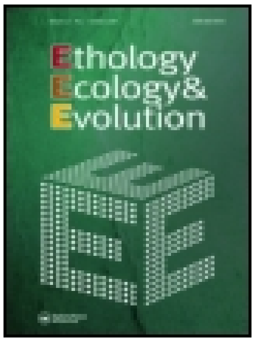

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Self-consciousness: beyond the looking-glass and what dogs found there

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Forum

Self-consciousness: beyond the looking-glass and what dogs found there

The state of the art of animal cognition and awareness studies

Self-recognition, that is, the recognition of one's own self, has been studied mainly by examining animals' and children's responses to their reflections in mirrors (Gallup et al. 2002). The definitive test is whether or not a subject is capable of using the reflection to notice and respond to a mark on the face, head or other parts of the body by touching the mark (Bard et al. 2006). The mark, which is placed on the subjects when they are distracted or under anaesthesia, is only visible to the subject when they look at themselves in a mirror. The basic idea behind the test is that the subject who understands the concepts of "self" and "others" can differentiate between the two, and can recognize himself in the reflection (Swartz et al. 1999). Based on these results other behavioural skills can be inferred, e.g. empathy (Bischof-Köhler 2012).

Indeed, the capacity to differentiate one's own self from others is often thought of as a prerequisite for understanding that someone else might be happy or sad, even if the beholder is not (Turner 1982). As a general pattern, studies agree that this response increases with age and could decline in old age (Bischof-Köhler 2012).

However, the ability to recognize oneself in a mirror is an exceedingly rare capacity in the animal kingdom (Bekoff & Sherman 2004). Up to now, only great apes (including, of course, humans) have shown extremely convincing evidence of mirror self-recognition (Povinelli et al. 1993). Moreover, the mirror test can yield false negatives because if an individual fails the test it does not necessarily mean that the species is not self-conscious (Bekoff & Sherman 2004).

The first evidence for self-awareness in a nonhuman species was experimentally demonstrated in the common chimpanzee (Gallup 1970), but numerous subsequent attempts showed no convincing evidence of self-recognition in a variety of other primates and non-primates, including monkeys, lesser apes, African gray parrots, one species of spider and elephants (Clark & Jackson 1994; Westergaard & Hyatt 1994; Pepperberg et al. 1995; Plotnik et al. 2006; Prior et al. 2008). All of these species demonstrate the ability to use a mirror to mediate or guide their behaviour. As of 2015, only the great apes (excluding gorillas), a single Asiatic elephant, dolphins, the Eurasian magpie and some ants (Cammaerts & Cammaerts 2015; Hill et al. 2015; Ma et al. 2015), have passed the mirror self-recognition (MSR) test. A wide range of species have been reported to fail the test, including gorillas, several monkey species, giant pandas, sea lions, pigeons and dogs (Delfour & Marten 2001; Ma et al. 2015). The social ecology, ethology and neurobiology of other species have been investigated since the acknowledgment of the apparent confinement of self-recognition to great apes and humans (Parker et al. 1994; Gallup 1997).

Dogs, in particular, showed no interest even in watching the mirrors, but they usually sniff or urinate around them (De Waal et al. 2005) or use them to solve a problem (Howell & Bennett 2011; Howell et al. 2013). Dogs and wolves, like dolphins, show a high level of behavioural and cognitive complexity (Connor et al. 1992; Marino 1998; Reiss & Marino 2001), but previous attempts to demonstrate self-recognition in these animals have been inconclusive because of difficulties in implementing and interpreting adequate controls necessary to obtain robust evidence from the mirror test in animals unable to display self-recognition by touching a marked part of the body with a hand, even if they could display something like MSR with other parts of the body (Marten & Psarakos et al. 1994; Taylor Parker et al. 2006).

In this study I suggest a new approach, which can shed light on different ways to check for animal cognition and open a renewed discussion on self-awareness.

I argue that, dogs being considerably less affected by visual events than are humans and most apes (Bekoff 2003), it is likely that the failure of MSR in dogs and other animals is due to the sensory modality used to test self-awareness. Some attempts to verify this idea have been previously realized, but most of them were only observational or lacked empirical and further proofs and, overall, were carried out on only one individual at a time (e.g. Bekoff 2001 used a "yellow snow test" to measured how long a dog sniffed his own vs other dogs' urine patches. The experiment was conducted with only one subject, the author's own dog, and not repeated with other individuals, particularly with other dogs of different sex and age).

Therefore, conclusive evidence of self-recognition in a species as phylogenetically distant from primates (i.e. with different display and sensory modality) as dogs was not reached (Bekoff 2003).

Here I show that, even when checked on different individuals living in a group, and with different age and sex, the sniff test of self-recognition (STSR) provides significant evidence of dogs' self-awareness and can play a pivotal role in demonstrating that this capacity is not a feature specific to great apes and humans (and few other animals), but depends on the way researchers test it.

An alternative test for dog self-cognition

Data reported in this study were collected once per season during 2010 (four replicates) and then elaborated after the stimulating, but uncertain and potentially affected by bias, evidence proposed on the same topic by Bekoff in 2003. I employed for the test four mongrel domestic dogs (*Canis familiaris*): one (vasectomized) male 10 years old, and three (ovariectomized) females 3, 7 and 9 years old. All the dogs were stray until they were 1 year old, at least, and then they were grown in semi-freedom (winter inside and summer outside a private-non-commercial enclosure). The test site was an open-air enclosure of 200 m^2 where these animals have been living during the previous few years (at least 8 months per year). Urine samples of each dog were collected, once per season, by pressing absorbent cotton, using latex gloves (and taking precautions to minimize odour cues), on their urinary organs at the end of each urinary episode during 2 days preceding the test. The samples of each dog were preserved in sterilized, closed, airtight containers, at a temperature of 5 °C, for the 2 days of collection. Twenty urine samples on absorbent cotton for each dog were collected, divided and preserved in five containers associated to each Dog ID, every season.

The third day, after the 2 days of collection, the animals were submitted to the test. I repeated the test 4 times during the year, at the beginning of each season. This test consisted of a modified version of the MSR, carried out to check olfaction, and not vision, as the main sense for self-awareness.

The four dogs were taken out of the enclosure, and five containers (with ID numbers referring to each dog) were randomly placed and fixed in holes in the ground, along a line 1 m distant from each other, inside the cage. Four out of five contained urine samples of each dog and one was a "blank sample", filled only with absorbent cotton and no urine smells. The containers were then opened.

Each dog was introduced alone into the cage, released 3 m from the samples and then left free to move for 5 min (Fig. 1). From that moment the time spent by each dog sniffing (or being interested in, measured by proximity: closer than 10 cm to) each sample was recorded with a stopwatch by two observers, one taking the time and the other noting the values referred to each sample. The total time (in seconds) spent by each dog sniffing each sample was calculated irrespective if it was continuous or split into different episodes during the 5 min.

The presence of only one male reduced to zero the times he urinated over (scent-marked) the samples, any competition with other males being absent. Similarly, no episode of urination over females' urine samples by the male, or the opposite, was recorded.

Before bring in the next dog, the five samples were replaced by new ones with the same scheme mentioned above (4 + 1). The dogs taken outside the enclosure were not allowed to watch inside to avoid any visual influence.

After testing the four dogs in isolation (the male was the last in every season), a final replicate of the five samples (4 + 1) was introduced and the dogs were allowed to enter together within the enclosure. The behaviour of the dogs during this final round was observed for 5 min, without recording the time spent by each dog around samples.

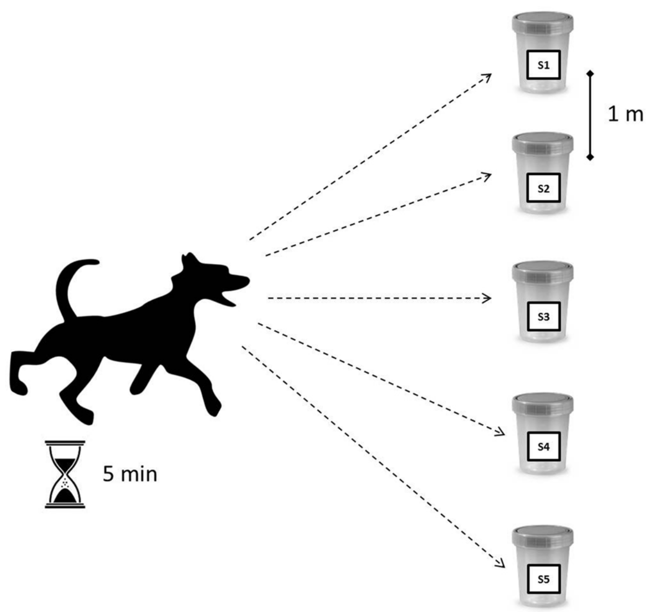

Fig. 1. — A simplified representation of the test. S: sample, with the respective reference number.

A χ^2 test $\left(= \sum \frac{(O-E)^2}{E}\right)$ was calculated to test the observed (O) mean time spent by each dog sniffing the samples, and the expected (E) values (i.e. H_0 = interaction time spent smelling is identical for all the samples). The correlation coefficient and t-test were calculated to check a potential relation between age and total percentage of time spent smelling (whether interest towards the samples was age-dependent). Finally, a Student's t-test was calculated to check the significance of the mean time spent by females sniffing the male's vs other females' samples.

Evidence of dogs' self-cognition

The association between each dog (the three females D1, D2 and D3 at 7, 3 and 9 years old, respectively, and the male D4, 10 years old) and the containers [i.e. sample 1 (S1) contained the urine sample of Dog 1 (D1); sample 2 (S2) contained the urine sample of dog 2 (D2); and so on] is reported in Table 1 as mean values averaged among the 4 recording times (seasons). Sample 5 (S5) is the control sample ("blank sample").

Table 1.

Mean time spent by each dog (D) sniffing each sample (S) during the 5 min. SD = standard deviation.

Dog ID	Sample ID	Mean time sniffing (sec)	Mean time sniffing (SD)
D1	S1	13.2	2.1
D1	S2	27.9	3.7
D1	S3	28.7	4.1
D1	S4	33.1	2.3
D1	S5	11.5	1.8
D2	S1	22.1	2.9
D2	S2	10.8	1.5
D2	S3	23.5	2.1
D2	S4	27.3	2.7
D2	S5	13.7	1.8
D3	S1	34.2	3.2
D3	S2	24.8	2.6
D3	S3	17.4	1.4
D3	S4	34.4	2.7
D3	S5	14.6	1.3
D4	S1	41.1	4.3
D4	S2	26.7	3.3
D4	S3	41.8	3.8
D4	S4	16.3	4.1
D4	S5	24.7	3.2

Table 2.

χ^2 test calculated for each dog's observed vs expected interaction time with samples (significant values with $P < 0.01$ are in bold; D2 value is significant with $P < 0.05$). Percentage of total time (over a total 5 min) and mean time spent sniffing all the samples by each dog (and standard deviation, SD) are reported, together with age and sex.

Dog ID	χ^2 test (P = 0.05)	Mean time sniffing all the samples (sec)	Mean time sniffing (SD)	Total time sniffing all the samples (%; 5 min)	Age	Sex
D1	**17.19**	22.88	9.83	32.69	7	F
D2	9.90	19.48	6.94	27.83	3	F
D3	**13.51**	25.08	9.20	35.83	9	F
D4	**16.24**	30.12	11.06	43.03	10	M

After checking with the χ^2 test (Table 2), the associations between the time spent by each dog and the samples show high significance ($P < 0.01$) for D1, D3 and D4, and significance ($P < 0.05$) for D2. Moreover, D2 was the dog who spent a lesser percentage of time sniffing during the 5 min.

I also plotted the age of each dog against the percentage of time spent sniffing (or being interested in) all of the samples (Fig. 2) for a correlation analysis.

The correlation between age and interest towards the sample is significant (r = 0.92; $t_{g.d.l.=6} = 5.84$, $P < 0.05$).

Finally, I checked a potential relation between the time spent by females sniffing the samples of other females and the time they spent to sniff the sample of the male (Table 3). Even if there is a prevalence in the mean time spent by females sniffing the male's rather than other females' samples (31.6 ± 9.62 sec vs 26.87 ± 7.01 sec), the difference is not significant (t = 0.37, $P > 0.05$).

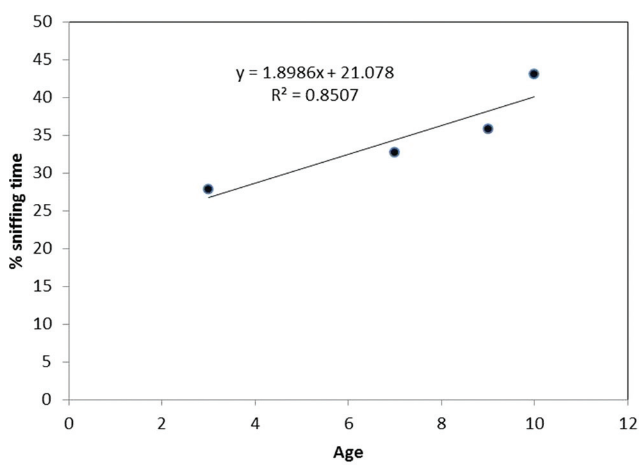

Fig. 2. — Correlation between the age of the dogs and the percentage of time spent being interested in the samples; x-axis: age; y-axis: % time sniffing. R^2 and regression equation are reported.

Table 3.

Mean time spent by females sniffing male's vs other females' sample. The table should be read from the first column (female group, F; mean) towards the first (male's samples, M) and the second (females' samples, F) line. SD = standard deviation; ↓ = "towards".

	F (↓)	SD	t-test
M	31.6	9.62	0.37
F	26.87	7.01	$P < 0.05$

Are dogs self-aware and self-conscious?

The higher time spent by each dog to sniff the others' urine samples rather than their own and the generality of this behaviour, for all four individuals tested, confirms the hypothesis that dogs seem to know exactly their own smell and to be self-aware. It has been suggested that even if these evidences were demonstrated, with empirical research such as that presented here, we could have not established whether dogs have a sense of "I-ness" rather than a sense of "body-ness", i.e. whether they are self-conscious or "only" self-aware (for more details on these concepts see Bekoff & Sherman 2004, and a summary below).

Henceforth, I will refer to self-recognition, or self-referencing, as a perceptual process involving matching phenotypic characteristics of a target individual against the phenotype of the discriminator, which compares labels of the target (such as of odor or appearance) against labels learned from their own phenotype, and accept or reject that target based on the degree of similarity (this process can be conscious or non-conscious); I will refer to self-awareness, or body-ness or mine-ness, as the cognitive process that enables an individual to discriminate between its own body and those of others (a brain is required for this level of self-cognizance, although the actual discrimination can be conscious or unconscious); and to self-consciousness, or I-ness as possessing the sense of one's own body as a named self, knowing that "this body is me" and thinking about one's self and one's own behaviour in relation to the actions of others (here, also, a brain is required and the underlying processes are conscious). The feeling of possessing and owning the parts of one's own body is strictly related to the sense of "mine-ness", i.e. self-awareness: the sense of what belongs to oneself and what belongs to others (Bekoff & Sherman 2004). For a dog, this latter includes also the awareness of its own territory, toys, kennels, etc. But self-recognition (self-consciousness) and the sense of "body-ness" (self-awareness) are very close concepts, and the only difference could be due to the abstraction capacity to imagine one's own self, of which we did not clearly confirm the existence even in other animals that passed the mirror test (Reznikova 2007).

Furthermore, three out of four dogs tested in this study spent more time sniffing the blank than the their own urine sample. One reason could be that they were completely uninterested in their own scent, but they seemed to expect to smell something in the control sample, even if it was blank, and so they checked more carefully.

Moreover, the correlation between the age and the time spent in sniffing urine samples strongly supports the idea that self-recognition increases with age (Amsterdam 1972; Rochat 2003), as demonstrated in other species such as the chimpanzee (Povinelli et al. 1993). The evidence of an age-dependency in dogs' self-awareness could also disentangle the ambiguity between "I-ness" and "mine-ness" because, for instance, puppies are well known to be aware of, and devoted to, their own toys, baskets, bones, etc., so the minor interest in others' smells by younger dogs could be more related to an age-dependent self-recognition than to the sense of "mine".

In any case, this last consideration could be biased by two facts: first, that within packs of wild dogs living together, the youngest individuals are subordinated to adult dominants, and the lack of responsibility towards the group (Silk 2007) could make them freer in paying attention to external signs (such as smells); second, that the dogs were all between 3 and 10 years old and could all be considered adults. I suggest that in future a test with young puppies and isolated young dogs could clarify this point.

The greater interest of females towards the male's than towards the other females' samples, being statistically not significant, confirms that they were not consistently influenced by the scent of the other sex in paying more attention to others' samples. In other words, their own urine samples were not ignored because females were much more interested in the male's sample than in other individuals' samples, but because each individual was aware of his own smell.

Self-consciousness has been defined (Bekoff & Sherman 2004, p. 177) as dependent "on the costs and benefits of previous responses of conspecifics to the focal individual". The dogs tested had lived together for at least 7 years preceding the study and they showed interactions typical of a social group, where "individuals benefit from analysing and revising their own behaviour in light of how specific members of their social group, including actual and potential mates, responded to their behaviour in the past" (Bekoff & Sherman 2004, p. 177). As these requirements were satisfied by the tested group, I can argue that the dogs showed real self-consciousness, and not only self-awareness.

A key difference between the STSR and MSR is that the latter considers the interaction with the mark apposed on the body of the subject as the confirmation of self-recognition. Evidently, with a smell this proof seems difficult to achieve (even if some chemical modification of dogs' own urine samples could be tested in future), but when released together inside the enclosure and left free to move and interact with each other and with the five samples, the four dogs repetitively sniffed the excretory organs of the others and the containers, sometimes stopping to sniff themselves. Interpretation of this latter behaviour (the repetitive sniffing of the excretory organs of the others after conducting the test) could be difficult to interpret at this stage, but dogs seem to pay more attention to bodies (in general) after the olfactory test, like other animals (De Waal 2008) after having seen themselves or other individuals in a mirror (irrespective of whether they have been marked or not).

This study confirms that the scarce results reached with dogs by the mirror test could be due to the dominance of olfactory organs over the visual organs in the Canidae family and other species.

The approach presented here for testing self-awareness with a sniffing test on a multi-individual approach underlines the need to shift the paradigm of consciousness to a less anthropocentric idea, towards a species-specific consideration. We could never expect that a mole or a bat would recognize itself in a mirror, but we now have strong empirical support to believe that if we test them with a chemical or an auditory method, we could get some unexpected results.

This experimental test for self-awareness (and self-consciousness) in dogs should not be considered definitive, but it represents a starting point to change the current methods and test with other species. We know well that many factors can influence the olfactory sense and the consequential behaviour, as much as the visual sense; therefore, neural activity techniques seem promising. What instead seems conclusive is that by using a mirror to test, self-recognition won't always work since reflected images have no scent, and therefore are not real or important enough in the mind of many species to warrant much attention.

Note

This study was not subject to animal ethics approval as the animals employed are owned by the author, were observed from a distance and are considered private, domestic animals. No additional animals were recruited into the study.

Disclosure statement

No potential conflict of interest was reported by the author.

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