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The perception of dogs' behavioural synchronization with their owners depends partially on expertise in behaviour

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ABSTRACT

Dogs' behavioural synchronization with humans is a new field of research in canine cognitive science. It has important societal implications, as dogs' propensity to mimic their owners' movements and reactions can be used as a tool to manage pets in public areas and ensure that they react appropriately when meeting third parties (humans or other dogs). To ascertain whether nonexperts can accurately assess dogs' behavioural synchronization with humans, we conducted a citizen science project via a website. A total of 731 nonexpert volunteers rated videos of dogs' behavioural synchronization with their owners while the two moved freely indoors. Interestingly, although synchrony was rated lower by the nonexperts than by the experts in canine ethology, the former understood behavioural synchronization and processed its changes similarly to the latter. Finally, all nonexperts evaluated behavioural synchronization similarly, indicating a robust perception of this synchronization across respondents.

1. Introduction

Dog-human interactions have been intensively studied over the past few decades (see, for example, Bensky et al., 2013, for a review). Dogs are skilled in using ostensive human communicative signals, such as pointing or gazing (see Duranton and Gaunet, 2015, for a review), and actively communicate with humans to ask for help (Gaunet and El Massioui, 2014; Miklósi et al., 2000, 2003; Savalli et al., 2014, 2016). These abilities foster the dyadic bond (Horn et al., 2013). In the two situations described above, the partners consciously interact with each other, but another kind of interaction can also take place between dogs and humans, and plays an essential role in maintaining bonds. Nonconscious interactions occur without the awareness or conscious decision of the dyadic partners (Duranton et al., 2016, 2017b). One of these types of interactions is nonconscious behavioural synchronization or mimicking, which is commonly observed in a number of species (see Duranton and Gaunet, 2016a, for a review), and has recently been demonstrated at an interspecific level, between dogs and humans (Duranton et al., 2016, 2017a,b,c).

Behavioural synchronization can be broadly defined as performing the same action/behaviour as others, at the same place and the same time (Duranton and Gaunet, 2016a). It is now acknowledged that freely moving dogs synchronize their behaviour with humans in a variety of situations, even if the degree of synchronization observed is dependent on the affiliation between the interacting partners (see e.g. Duranton et al., 2017a). In an enclosed room with no stimulation, dogs go where their owners go, walk when their owners walk, and stop walking when their owners stop walking (Duranton et al., 2017b). In open outdoor areas, dogs also synchronize their movements with those of their owners, staying still or moving according to their owners' actions, and even synchronizing their walking speed (Duranton et al., 2017c; see also Gaunet et al., 2014), for synchronization during walks in urban areas). Finally, dogs synchronize their reactions with those of their owners in more complex situations too, such as facing an unknown and ambiguous object (Merola et al., 2012) or encountering an unfamiliar person (Duranton et al., 2016). In all these studies, the owners never asked their dogs to follow them, walk or stay still, or react in a particular way, and all dogs were off the leash, free to move. Thus, dogs spontaneously synchronized their movements and activities with those of their owners, helping to maintain affiliative bonds between the dyadic partners. Finally, humans are known to develop a social preference for dogs that synchronize with them (playing when they play, resting when they rest, lying close to them) even if they are unaware of it (Protopopova and Wynne, 2014).

Dogs' propensity to mimic their owners' reactions can be used by the latter as a tool for managing them in public areas (Duranton et al.,

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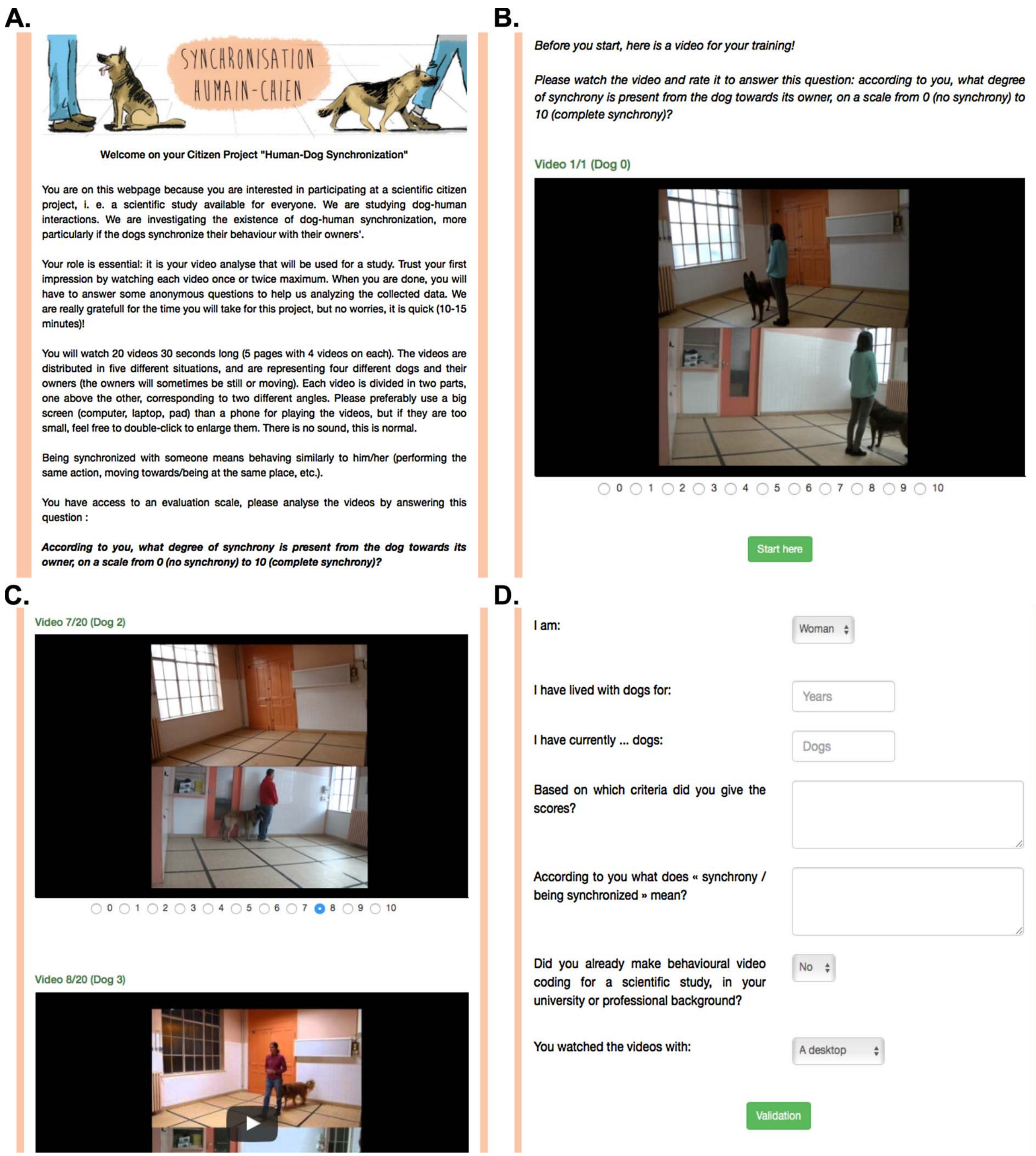

Fig. 1. Sample pages of the citizen science project's website (www.dog2human-synchrony.fr). A. Instructions to volunteers about their role in the study. B. Training video. C. Examples of test videos. D. Anonymous questionnaire.

2016), such as guiding their dogs' reactions when they encounter new people (Duranton et al., 2016). If people are to be taught to use this tool in an appropriate way, it is important to ensure that nonexpert members of the public observe and interpret dogs' behavioural synchronization similarly to expert academics (i.e. presumably the most knowledgeable dog behaviour professionals). *Expertise* refers to the manifestation of skills resulting from the accumulation of a large body of knowledge in a specific field (Chi, 2006). So far, in studies investigating dogs' synchronization with humans, the data have always been analysed by expert scientists trained in video coding (e.g., Duranton et al., 2016, 2017a,b,c). It is thus essential to verify that scientific findings are consistent with the observations and interpretations of nonexpert members of the public, and can be effectively used by the latter (Hecht and Spicer Rice, 2015).

The present study was designed to check that members of the general public interpret behavioural synchronization similarly to professional researchers. To this end, we took videos from Duranton et al. (2017b) and asked nonexpert volunteers to analyse them using a simplified rating scale. Experts and members of the general public are both able to determine dogs' facial expressions from photos (Bloom and Friedman, 2013), and can also identify individual dogs of the same breed from photographs of their whole bodies (Diamond and Carey, 1986; Exp. 2 and 3). Nor do they differ when describing dogs' general behaviour from videos (Tami and Gallagher, 2009). Another study comparing experts' and nonexperts' ratings of canine behaviour reported good levels of inter-observer reliability and criterion validity. The authors concluded that nonexperts' ratings of behaviour can be a viable alternative to experts' ratings (Fratkin et al., 2015), under certain circumstances, i.e. when coding for behaviour not including interactions with humans. We therefore hypothesized that members of the general public rate synchronization similarly to trained expert scientists. We also investigated whether individual parameters, such as sex or familiarity with dogs, influence the nonexperts' ratings.

2. Methods

2.1. Participants

A total of 731 anonymous volunteers (90% women) took part in an online citizen science project between the 1st of November 2017 and the 31st of December 2017. They were recruited via social media, as well as via scientific blogs and websites. At the time of the study, 84% of participants owned at least one dog, had done so for an average of 20.75 ± 0.5 years, and 90% had never previously performed a video analysis.

2.2. Experimental material

Videos utilized previously by Duranton et al. (2017a) were used for this study during two phases. In the training phase (control condition), all participants were shown the same video (see details below). In the test phase, participants were shown 20 videos in a randomized order to avoid any order effects. To avoid biases, the videos featured five different shepherd dogs of similar shape in both the training (one dog) and test phases (four different dogs with their owners; 3 female owners and 1 male owner). No information about the dogs (e.g., name, sex or age) was provided.

Each video showed one dog and its owner in an enclosed room, in one of five different situations (control, still, move, still-move, and move-still). In the control condition, the owner went to the centre of the room and stayed still for 30 s. In the still condition, the owner went to a predefined location on the right or left side of the room (side randomly assigned, but counterbalanced across the dogs) and remained still for 30 s. In the move condition, the owner went to a predefined location on the right or left side of the room (side randomly assigned, but counterbalanced across the dogs) and started to walk up and down the room. After 30 s, the owner stopped wherever he or she happened to be. In the still-move condition, the owner went to the centre of the room and stayed still for 15 s, then walked up and down the room for 15 s. At the end of this time, the owner stopped wherever he or she happened to be. In the move-still condition, the owner went to the centre of the room and walked up and down for 15 s, then stopped in the centre of the room and stayed still for 15 s.

2.3. Website

When logging onto www.dog2human-synchrony.fr, participants were prompted to choose their language (English or French), prior to the initiation of the test. The first page contained instructions about the participants' role in the study (Fig. 1A). They were asked to make a general assessment of the synchronization between dogs and owners, that is, without distinguishing between activity synchrony (is the dog doing the same thing as the owner?) and local synchrony (is the dog going to the same place as the owner?), and to avoid any complex analyses that might bias their answers (Hecht and Spicer Rice, 2015). After reading the instructions, the participants were redirected to the page featuring the training video (Fig. 1B). After clicking on the start button, participants were redirected to a series of pages where they were asked to rate 20 videos. After watching each video, participants were asked to rate the dog's degree of synchronization with its owner on a scale ranging from 0 (*no synchrony*) to 10 (*perfect synchrony*) (Fig. 1C). After rating all 20 videos, respondents were directed to a final page containing an anonymous questionnaire about their sex, previous experience with dogs (number of years living with dogs and number of dogs owned at the present time), any previous experience of video coding. They were also asked two open questions about the criteria they used to rate the degree of synchronization between dog and human, as well as their definition of being synchronized/synchrony (Fig. 1D). As both questions were open, each participant could answer freely, and the sum of the percentages for references to the different lexical categories could potentially be more than 100% (respondents could refer to 0 or more categories in a single answer).

2.4. Data analysis

We calculated the mean ratings for each of the videos by the nonexperts.

According to the volunteers' answers, it appeared that the experts' analysis of the time each dog spent in proximity to its owner with the software Actogram (data extracted from Duranton et al., 2017b) could be equated with the nonexperts' coding of its degree of synchronization. Indeed to remain close to its owner, the dog had to perform the same activity, go to the same place, and switch between activity at the same time as its owner. Time spent in proximity was therefore a good indicator of the dog's general behavioural synchronization, as the volunteers often answer that they used it as an indicator to rate the videos. We thus converted this time into a percentage (e.g., 27.3 s out of 30 s represented 91% of the time spent in close proximity to the owner). This percentage was then converted into a score that was directly comparable with the volunteers' mean rating for each of the 20 videos (e.g., 91% corresponded to a score of 9.1 on the 10-point scale). In Duranton et al. (2017b), two researchers rated the video (one expert validated by another expert): one 100% of the videos, and another rated 40% of the videos. All scores of the researchers were strongly correlated (time spent in proximity to the owner: 98% agreement, for more details, see Duranton et al., 2017b), confirming the latter's reliability.

2.5. Statistical analysis

First, we investigate the lexical used by volunteers to define behavioural synchronization. To assess whether the nonexpert volunteers understood behavioural synchronization similarly to the expert scientists, we undertook a text mining analysis using Perl language to classify and describe the terms they most frequently used to answer the two open questions (see Supplemental Information for more details).

Second, we investigated the potential effects of different parameters on the volunteers' coding. To test the effects of situation and individual parameters (sex, experience with dogs, experience of video coding) on participants' scoring of the videos, we used a linear mixed model for independent data on R software (version 3.2.0). Where needed, we carried out post hoc tests, applying the Holm-Bonferroni correction for multiple comparisons.

Third and last, we investigated if experts and nonexperts rated the video similarly. To compare the nonexpert volunteers' mean score with the expert scientists' score for each video, as well as for each situation (all four dogs pooled) and each dog (all five situations pooled), we used permutation tests for independent data on R software. We also analysed correlations between experts and nonexperts' scores (i.e. did they score higher/lower the same videos), still using R software.

3. Results

3.1. Description of vocabulary used by the nonexpert volunteers

The terms used by the nonexpert participants to define behavioural synchronization could be divided into eight categories, including four identified by Duranton et al. (2017a): broad terms, action, timing, and location. Interestingly most participants (60.33%) used broad terms, such as *same*, *together*, *synchrony*, *simultaneous*, *identical*. Some (39.12%) provided action terms, such as *action*, *activity*, *coordination*, *adjusting*, *mirroring*, *matching*, and some (32.97%) timing terms, such as *time*, *moment*, *simultaneously*, *changing*, *pace*, while 15.05% referred to location, using terms such as *place*, *location*, *crowding*, *close*, *following*. The four other categories were visual attention (17.78%), with words such as *attention*, *tuned*, *focusing*, *checking*, *watching*, emotional relations (10.40%), with words such as *bond*, *connection*, *harmony*, *complicity*, imitation (6.02%), with words such as *imitation*, *copying*, *mimetic*, and anticipation (4.10%), with words such as *anticipate*, *expecting*, *understanding*.

The criteria used by participants to rate the videos could be divided into three categories identified by Duranton et al. (2017a): activity synchrony (50.27%), with words such as *walking*, *motion*, *locomotion*, *still*, *time*, *changing activity*; location synchrony or proximity (33.20%), with words such as *path*, *position*, *close*, *proximity*, *distance*, *follow*; and gazing activity (52.87%), with words such as *look*, *gazing*, *focus*, *attentiveness*.

3.2. Individual factors influencing nonexperts' ratings

Our results failed to reveal any effect of individual factors on the nonexpert volunteers' ratings of the videos (LMERs, sex: $p = 0.07$, $F = 3.68$, $df = 1$; years of dog ownership: $p > 0.17$, $F = 3.11$, $df = 1$; number of dogs in the household: $p = 0.11$, $F = 2.44$, $df = 1$; previous experience of video analysis: $p = 0.36$, $F = 0.83$, $df = 1$). We found no effect of either situation ($p > 0.35$, $F = 4.41$, $df = 4$,) or dog ($p = 0.35$, $F = 3.29$, $df = 3$) on participants' ratings.

3.3. Comparison with expert scientist's ratings

We found a good correlation between expert's versus nonexperts' scores across videos (Pearson's correlation on the 20 videos, $r = 0.62$, $p = 0.003$, 95% CI [0.24, 0.83]). However, we found that nonexperts provided lower mean scores ($M = 7.01 \pm 0.05$) than the expert (LMER, 8.94 ± 0.035, $p < 0.001$, $F = 23.11$, $df = 1$). Details of the scoring per dog and per situation are provided in Table 1.

4. Discussion

The present study showed that nonexperts appear to use similar words and lexical categories as experts to define and rate behavioural synchronization. However, we found that although the mean scores provided by the experts versus the nonexperts were positively correlated and thus varied similarly, the nonexperts rated the synchrony differently from the experts. Our working hypothesis was thus partially confirmed, and we argue that it was because of the difficulty of the task (i.e., processing the activity of two individuals from different species and computing its similarity).

Table 1
Scores of experts and nonexpert volunteers.

Video	Nonexperts	Experts
Dog 1	6.50 ± 0.05	8.93 ± 0.40
Dog 2	8.21 ± 0.05	9.88 ± 0.11
Dog 3	6.04 ± 0.06	7.50 ± 1.06
Dog 4	7.29 ± 0.05	9.43 ± 0.51
Situation 1	7.26 ± 0.06	9.77 ± 0.23
Situation 2	7.41 ± 0.05	8.39 ± 1.60
Situation 3	7.65 ± 0.04	9.01 ± 0.51
Situation 4	6.38 ± 0.05	9.21 ± 0.43
Situation 5	6.33 ± 0.05	8.30 ± 0.58
General	7.01 ± 0.05	8.94 ± 0.03

For the nonexpert volunteers, results are provided as mean scores ± standard error. For the expert, results are provided as estimated scores ± standard error. The data are provided per dog (all conditions pooled) and per condition (all dogs pooled). Situation 1 = control condition; Situation 2 = still condition; Situation 3 = move condition; Situation 4 = still-move condition; Situation 5 = move-still condition.

We found that the nonexperts rated the behavioural synchronization shown in the videos lower than the experts did. It may be that their lack of specialized knowledge made them failed to realize the strength of the behavioural synchronization they observed, and rated it lower than the expert did, i.e. closer to the mean level. It is also possible that as they were asked to rate the videos in a more general way than the experts (who used a video coding software and had the possibility to slow down the video and thus be more accurate), they were less sensitive to the actual behavioural synchronization. The present result is consistent with the finding that experts and nonexperts perform similarly when asked to determine dogs' identities in easy tasks featuring single behaviours (Fratkin et al., 2015; Tami and Gallagher, 2009) or upright pictures (Diamon and Carey, 1986), but diverge when the task is more complicated (e.g., pictures inverted; Diamond and Carey, 1986; Exp. 2 and 3). Experts are assumed to be more sensitive to details than nonexperts, when it comes to their field of expertise (Wan et al., 2012). Also, fMRI studies revealed that the ability to detect change in dog behaviour is significantly better in experts of canine behaviour compare to nonexperts (Kujala et al., 2012). Such findings are thus consistent with the difference we found in the present study. However, we found a positive correlation between variations in the expert's and nonexperts' scores, as both rated the same videos higher, and the same videos lower. Changes in dogs' behaviour were therefore perceived similarly by the experts and the nonexperts alike, in line with our finding that the experts and nonexperts used similar words and lexical categories to describe the behavioural synchronization. This is an essential finding, as in real life, when citizen are encountering dogs and owners, they have to directly evaluate the situation, and cannot analyse it as accurately as scientist with softwares. It is thus a strong result that we observed similar coding in the variation of behavioural synchronization, meaning that nonexperts, similarly than experts, are able to assess whether a dog-human dyad is exhibiting behavioural synchronization, and can thus potentially adjust their own behaviour accordingly.

We did not observe any influence of the nonexperts' individual parameters on the way they rated the videos. It is unlikely due to a floor effect, as the task was considered as difficult, and if there had been a floor effect, we would not have observed a difference from the experts' ratings. It is more likely that the behavioural synchronization was clear enough to be robust for all of the nonexperts, whatever their age and experience with dogs. It is consistent with the fact that being sensitive (even unconsciously) to behavioural synchronization is widespread in mammals, including humans (Duranton and Gaunet, 2016). In humans being sensitive to others' behavioural synchronization has various adaptive values such as allowing one to understand the social relationship among other individuals and to adjust one's behaviour accordingly (see e.g. Fawcett and Tunçgenç, 2017). However, it is worth mentioning that 90% of the participants were women in the present study. Such a high percentage is representative of the fact that most owners participating in scientific studies in canine science (when the authors provided the information) are women (see e.g. Duranton et al., 2016; Fratkin et al., 2015; Gaunet and Milliet, 2010; Miklósi et al., 2000; Soproni et al., 2001). Such a high proportion of women could also explain the high sensitivity to dogs' behaviour observed among the nonexperts, as it is proposed that women are more experienced at observing dogs' behaviour (Hennessy et al., 1998; Kidd and Kidd, 1989). Maybe that counterbalanced sex ratio could have revealed a sex effect in the nonexperts rating of behavioural synchronization, with a possible higher scores in women compare to men. However, more recently it has been evidenced that women and men interest, affiliative behaviours and attachment towards dogs did not differed (Prato-Previde et al., 2006), which is consistent with the absence of sex effect we found in the present study. Nevertheless, to disambiguate the role of owner's gender, we encourage further citizen science studies to better control for the sex ratio among participants. Additionally, we did not find any effect of citizen's experience with dogs (e.g. number of dogs owned, or number of years living with a dog) on the way they rated behavioural synchronization. This is in contradiction with recent findings evidencing that in complex tasks such as assessing behavioural cues associated with different dogs' emotional states, experience of raters influenced the number of features they were paying attention to, and the level of experience with dogs predicted the identification of fear (Wan et al., 2012). However, the authors also found that when it comes to more neutral or positive situations, experience with dogs does not influence citizen's perception of dogs' behaviour (Wan et al., 2012). This is consistent with the fact that in the present study, dogs were not stressed nor fearful, explaining why all citizen coded similarly whatever their previous experience with dogs.

Finally, the high number of participants in only 2 months reveals the interest of citizen science for citizens themselves, emphasising that citizen are interested in better understanding dogs' behaviour. Additionally, the topic of the present study, about behavioural synchronization, evidenced citizens' ability in judging the nonverbal behaviour of dogs. Indeed, the nonexperts processed the variations in behavioural synchronization similarly to the expert scientists. The results were reliable, even if the strength of the synchronization was evaluated differently between the nonexpert volunteers and expert scientists. All nonexperts evaluated behavioural synchronization in a similar way, consistent with a robust perception across the sample, whatever their previous experience with dogs. Such a skill can be used to draw the attention of people on dog's behaviour with their owner (see also Tami and Gallagher, 2009). This is essential if we are to establish guidelines that members of the general public can use, such as the importance of simultaneously considering the behaviour of the dog and its owner, and not just the dog's, when meeting a new dog or person for the first time. It has direct applied implications for example when walking in outside public areas. It is known that there are often problems with people misunderstanding dogs' behaviour that can lead to biting and other aggressive behaviours when in public areas (e.g. Cornellissen and Hopster, 2010). If a citizen is encountering a dog-owner dyad for the very first time, observing if the dog is synchronized with the owner will provide useful information: for example, the degree of synchronization indeed informs about the strength of the bond between them, and thus indicates the potential controllability of the dog by its owner (see also Duranton et al., 2016, 2017b). Also, we can propose that being sensitive to, and able to evaluate the degree of behavioural synchronization among a human and a dog is usefull for shelter staff. Indeed, it is known that a high degree of behavioural synchronization is linked with a high affiliation (see e.g. Duranton and Gaunet, 2015; Duranton et al., 2017a). Thus, we recommend shelter staff to observe the behaviour of the dogs towards the potential adopters, and to favour adoptions of dogs who exhibit some degree of behavioural synchronization towards them.

To conclude, the present study emphasizes the societal relevance of citizen science in assessing nonexperts'skills at analysing canine behaviour, and evidences the consistency between scientific studies and applied canine behaviour when interacting with humans.

Conflict of interest

The authors declare that there is no conflict of interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.applanim.2017.11.004.

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