Journal of Veterinary Behavior 36 (2020) 48–53

Contents lists available at ScienceDirect

Journal of Veterinary Behavior

journal homepage: www.journalvetbehavior.com

Canine Research

Local synchrony as a tool to estimate affiliation in dogs

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ARTICLE INFO

Article history:
Received 4 June 2019
Received in revised form
20 July 2019
Accepted 1 October 2019
Available online 9 October 2019

Keywords:
dog-dog synchronization
local synchrony
dog affiliation
affiliative behaviors
dog-dog interactions

ABSTRACT

Affiliation between individuals is socially adaptive as it helps to build and maintain bonds between group members and is central to social cohesion. One of the main factors in creating and maintaining affiliation is behavioral synchronization, particularly local synchrony which is defined as being at the same place as other individuals, whatever the activity. In dogs, a very social species, it is known that individuals who are more closely affiliated will exhibit more local synchrony that less affiliated individuals. In ethology, significance of the phenomenon is still undervalued, even in studies specifically aiming to describe the social organization within groups. We suggest that local synchrony could be very informative for scientists to consider when observing groups of dogs interacting. The present study thus investigated whether local synchrony could be a tool to measure the degree of affiliation existing between dogs. To do so, a target dog surrounded by three different dogs (one affiliated with the target dog, and two unfamiliar) was observed during a walk. An observer, who was deliberately unaware of the identity of the three dogs relative to the target dog, analyzed the target dog's behavior toward the other dogs. Results revealed that the target dog spent significantly more time associating with the affiliated dog. The target dog was observed in the same area, as well as in close proximity to the affiliated dog, and the target dog also initiated more closeness with its affiliated conspecific compared to the two unfamiliar dogs. It is concluded that local synchrony is therefore an effective tool to evaluate affiliation between dogs. Theoretical as well as practical implications are discussed.

Introduction

To remain stable, a group needs to have a strong, social cohesion between individual group members; this depends on various factors attracting individuals toward each other and keeping them in a coordinated social unit (Lehmann et al., 2007). Affiliation between individuals is thus a key factor. Affiliative behaviors are defined as behaviors that participate in maintaining proximity between individuals, and they are thus acknowledged as actively participating in increasing social cohesion (Engel & Lamprecht, 1997; Gautrais et al., 2007; Duranton & Gaunet, 2016). One of the main factors in creating and maintaining affiliation is behavioral synchronization, broadly defined as doing the same thing at the same place at the same time as other individuals (Duranton & Gaunet, 2016). There are three components of behavioral synchronization: temporal synchrony, when several individuals switch activities at the same time; local synchrony, when several individuals are in the same place at the same time; and finally, activity synchrony, when several individuals are doing the same activities at the same time (Duranton & Gaunet, 2016; Duranton et al., 2017a).

In mammals, the relationship between affiliation and synchronization is well documented. Behavioral synchronization is indeed known to increase with affiliation between individuals, for example, in baboons (King & Cowlishaw, 2009), wild bottlenose dolphins (Sakai et al., 2010), and orangutans (Ross et al., 2008). In humans, synchronization between individuals has been intensively studied too. Humans synchronize their behaviors in numerous daily situations such as when sitting side by side in rocking chairs (Richardson et al., 2007), walking together (van Ulzen et al., 2008), or simply chatting together (Richardson et al., 2008). It is known that the more the people are affiliated, the more they behave in synchrony (Cheng & Chartrand, 2003; Lakin et al., 2003). In adults, it is also observed the other way around: individuals reported to prefer someone who synchronized with them (even if nonaware of it), compared with those who are not synchronized (Chartrand & Bargh, 1999). It has been recently evidenced that behavioral

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https://doi.org/10.1016/j.jveb.2019.10.007
1558-7878/

synchronization even occurs between species; when considering humans and dogs, behavioral synchronization increases with affiliation between individuals from these two species (Duranton et al., 2016, 2017a,b, 2018b,c).

One important aspect of behavioral synchronization is location synchrony. Synchronization is strengthened when group members are close to each other, for example, when they forage together at specific locations (King & Cowlishaw, 2009). Moving together to the same places prevents group members from becoming isolated from each other, thus increasing their survival chances through a better visual, chemical, or vocal communication (Braune et al., 2005; Cortopassi & Bradbury, 2006; King & Cowlishaw, 2009). In addition, it is known that local synchrony increases with affiliation and helps to foster bonds between group members (Duranton & Gaunet, 2016). Thus, this primordial aspect of synchronization can be very useful to consider when observing groups of individuals and the way they interact together.

One species in which the importance of the local synchrony has been described is dogs. It is known that behavioral synchronization is “a basic part of social life in dogs” (Scott & Fuller, 1965), with a special emphasis on local synchrony as to behave in a synchronous way, dogs maintain close contact with one another (Scott & McGray, 1967). The link between local synchrony and affiliation is also described in dogs: (1) when they are still, affiliated dogs are often observed resting close to each other (Scott & Fuller, 1965) and (2) when they are moving, free-ranging dogs locally synchronize their movements more with a leader toward whom they are affiliated than with other groups members (Bonanni et al., 2010). In artificial settings, the phenomenon of local synchrony has also been observed at interspecific level: dogs exhibit more local synchrony toward humans with whom they are affiliated to compared to humans with whom they share a lower degree of affiliation (Duranton & Gaunet, 2018).

Even if behavioral synchronization, and more precisely local synchrony, of dogs with others (i.e., conspecifics or humans) is a robust phenomenon now well documented and easily identifiable by observers (Duranton et al., 2018a), it has been little investigated in natural contexts, and its overall value is still underevaluated in ethology. Many studies have investigated the relationship between dogs and humans (Topál et al., 1998; Prato-Previde & Valsecchi, 2014; Topál et al., 2015), or social organization among dogs of a group (Bradshaw & Nott, 1995; Feddersen-Petersen, 2007; Cafazzo et al., 2010) but rarely have they considered behavioral synchronization as an indicator of affiliation between individuals. We propose that such observations could add valuable information to better understand the relationship between individuals and would therefore be relevant to include in the studied variables when building sociograms in dogs. We thus have investigated if observing the degree of behavioral synchronization between dogs while they are interacting with each other could enable ethologists to evaluate the degree of affiliation between dogs. We suggest that local synchronization can be used as a tool to estimate affiliation between individuals.

Methods

Participants

Thirty-six dogs were recruited in Maisons-Laffitte, France (see Annex Table 1 for more details). The dogs were between 1 and 10 years old (mean ± standard error: 6.53 ± 0.42 years). They all regularly consulted a veterinarian and were up to date with their vaccines and did not show any signs of aging (e.g., eye or joint problems) that could have prevented them from walking, trotting, or running. All selected dogs were used for meeting and interacting with unfamiliar humans and dogs, and were described as friendly with them (they were willing to interact and did not show any signs of stress in social situations with novel humans or dogs).

Table 1
Characteristics of the dogs who took part in the study

Dog’s name	Race	Age (years)	Sex
Apple	Mixed shepherd	5	Female
Arya	Mixed shepherd	8	Female
Astra	Groenendal	9	Female
Bambou	Mixed shepherd	10	Male
Beedle	Pyrenean shepherd	10	Male
Betty	French bulldog	10	Female
Cachou	French bulldog	10	Female
Drop	Golden retriever	8	Male
Ebene	Samoyede	6	Male
Eden	Jack Russell	3	Female
Endy	Bichon	8	Male
Ethology	Jack Russell	3.5	Female
Fancy	Yorkshire terrier	8	Female
Ficelle	Border collie	6	Female
Flèche	Border collie	9	Female
Foufie	Border collie	9	Female
Gringo	Tervueren shepherd	5	Male
Guizmo	Boxer	6	Male
Happy	Jack Russell	3	Female
Jodie	Border terrier	5	Female
Le Pti	Leonberger	7	Male
Léon	Bernese mountain	7	Male
Lina	Mixed shepherd	2.5	Female
Lola	Bernese mountain	2	Female
Maika	Akita inu	1.5	Female
Max	Boxer	9	Male
Méo	Australian shepherd	4	Male
Oréo	Newfoundland	7	Male
Peanuts	Mixed molossoid	6	Male
Pongo	Dalmatian	10	Male
Prince	Australian shepherd	9	Female
Romy	Shih tsu	6	Female
Shinook	Mixed shepherd	5.5	Female
Time	Jack Russell	5	Female
Vanille	Labrador	4	Female
Zelda	Labrador	8	Female

Ethical note

The study was conducted in accordance to the ASAB/ABS Guidelines for the Use of Animals in Research, the legal requirements of France (where it was carried out), and the institutional guidelines of Ethodog. The dogs were neither physically nor psychologically harmed in the course of the study. All the dogs were free to move around within the testing area without any physical constraints. After the test, each of the pet dogs returned to their homes with their owners.

Procedure

Nine groups of 4 dogs were observed while walking together (see Annex Table 2). All walks took place in the same area (see Figure 1) to avoid any differences in behavior due to variations in the landscape. All groups were composed of 2 dogs from the same family (the target dog, D0, and his group mate D1), highly affiliated, and 2 other dogs (D2 and D3) that were unfamiliar both to each other and to the other dogs. All dogs were unleashed and were thus free to move throughout the test area. The owners were instructed not to talk to nor to interact with their dogs to ensure that they were not modifying the dogs’ spontaneous behavior. In addition, owners were instructed to walk very slowly to let the dogs move and interact at their own rhythm. All walks lasted for 15 minutes and followed the same trajectory through the testing area (the same for all dogs, and no coming back, see details on Figure 1).

Table 2
Groups' constitution

Group	Number	Dog's name
1	D0	Le Pti
	D1	Foufie
	D2	Maika
	D3	Guizmo
2	D0	Gringo
	D1	Time
	D2	Happy
	D3	Méo
3	D0	Lola
	D1	Max
	D2	Flèche
	D3	Apple
4	D0	Ethologie
	D1	Beedle
	D2	Oréo
	D3	Ficelle
5	D0	Endy
	D1	Lina
	D2	Prince
	D3	Zelda
6	D0	Shinook
	D1	Eden
	D2	Peanuts
	D3	Vanille
7	D0	Arya
	D1	Léon
	D2	Pongo
	D3	Romy
8	D0	Bambou
	D1	Betty
	D2	Astra
	D3	Drop
9	D0	Jodie
	D1	Cachou
	D2	Ebène
	D3	Fancy

Behavioral analysis

Experimenter 1 recorded D0's behaviors with a focal sampling strategy during the whole walk. Observed variables were as follows: (1) close proximity: time spent by D0 with one part of its body less than 1 meter from D1, D2, and D3 (in seconds); (2) same area: time spent by D0 within a circle of 5 meter radius from D1, D2, and D3 (in seconds); and (3) initiation: when close proximity to a dog is due to D0 initiating the movement, that is, getting in close proximity with the other dog (in occurrences).

Experimenter 2 blind-coded the videos and experimenter 3 did the blind reliability coding. Both of them did not know which dogs were familiar or unfamiliar to each other and ignore the sex and age of all dogs. Experimenter 1 provided only the names of each dogs to experimenters 2 and 3 to ensure that experimenters 2 and 3 were not aware of any information that could have let them know anything about the dogs' previous history. Dogs were not identified by experimenter 1 as D0, D1, D2, and D3. After receiving the coding, experimenter 1 was able to label the data by the correct dogs (D1, D2, and D3), and it was on these data that statistics were performed. The resulting Pearson correlation coefficients were good for all variables (close proximity: 92% agreement, $P < 0.001$; same area: 90% agreement, $P < 0.001$; initiation: 98% agreement, $P < 0.001$).

Statistical analysis

A linear mixed-effects model (LMER) for dependent data was used to test the influence of the dog (D1, D2, or D3) on D0's close proximity, same area, and initiation variables. Where needed, we carried out post hoc comparisons with Holm-Bonferroni corrections for multiple tests. Effect sizes (Cohen's *d*) and 95% confidence intervals (CIs) are provided.

Figure 1. Testing area. Open outside testing area, with green parts representing subareas with grass and trees, and beige parts representing paths crossing the green parts. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Results

Close proximity

Dog D0 spent significantly more time in close proximity to dog D1 (M = 66.26 ± 15.69 seconds, n = 9) than to either dog D2 (M=17.51 ± 4.72 seconds, n = 9) or dog D3 (M =17.6 ± 4.94 seconds, n = 9); LMER: overall effect: $\chi^2 = 21.90$, df = 2, $P < 0.001$. Pairwise post hoc comparisons yielded the following results: D1/D2: $\chi^2 = 11.63$, df = 1, $P < 0.001$ (significant after correction for multiple tests), Cohen's d = 1.40, 95% CI [13.78-83.72]; D1/D3: $\chi^2 = 10.99$, df = 1, $P < 0.001$ (significant after correction for multiple tests), Cohen's d = 1.39, 95% CI [12.72, −84.60]; and D2/D3: $\chi^2 = 0.00$, df = 1, $P = 0.98$, Cohen's d = 0.00, 95% CI [−8.98 to 8.80]; see Figure 2A).

Same area

Dog D0 spent significantly more time in the same area as dog D1 (M = 425.71 ± 41.5 seconds, n = 9) than to either dog D2 (M = 253.68 ± 21.13 seconds, n = 9) or dog D3 (M = 248.46 ± 37.66 seconds, n = 9); LMER: overall effect: $\chi^2 = 30.74$, df = 2, $P < 0.001$). Pairwise post hoc comparisons yielded the following results: D1/D2: $\chi^2 = 21.24$, df = 1, $P < 0.001$ (significant after correction for multiple tests), Cohen's d = 1.74, 95% CI [80.73-263.30]; D1/D3: $\chi^2 = 38.85$, df = 1, $P < 0.001$ (significant after correction for multiple tests), Cohen's d = 1.49, 95% CI [107.69, −246.79]; and D2/D3: $\chi^2 = 0.01$, df = 1, $P = 0.91$, Cohen's d = 0.05, 95% CI [−97.65, 108.10]; see Figure 2B).

Initiation

Dog D0 initiated significantly more close proximity toward the dog D1 (M = 6.88 ± 1.96, n = 9) than to either dog D2 (M = 1.55 ± 0.47, n = 9) or C3 (M = 2.11 ± 0.86 s, n = 9); LMER: overall effect: $\chi^2 = 18.74$, df = 2, $P < 0.001$. Pairwise post hoc comparisons yielded the following results: D1/D2: $\chi^2 = 14.96$, df = 1, $P < 0.001$ (significant after correction for multiple tests), Cohen's d = 1.40, 95% CI [1.96-8.70]; D1/D3: $\chi^2 = 8.34$, df = 1, $P < 0.01$ (significant after correction for multiple tests), Cohen's d = 1.16, 95% CI (0.73-8.70);

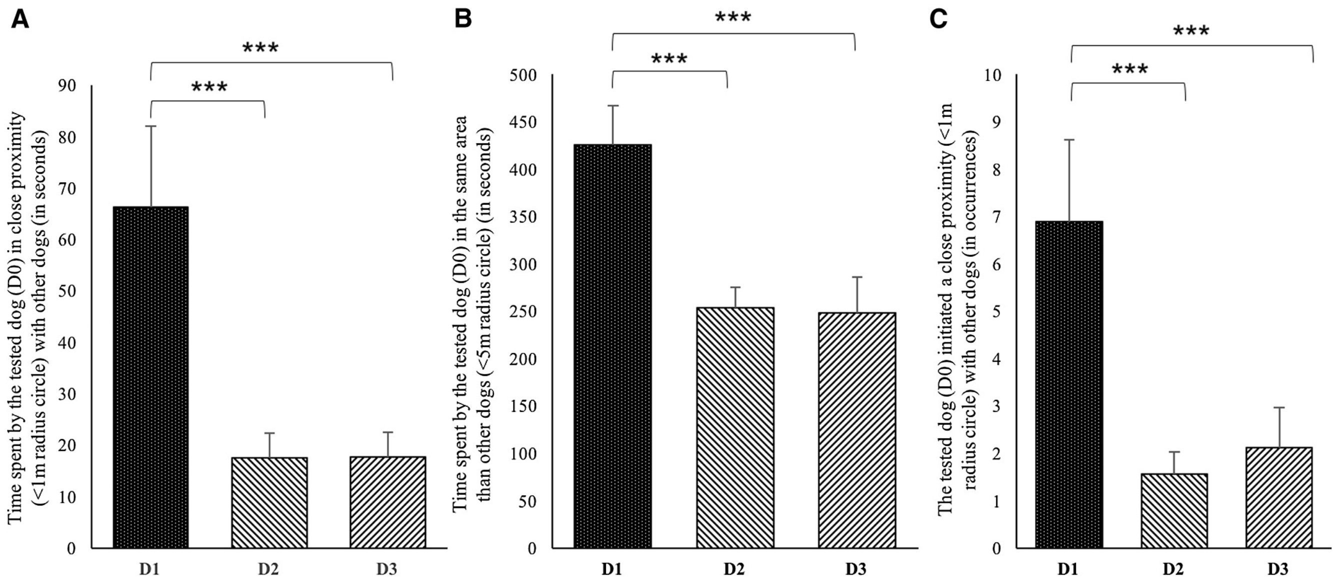

Figure 2. Main results. ANOVAs, ***$P < 0.001$, still significant after correction for multiple tests.

and D2/D3: $\chi^2 = 0.36$, df = 1, $P = 0.54$, Cohen's d = 0.26, 95% CI (−2.83, 1.72); see Figure 2C.

Discussion

The present study showed that when observing a group of dogs interacting together, local synchrony is a relevant tool to assess affiliation between individuals. When allowed to move freely through the testing area, dogs that were closely affiliated with each other spent more time in close proximity to each other, spent more time exploring the same areas together, and initiated more closeness between each other than with those who were less affiliated.

Such findings are in line with previous research supporting that behavioral synchronization is linked to affiliation between dogs and humans (Duranton & Gaunet, 2018) as well as between dogs (Bonanni et al., 2010; Duranton & Gaunet, 2015). This is the first time that local synchrony is validated as a functional tool to assess affiliation when observing interacting dogs. These findings indicate that synchronization and thus affiliation can be used in observational studies in, for example, free-ranging dogs, to add valuable data and help ethologists build sociograms based on affiliative behaviors between individuals (Bonanni et al., 2010; Bonanni & Cafazzo, 2014).

It is important to note that one could have expected to observe the opposite phenomenon. Dogs are considered as a neophilic species, implying that—despite any previous learning—they are attracted to new objects, new individuals, or new aspects of the environment that they had never met before (Greenberg, 2003). One could thus have expected that dogs would have spent more time in proximity to and interacting more with unfamiliar dogs compared to familiar ones, especially during walks. Various studies have described "neophilia" in dogs: puppies aged between 3 to 5 weeks approach unfamiliar objects without any fear-related behaviors (Freedman et al., 1961; Pluijmakers et al., 2010), and adult pet dogs prefer interacting with new toys compared to familiar ones (Kaulfuss & Mills, 2008; Kniowski, 2012). It has been suggested that dogs might be naturally predisposed toward neophilia when there are no other cues to indicate the valence of an object (Kniowski 2012). Comparative studies demonstrate that, when raised similarly, dog puppies and adults are more willing to approach new objects than wolf puppies and adults (Moretti et al., 2015; Marshall-Pescini et al., 2017).

There are significant limitations to these statements: (1) learning experiences can modify neophilia tendencies in dogs (Pyari, 2016); (2) all the cited studies pertained to neophilia toward unfamiliar objects, not toward unfamiliar conspecifics. When facing an unfamiliar conspecific, dogs may have a left-sided bias of tail wagging, which implies a role of the right hemisphere of the anterior brain regions, linked with withdrawal processes (Quaranta et al., 2007). Such aspects were not investigated here. Owners' attitudes may have influenced the dog's behavior through social referencing—the fact that the dog is looking at its owners' reaction toward a stimulus to synchronize its own reaction (Duranton et al., 2016). The owners indeed received instructions that they could not interact with the dogs during the walk: it is plausible that dogs perceived such a behavior as a signal not to interact with the other dogs, as it has been previously demonstrated that an absence of reaction from the owners leads dogs to be less willing to approach and interact with an unfamiliar stimulus (Duranton et al., 2016).

We suggest that such a strong local synchrony observed between affiliated partners is likely due to attachment bonds, even if there are no specific data enabling us to support such a statement at this time. An attachment bond is a close, emotional relationship between two individuals (Bowlby, 1958). Dogs' ability to form attachment bonds with humans (more specifically their owners) has been well studied during the last decades: dogs are considered as being able to form attachment bonds with their owners (Prato-Previde & Valsecchi 2014; Nagasawa et al., 2015; Udell & Brubaker, 2016). Surprisingly, very little is known about intraspecific attachment in dogs, as this field of research has been neglected by ethologists. One preliminary study conducted on attachment bonds between puppies and their mothers evidenced that puppies exhibit attachment toward their mothers, and they consider them as a secure base (Prato-Previde et al., 2009). When considering adult-adult attachments between dogs, to our knowledge, only two studies were conducted. One has shown that adult dogs exhibit more attachment behaviors toward their mother than toward another cohabitant dog (Mariti et al., 2017). The other study failed to evidence clear attachment behaviors between dogs living in the same household, although the authors highlighted that dogs were less stressed when they were in the presence of a cohabitant dog (Mariti et al., 2014). These failures are surprising as, based on what is known in mammals, dogs living together and spending a lot of time together are likely to develop attachment bonds (Cairns, 1966). Two of the essential criteria needed to identify attachment are the ability to discriminate between individuals, and the demonstration of a special behavior shown toward the specific individual of attachment (Bowlby, 1969). Dogs do have the ability to discriminate between an unfamiliar and a cohabitant dog and behave differently toward the cohabitant (i.e., they exhibit prosocial behaviors only toward their cohabitant dog [Quervel-Chaumette et al., 2015]). Thus, the ability to form attachment bonds between adult dogs appears plausible. Because the more two individuals are synchronized, the more they are affiliated (Duranton & Gaunet, 2018), we suggest that, as a first step, investigation of the existence of attachment bonds between pet dogs has to be done between partners exhibiting high level of behavioral synchronization, to ensure that they are strongly affiliated. We also think that the present study could add a relevant tool to estimate the existence of attachment between adult dogs and encourage further research to incorporate observations of behavioral synchronization (with at least local synchrony) as an indicator of affiliation, and maybe attachment, between dogs.

Finally, our findings also have applied consequences for both pet and shelter dogs. Pet dogs are captive animals that cannot choose their living place nor the other dogs they live with. Dogs within the same household may have conflicts leading to aggression and injuries (Sherman et al., 1996; van Kerkhove, 2004). We suggest that using behavioral synchronization as a tool to identify the degree of affiliation between dogs of the house could help to have a better understanding of the social organization between them, to identify the affinities between individuals, and thus to better manage them. Behavioral synchronization, by helping identifying affiliation between group members could also be a useful tool to help managing free-ranging dogs to improve the security of both humans and dogs when relevant (Wright, 1991; Ostanello et al., 2015). In addition, it is relevant to know that dogs are capable of social learning through interactions with conspecifics (Pongrácz et al., 2001; Kubinyi et al., 2009), and more importantly that the similarity of behavior between interacting dogs is a precondition for social learning to occur (Kubinyi et al., 2009). In other words, behavioral synchronization, particularly local synchrony and affiliation, between cohabiting dogs may be a useful tool to increase training efficiency. We suggest using behavioral synchronization as a tool to estimate which dogs are most likely to be involved in social learning together to improve the efficiency of learning a new task for, for example, working dogs, even from early ages (Slabbert & Rasa, 1997) or to reduce fear in a dog through social facilitation, emotional contagion, or observational learning from a highly affiliated referent dog (Moretti et al., 2015; Quervel-Chaumette et al., 2016). When considering shelter dogs, it is known that behavioral synchronization of a dog with a potential adopter increases the likelihood of adoption (Protopopova & Wynne, 2014), but nothing is known about its role with the other dogs of the house, if applicable. We propose that, during preadoption visits, observing the degree of behavioral synchronization between the dog and other dogs from the house of the potential adopter could be a useful tool to evaluate the potential of a successful adoption.

Acknowledgments

The author is grateful to the owners and their dogs for participating in the present research. Special thanks go to Manon Corneille for her help when video recording the tests, to Guillemine Gosset for the video coding, to Marie Legain for the reliability coding, and to Dr. Jessica Rock for her useful corrections and suggestions.

Ethical considerations

The study was conducted in accordance to the legal requirements of the country for animal welfare, Rural Code Article R214-17, and of the official French Legal Code of Animals (2018). The study was observational and the dogs were neither physically nor psychologically harmed in the course of the study. The dogs did not undergo any physical intervention. The owners confirmed that they were voluntarily participating in the study and knew that they could stop at any time.

Conflict of interest

The author declares that there is no conflict of interest.

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