

The potential effect of behavioral stimulation on social competence in dogs (via endogenous oxytocin release)

ABSTRACT:

Background

Dogs show behaviors analogous to human socio-cognitive skills, and the oxytocin system is related to their human-directed social behavior.

Aims

It is expected that the combination of different methodological approaches enables us to disentangle this complex relationship.

Method

Dog social behaviour was assessed with different methods including behavioural observations and spontaneous interactions, eye-tracking and projected images. This was complemented with physiological measurements using non-invasive polysomnography (sleep EEG and ECG), as well as serum oxytocin measurements and genetical analyses.

Results

Intranasal oxytocin administration was found to effect different forms of human-directed social behaviour in dogs (processing of emotional faces, contagious yawning). Polymorphisms in dogs' oxytocin receptor gene co-varied with their social behaviour (gaze-following, attachment). Dogs' serum oxytocin level increased after positive social interaction.

Methodological advancements were made to enable the use of non-invasive canine polysomnography for the study of neural mechanisms related to social cognition (reliability of sleep stage scoring, first-night effect, influence of pre-sleep activity and sleep location). It was found that positive versus negative pre-sleep social interactions have an effect on dogs' subsequent sleep macrostructure, and such effects are related to subjects' individual reaction during pre-treatment. Using a selective REM deprivation paradigm, a causal link was found between dogs' sleep structure and emotion processing in a picture-sound matching paradigm.

Conclusions

Significant advancements were made in understanding the relationship between dogs' human-like socio-cognitive skills and their neuro-hormonal regulation.

Keywords

Dog (*Canis familiaris*), Social stimulation, Oxytocin, Social cognition

Published Work:

- Bódizs, R., Kis, A., Gácsi, M., & Topál, J. (2019). Sleep in the dog: comparative, behavioral and translational relevance. *Current Opinion in Behavioral Sciences*, 33, 25-33. doi: 10.1016/j.cobeha.2019.12.006
- Bolló, H., Kovács, K., Lefter, R., Gombos, F., Kubinyi, E., Topál, J., & Kis, A. (2020). REM versus Non-REM sleep disturbance specifically affects inter-specific emotion processing in family dogs (*Canis familiaris*). *Scientific Reports*, 10: 10492. doi 10.1038/s41598-020-67092-5
- Bunford, N., Andics, A., Kis, A., Miklósi, Á., & Gácsi, M. (2017). *Canis familiaris* as model for non-invasive comparative neuroscience. *Trends in Neuroscience*, 40(7), 438-452. doi: 10.1016/j.tins.2017.05.003
- Bunford, N., Reicher, V., Kis, A., Pogány, A., Gombos, F., Bódizs, R., & Gácsi, M. (2018). Differences in pre-sleep activity and sleep location are associated with variability in daytime/nighttime sleep electrophysiology in the domestic dog. *Scientific Reports*, 8: 7109. doi: 10.1038/s41598-018-25546-x
- Gähwiler, S., Bremhorst, A., Tóth, K., & Riemer, S. (2020). Fear expressions of dogs during New Year fireworks: a video analysis. *Scientific Reports*, 10: 16035. doi: 10.1038/s41598-020-72841-7
- Gergely, A., Kiss, O., Reicher, V., Iotchev, I., Kovács, E., Gombos, F., ... Kis, A. (2020). Reliability of family dogs' sleep structure scoring based on manual and automated sleep stage identification. *Animals*, 10(6), 927. doi:10.3390/ani10050000
- Gunde, E., Czeibert, K., Gábor, A., Szabó, D., Kis, A., Arany-Tóth, A., ... & Kubinyi, E. (2020). Longitudinal Volumetric Assessment of Ventricular Enlargement in Pet Dogs Trained for Functional Magnetic Resonance Imaging (fMRI) Studies. *Veterinary Sciences*, 7(3), 127. doi: 10.3390/vetsci7030127
- Hritcu, L. D., Horhoge, C., Ciobica, A., Spataru, M. C., Spataru, C., & Kis, A. (2019). Conceptual replication of canine serum oxytocin increase following a positive dog-human interaction. *Revista de Chimie*, 70(5), 1579-1581
- Iotchev, I. B., Kis, A., Turcsán, B., Tejada Fernández de Lara, D. R., Reicher, V., & Kubinyi, E. (2019). Age-related differences and sexual dimorphism in canine sleep spindles. *Scientific reports*, 9(1), 10092. doi:10.1038/s41598-019-46434-y
- Iotchev, I. B., Reicher, V., Kovács, E., Kovács, T., Kis, A., Gácsi, M., & Kubinyi, E. (2020). Averaging sleep spindle occurrence in dogs predicts learning performance better than single measures. *Scientific Reports*, 10: 22461. doi: 10.1038/s41598-020-80417-8
- Iotchev, I. B., Szabó, D., Kis, A., & Kubinyi, E. (2020). Possible association between spindle frequency and reversal-learning in aged family dogs. *Scientific Reports*, 10(1), 6505. doi: 10.1038/s41598-020-63573-9
- Kis, A., & Topál, J. (2020). Response to intranasal oxytocin, empathy, and contagious yawning in dogs and humans. *Applied Animal Behaviour Science*, 224, 104969. doi: 10.1016/j.applanim.2020.104969

- Kis, A., Ciobica, A., & Topál, J. (2017). The effect of oxytocin on human-directed social behaviour in dogs (*Canis familiaris*). *Hormones and Behavior* 94, 40-52. doi: 10.1016/j.yhbeh.2017.06.001
- Kis, A., Gergely, A., Galambos, Á., Abdai, J., Gombos, F., Bódizs, R., & Topál, J. (2017). Sleep macrostructure is modulated by positive and negative social experience in adult pet dogs. *Proceedings of the Royal Society B*, 284(1865). doi: 10.1098/rspb.2017.1883
- Kis, A., Hernádi, A., Miklósi, B., Kanizsár, O., & Topál, J. (2017). The way dogs (*Canis familiaris*) look at human emotional faces is modulated by oxytocin. An eye-tracking study. *Frontiers in Behavioral Neurosciences*, 11: 210. doi: 10.3389/fnbeh.2017.00210
- Kis, A., Oliva, J., Virányi, Z., & Topál, J. (2019). Editorial: Oxytocin and social behaviour in dogs and other domesticated species. *Frontiers in Psychology*, 10:732. doi: 10.3389/fpsyg.2019.00732doi: 10.3389/fpsyg.2019.00732
- Kis, A., Toth, K., Kanizs, O., & Topál, J. (2019). The effect of oxytocin on yawning by dogs (*Canis familiaris*) exposed to human yawns. *Applied Animal Behaviour Science*, 223: 104916. doi: 10.1016/j.applanim.2019.104916
- Kiss, O., Kis, A., Scheiling, K., & Topál, J. (2020). Behavioral and neurophysiological correlates of dogs' individual sensitivities to being observed by their owners while performing a repetitive fetching task. *Frontiers in Psychology*, 11: 1461. doi: 10.3389/fpsyg.2020.01461
- Kovács, E., Kosztolányi, A., & Kis, A. (2018). Rapid eye movement density during REM sleep in dogs (*Canis familiaris*). *Learning & Behavior*, 46(4), 554-560. doi: 10.3758/s13420-018-0355-9
- Kovács, K., Virányi, Z., Kis, A., Turcsán, B., Hudecz, Á., Marmota, T., Koller, D., Rónai, Z., Gácsi, M., & Topál, J. (2018). Dog-owner attachment is associated with oxytocin receptor gene polymorphisms in both parties. A comparative study on austrian and hungarian border collies. *Frontiers in Psychology*, 9, 435. doi: 10.3389/fpsyg.2018.00435
- Oláh, K., Topál, J., Kovács, Z., Kis, A., Koller, D., Park, S. Y., & Virányi, Z. (2017). Gaze-following and reaction to an aversive social interaction have corresponding associations with variation in the OXTR gene in dogs but not in human infants. *Frontiers in Psychology*, 8: 2156. doi: 10.3389/fpsyg.2017.02156
- Reciher, V., Kis, A., Simor, P., Bódizs, R., Gombos, F., & Gácsi, M. (2020). Repeated afternoon sleep recordings indicate first-night-effect-like adaptation process in family dogs. *Journal of Sleep Research*, 29(6), e12998. doi: 10.1111/jsr.12998
- Varga, B., Gergely, A., Galambos, Á., & Kis, A. (2018). Heart rate and heart rate variability during sleep in family dogs (*Canis familiaris*). Moderate effect of pre-sleep emotions. *Animals*, 8(7), 107.

Researcher's Contacts:

Anna Kis
Research Centre for Natural Sciences
Budapest, Hungary
Phone: +36 1 3826 810
Email: vargane.kis.anna@ttk.hu