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Is dog domestication due to epigenetic modulations in brain?

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Abstract:

Dogs (Canis lupus familiaris), derived from wolves (Canis lupus), are known as the first domesticated animal and they have been living in human (Homo sapiens) environment at least 15.000 years. During the Palaeolithic period, humans and wolves lived in similar structured family clans as cooperative hunters in the same ecological niche. Wild wolves lived - and still live today - in competition with humans and exactly this was the reason for meeting each other during a hunt or while scavenging at a carcass. Achieving an evolutionary benefit, ancient wolves, especially those with genetically disposed friendly behavior, are supposed to have started interspecific pro-social communication, first in all likelihood in order to avoid risk of injury. The evolutionary continuity of mammalian brains enabled humans and wolves interspecific pro-social communication which in turn reduced stress and aggression and helped both of them to become confident to each other. Thus, behavioral cultures were formed and genetic isolation of human associated wolves started.

Today researchers tend to proclaim dog domestication as a self-domestication-process, but the question is still, why and how dog domestication started. The hypothesis of Active Social Domestication considers genetic selection as a necessary prediction but not a sufficient explanation of dog domestication, because domestication syndrome occurs very rapidly and frequently and therefore cannot be explained only by selection for mutations. In addition, dog domestication is suggested to be an epigenetic disclosure. Epigenetic mechanisms are involved in gene silencing, affecting chromatin structures and acute stress is known to regulate expressions of retrotransponsons via epigenetic modulations. Domestication means decreased aggression and decreased flight distance concerning to humans. Therefore, changes of the activity of the Hypothalamic-pituitary-adrenal (HPA) stress axis which is influenced thru an enhancement of the amygdala and an inhibition thru the hippocampus are suspected to be crucial during the domestication processes. Dog domestication is suggested to be essentially an epigenetic based process that changes the interactions of the HPA stress axis and the 5-Hydroxytryptamine-calming system in brain. Evolved pro-social wolf-human communication improved interspecific empathy and pro-social care which increased serotonin release in brain initiating an enzymatic cascade which effects epigenetic demethylation of hippocampal glucocorticoid receptor (hGCR) promotor genes. Hence, increased density of hGCR enhances glucocorticoid negative feedback loop thus decreasing stress activity. Furthermore epigenetic mechanisms are also known to affect

oxytocin receptors as well as estrogen, gabas and benzodiazepine receptors. In addition epigenetic interactions with retrotransponsons are described due to stress activity. And to what extend decreased maternal cortisol levels might influence embryonic neural crest cell migration alteration is still an open question.

Lower cortisol levels increase dendritic growth thus enhancing social learning capability and improving prefrontal inhibitory control. Over time, those tame wolves which were living together with humans in behavioral cultures were able to develop human analogue behavior. Eventually those first proto-dogs integrated themselves into human social structures accepting humans as their preferred social binding partners. But described epigenetic mechanisms did work in humans during the dog domestication process as well. In the time window of dog domestication, archaeologist describe a sudden increase of human cultural evolution in the Aurignacien: Cave paintings, sculptures, flutes, javelin spins occurred possibly facilitated by increased mental skills due to dog domestication. And indeed, recent research validates that human-dog bonding still reduces stress in both specimen and improves social and cognitive capabilities and thus might have played a role in human cognitive evolution as well.