Author Correction: EEG Transients in the Sigma Range During non-REM Sleep Predict Learning in Dogs

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This Article contains multiple errors. In the Methods section under subheading 'Subjects and Behavioural paradigm'.

“15 adult pet dogs, mean age ± SD: 3.67 ± 1.91; 8 males, 7 females; from 7 pure breeds (3 Border Collies, 2 Golden Retrievers, 1 Labrador Retriever, 1 Poodle, 1 Belgian Shepherd, 1 Puli, 1 Miniature Schnauzer) and 3 mixed breeds (3 unknown, 1 mixed Briard and 1 mixed Malinois), participated three times in 3-hour-long polysomnography recordings3, on a total of 3 days (see Fig. 1)7.

should read:

“15 adult pet dogs, mean age ± SD: 3.87 ± 2.17; 8 males, 7 females; from 7 pure breeds (3 Border Collies, 2 Golden Retrievers, 1 Labrador Retriever, 1 Poodle, 1 Belgian Shepherd, 1 Puli, 1 Miniature Schnauzer) and 3 mixed breeds (3 unknown, 1 mixed Briard and 1 mixed Malinois), participated three times in 3-hour-long polysomnography recordings3, on a total of 3 days (see Fig. 1)7.

In the Results section under subheading 'Age, sex, and learning gain'.

“An initial exploration into how learning gain (difference in percentage correct responses after sleep – before sleep in the learning condition) was predicted by sex and age revealed no effect of age (GLMM, F1,12 = 0.075, P = 0.401), but a significant effect of sex (GLMM, F1,12 = 6.948, P = 0.022). Females displayed a higher learning gain (15.6 ± 3.6 versus 4.4 ± 2.2, means ± SE, t12 = 2.636, P = 0.022), see Fig. 3B.

Next the overall predictive strength of detections from each frequency-definition was compared by testing how age, sex and learning gain would predict spindle density in the learning condition. Transients in the 5–12 Hz and 12–14 Hz range showed no relationship to learning or age (see supplementary). Below we present the results for transients in the 9–16 Hz range (Fig. 3).

We found that spindle density in the learning condition increased with learning gain (GLMM, F1,11 = 7.656, P = 0.018). This relationship remained significant in post-hoc testing (GLMM, F1,11 = 9.293, P = 0.009, Fig. 3A). Spindle density also increased with age (GLMM, F1,11 = 6.492, P = 0.027) and was different for the sexes (GLMM, F1,11 = 14.489, P = 0.003). Females had a higher spindle density than males (4.75 ± 0.2 versus 2.69 ± 0.4, means ± SE, t11 = 4.787, P = 0.001, Fig. 3C), but the effect of age was not significant post-hoc (GLMM, F1,13 = 0.178, P = 0.68)7.

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We found that spindle density in the learning condition increased with learning gain (GLMM, $F_{1,11} = 8.798, P = 0.013$). This relationship remained significant in post-hoc testing (GLMM, $F_{1,13} = 9.293, P = 0.009$, Fig. 3A). Spindle density also increased with age (GLMM, $F_{1,11} = 7.869, P = 0.017$) and was different for the sexes (GLMM, $F_{1,11} = 10.956, P = 0.007$). Females had a higher spindle density than males ($4.785 \pm 0.2$ versus $2.69 \pm 0.4$, means $\pm$ SE, $t_{11} = 4.787, P = 0.001$, Fig. 3C), but the effect of age was not significant post-hoc (GLMM, $F_{1,13} = 0.178, P = 0.689$). In the Results section under subheading ‘Slow and fast spindles’. should read:

2. Fast spindles: The density of fast spindles was not predicted by learning gain (GLMM, $F_{1,8} = 0.005, P = 0.946$) or age (GLMM, $F_{1,8} = 0.093, P = 0.768$) but was significantly predicted by sex (GLMM, $F_{1,8} = 10.83, P = 0.009$). Females displayed more fast spindles/minute than males ($4.1 \pm 0.3$ versus $2.6 \pm 0.4$, means $\pm$ SE, $t_{11} = 3.031, P = 0.011$, Fig. 6B). There was a trend for density to increase with age (GLMM, $F_{1,11} = 4.124, P = 0.067$). There was also a trend for more fast spindles/minute in the learning condition as compared to the control condition (3.4$\pm$ 0.4 versus 2.6$\pm$ 0.5, means $\pm$ SE, $t_{12} = 2.135, P = 0.051$). This effect was significant upon excluding dogs with more than 10 days waiting time between the EEG sessions (3.2$\pm$ 0.5 versus 2.9$\pm$ 0.5, means $\pm$ SE, $t_{10} = 2.959, P = 0.014$, Fig. 6C). Age was not predicted by the mean amplitude (GLMM, $F_{1,11} = 0.285, P = 0.604$), mean frequency (GLMM, $F_{1,11} = 1.351, P = 0.27$) or mean density of slow spindles (GLMM, $F_{1,11} = 0.673, P = 0.429$).

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In the discussion section:

“In both groups sex remained a significant predictor of spindle density, but only slow spindles maintained the previously observed relationships with learning and memory. Slow spindles are localized in frontal areas21, where associations between spindling and verbal memory have been reported for humans16. A specific association of slow spindles with learning of verbal commands squares with other findings suggesting that the canine brain processes aspects of verbal information similar to the human brain64, 68. Only frequency, amplitude and density of fast spindles, however, did predict age similarly as in the human literature, where aging causes spindle density and amplitude to drop40, but frequency to rise39

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In addition, this Article contains an error in the Figure legends throughout the paper. All instances of “medians and standard errors” should be “means ± SD.”