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Intranasal oxytocin, empathy, and contagious yawning in dogs and humans

Kis et al. (2020) recently investigated whether intranasal oxytocin (OT) alters inter-species contagious yawning in domesticated dogs (*Canis familiaris*), as well as how contagious yawning was related to measures of empathy in this species. A total of 33 dogs were tested on two separate occasions, once following intranasal administration of 12 IU OT and the other following a similar administration of a placebo solution. With the owner present, about half of the dogs were then exposed to a human researcher that repeatedly yawned and the other half were exposed to an experimenter that repeatedly gaped their mouth (control) during a 5-minute testing phase. Yawning and mouth licks of the dogs were recorded both during the testing phase and a 5-minute post phase. Each of the dog owners also completed a canine empathy questionnaire reporting the frequency in which their dogs displayed behaviours that may be indicative of emotional contagion outside the laboratory.

The results of Kis et al. (2020) showed no evidence for inter-species contagious yawning, as the frequency of yawning was similar in both the yawning and mouth gaping conditions. This finding adds to the mixed results reported previously in the literature (Joly-Mascheroni et al., 2008; Harr et al., 2009; O'Hara and Reeve, 2011; Silva et al., 2012; Madsen and Persson, 2013; Romero et al., 2013; Buttner and Strasser, 2014). Moreover, OT was shown to significantly *decrease* (rather than increase) yawning during testing, and owner responses to the emotional contagion scale were not a predictor in any of the statistical models. In addition, the authors found that mouth licking, which was included as a potential measure of stress and anxiety, was positively correlated with yawn frequency during the post phase of the experiment. Taken together, the authors concluded that the few observed dog yawns in these trials were not an empathic response and may be largely due to situational stress.

This report provides an important contribution to the literature on empathy and contagious yawning, particularly given that it tries to examine this connection by actually including measures of empathy (albeit self-report) and attempting to manipulate empathic responses during testing via OT administration. The purpose of this Letter to the Editor is to (1) compare this study to a previous publication that examined the effect of intranasal oxytocin on contagious yawning in humans, (2) provide an alternative explanation for the correlation between mouth licks and yawning, (3) provide an alternative explanation for the lack of yawn contagion in dogs related to the OT treatment, (4) question the validity and reliability of the empathy questionnaire, and (5) place this research within broader literature on empathy and contagious yawning in humans.

Within the introduction of the paper, Kis et al. (2020) incorrectly state that their study is the first to examine the effect of intranasal oxytocin on contagious yawning in either dogs or humans. Gallup and Church (2015) previously investigated this in humans, in which they administered either 30 IU OT or a placebo solution to participants before presenting a contagious yawning stimulus. Notably, the results of Gallup and Church (2015) showed a similar, though non-significant, decrease in yawning during trials in the OT condition. While Kis et al. (2020) interpret the decrease in dog yawning as a result of a stress-relieving effect from OT, Gallup and Church (2015) suggest it may be related to heightened social awareness since these authors also observed participants in the OT condition being more likely to conceal their yawns.

Furthermore, as it relates to stress, mouth licking may not be a reliable indicator given that licking and swallowing tend to occur together in dogs. Previous studies on humans suggest a common neuroanatomico-physiological pathway for yawning and swallowing. In particular, Abe et al. (2015) first reported a strong temporal association between yawning and swallowing, showing that 65 % of contagious yawns were followed by swallowing. Thereafter, Ertekin et al. (2015) further showed that the vast majority of spontaneous yawns (85.6 %) were also followed by swallowing. Thus, instead of representing a stress response, the correlation between mouth licking and yawning could be explained by the demonstrated association between yawning and swallowing. As it stands, there are already grounds to question whether mouth licking even represents a stress response (see Pastore et al., 2011).

The data reported within Kis et al. (2020) can shed light on this issue. If OT produces a stress-relieving effect in dogs (as suggested by the authors) and mouth licking is indeed a reliable indicator of stress in this context, then the association between mouth licking and yawning should only be present following administration of the placebo. However, the interaction between mouth-licking and pre-treatment was not a significant factor in the model. Thus, the interpretations provided for the decrement in yawning following OT administration and the correlation between mouth licking and yawning in the post phase appear to directly conflict with one another.

An often overlooked, yet critical, characteristic of OT is that its effects are specific for the in-group (De Dreu and Kret, 2016; Samuni et al., 2017). Importantly, in humans it has been shown that OT treatment creates an increased focus / attention for the in-group in comparison to the out-group (cf. ethnocentrism) (De Dreu et al., 2011). Whereas we applaud the authors' efforts to create a more natural situation with the owner of the dogs present while the experimenter either yawns or gapes, in combination with the OT treatment exactly this situation might have caused the dogs to pay less attention to the experimenter and more towards the owner (see also methods section Kis et al., 2020), which in turn may explain the lack of contagious yawning in the OT treatment.

As mentioned, we commend the authors' attempt to measure the hypothesized effect of empathy on contagious yawning with a direct measure, rather than inferring such a link through indirect evidence. However, the canine empathy questionnaire used by Kis et al. (2020) has not been validated to in fact measure empathy or emotional contagion in dogs. Moreover, given that the use of questionnaires is by

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default subjective, the reliability of the measures should have been tested (inter-rater reliability). Kis et al. (2020) argue that the questionnaire approach still appears to be the most reliable, as behavioural tests so far are not sufficiently realistic to evoke empathic-like behavior in dogs. They, however, fail to argue why the questionnaire approach is (more) reliable, and this position has been challenged in the study of animal personality, where recent results show large discrepancies between measures obtained from questionnaires and actual behaviour (Šlipogor et al., 2019).

Nevertheless, based on the overall findings reported in Kis et al. (2020), the authors appropriately argue that contagious yawning may not be an empathic response in dogs. However, the authors fail to link these results to the broader literature evaluating this connection in humans and other animals (reviewed by Massen and Gallup, 2017). In particular, the evidence for the connection between empathy and contagious yawning in humans is quite mixed, inconsistent and indirect at most. For example, less than a third of all studies show the predicted connection between variability in empathy measures and yawn contagion (e.g., Platek et al., 2003), the vast majority of research reveals no difference in contagious yawning between men and women (Gallup and Massen, 2016), and decreased yawn contagion in populations with deficits in empathy (e.g., autism) are lost when controlling for attention towards the stimulus (Senju et al., 2009). Similarly, when specifically told to pay attention to the stimulus, contagious yawning develops earlier in human children than reported by the authors (Hoogenhout et al., 2013). Within the context of this larger literature on humans, the results reported by Kis et al. (2020) provide a more compelling case against an empathy-yawning connection.

In conclusion, the findings reported within Kis et al. (2020) improve our understanding of contagious yawning, align with a previous intranasal OT study in humans, and add to a growing body of research challenging the empathy modeling hypothesis. However, some of the interpretations within this paper are inconsistent, and further research is needed to understand the connections between intranasal OT, contagious yawning, and stress. Moreover, it is suggested that alternative measures of stress be used in future studies of contagious yawning in dogs.

Declaration of Competing Interest

The authors declare no conflicts of interest.

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