality toward familiar conspecifics has recently been highlighted in dogs (Quervel-Chaumette et al. 2016a), but studies have failed to observe prosociality toward familiar persons (e.g., Marshall-Pescini et al. 2016; Quervel-Chaumette et al. 2016b). It is significant that human infants are known to exhibit more prosocial behaviors towards people who behave in synchronization with them (Cirelli et al. 2014, 2016), because dogs are considered to have analogous social skills to those of human infants (Miklósi et al. 2007). As the present study evidenced that pet dogs, like infants, prefer people who synchronize with them, we recommend further studies investigating interspecific prosociality to consider dog–human partners with a high level of behavioral synchronization, as this may interfere with prosociality.

Finally, our results support recent suggestions that convergent selection pressures, such as a similar developmental environment, social networks or cooperative activities, explain the social skills of different species (Miklósi et al. 2007; Quervel-Chaumette 2016a), including sensitivity to others' synchronized behaviors. The new data yielded by the present study support the hypothesis that human-like social skills have functionally developed in domestic dogs during the course of their evolution and selection to live together with humans (e.g., Hare et al. 2002; Gaunet and El Massioui 2014). Interestingly, we also showed that genetic selection of specific breeds and groups of dogs for varied working activities also modulates behavioral synchronization skills. Such findings add consistent data to the existing literature on dog–human behavioral synchronization (see e.g., Duranton et al. 2017b) but may even allow us to go further in the understanding of the phenomenon. We suggest that both the dogs' ability to synchronize with humans, and the dogs' sensitivity to human's behavioral synchronization are skills which have been selected for at different times in the evolutionary history of dogs: the first one early in the domestication history of the species as it is adaptive and found in all dogs, and the second with later artificial selection to enhance specific breeds' abilities. Genetics, therefore, appear to be at play in the evolution of sensitivity to the synchronized behaviors of others, suggesting its plausible implication in humans too, as found for other social skills (Ebstein et al. 2010). Still, the present study and available data (Paukner et al. 2009; Chartrand and Lakin 2013) do not disambiguate the origin of sensitivity to the behavioral synchronization of others. Did such a skill evolve due to genetic selection through the pressure of social life (through a common ancestor, or evolutive convergence), and/or is it due to ontogenic effect and learning experiences during individuals' development in community? What are the respective roles of both genetic and ontogeny? We suggest five hypotheses: (1) the skill was present in a common ancestor to all three species (humans, capuchins, and dogs) and does not depend on life experiences, (2) the skill was present in a common ancestor to all three species, and is modulated by life experiences, (3) the skill was present in the common ancestor of primates, and appeared in dogs through evolutive convergence, (4) the skill was present in the common ancestor of primates, appeared in dogs through evolutive convergence, and is also modulated by life experiences, and (5) the skill is present in the three species only due to life experiences. Further studies are needed to identify the origins of behavioral synchronization and to better understand its appearance in humans' evolutive history.

To conclude, the present study showed for the first time that dogs possess human-like sensitivity to behavioral synchronization, exhibiting social preference for people who mimic them. It also provided new evidence that human-like social skills have evolved in dogs and that behavioral synchronization acts as an interspecific social glue between dogs and humans.

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Data Availability The data associated with this research are available at [link].

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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