Relational and procedural memory systems in the goldfish brain revealed by trace and delay eyeblink-like conditioning

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The presence of multiple memory systems supported by different neural substrata has been demonstrated in animal and human studies. In mammals, two variants of eyeblink classical conditioning, differing only in the temporal relationships between the conditioned stimulus (CS) and the unconditioned stimulus (US), have been widely used to study the neural substrata of these different memory systems. Delay conditioning, in which both stimuli coincide in time, depends on a non-relational memory system supported by the cerebellum and associated brainstem circuits. In contrast, trace conditioning, in which a stimulus-free time gap separates the CS and the US, requires a declarative or relational memory system, thus depending on forebrain structures in addition to the cerebellum. The distinction between the explicit or relational and the implicit or procedural memory systems that support trace and delay classical conditioning has been extensively studied in mammals, but studies in other vertebrate groups are relatively scarce. In the present experiment we analyzed the differential involvement of the cerebellum and the telencephalon in delay and trace eyeblink-like classical conditioning in goldfish. The results show that whereas the cerebellum lesion prevented the eyeblink-like conditioning in both procedures, the telencephalon ablation impaired exclusively the acquisition of the trace conditioning. These data showing that comparable neural systems support delay and trace eyeblink conditioning in teleost fish and mammals suggest that these separate memory systems and their neural bases could be a

shared ancestral brain feature of the vertebrate lineage.

Cerebellum

Delay versus trace eyeblink classical conditioning

Episodic-like memory

Telencephalon

Teleost fish

Vertebrate brain evolution

animal experiment

Article

cerebellum

cerebellum injury

conditioned reflex

conditioning

controlled study

eyelid reflex

goldfish

habituation

latent period

nonhuman

photostimulation

priority journal

procedural memory

telencephalon

adverse effects

analysis of variance

animal

auditory stimulation

blinking

brain

brain injury

goldfish

memory

pathophysiology

physiology

reaction time

time factor

Acoustic Stimulation

Analysis of Variance

Animals

Blinking

Brain

Brain Injuries

Conditioning, Classical

Goldfish

Memory

Reaction Time

Time Factors