

**Beyond the "three-second fish memory" folk psychology belief:
experimental evidences from active avoidance conditioning in
goldfish to olfactory learning in carp and miscellaneous training in
zebrafish or other teleost fishes**

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Learning abilities have been widely documented in rodents from experimental psychological studies for a long time. However, learning and memory play a pivotal role in the behavioural development of all vertebrates, and fish are no exception. For example, a learned foraging behaviour in zebrafish has been characterized in food-restricted situation using methods such as "time-place learning". In more natural laboratory conditions, many behavioural or "cognitive ecology" experiments have argued strongly the social facilitation of learning devoted to locate food, avoid predator or gathering information about conspecifics (eavesdropping). Moreover, different laboratory learning paradigms typically applied in rodents have been successfully validated in fish physiology. Recently, for the first time in fish, a conditioned endocrine response (cortisol) to a stressor was demonstrated in Nile tilapia, using the Pavlovian conditioning.

Furthermore, motivational conflicts that have been thoroughly studied in birds and mammals over the last decades have begun in zebrafish lab studies. Newly, researches have revealed that, emotion and cognition also play a pivotal role in the expression of fish behaviour. Fish exhibit fear, long-term memory, attentional and learning capacities that are comparable with those of other vertebrates, including nonhuman primates. Thus, fish can be expected to manage motivational conflicts using cognitive similar resources. As many other teleost fishes, the trendy zebrafish (*Danio rerio*) is a good and a valuable candidate to study the behavioural effects of approach-avoidance conflicts because of its genetic and neurophysiological proximity with "higher" vertebrates.

Main of these researches uses the two conditioning paradigms. Classical conditioning (or Pavlovian conditioning) takes place when two events overlap in time (and space) so that an originally neutral stimulus can be associated with a rewarding (appetitive or reward conditioning) or an aversive (avoidance and fear conditioning) stimulus. In aquaculture, reward conditioning often occurs automatically in connection with feeding (sound of the pellets in the feeding pipes for instance). Light or olfactory signals (conditioned stimulus or CS) are used in planned conditioning procedures to release anticipatory behaviour that should increase exploration and motivation for searching and ingesting, for instance, an appetitive less novel food (unconditioned stimulus or US). Operant conditioning (or Skinnerian conditioning) occurs in situations where the behavioural response is selected and shaped by its consequence. On reward situation, the probability that the behaviour will be repeated gradually increases, resulting in an "instrumental association" between an action (conditioned response) and a stimulus (reinforcement). Several typical "fish examples" will illustrate the oral presentation.