Marek Stolarski
Mgr inż.
NEEL Sp. z o.o.

DOI: 10.35117/A_ENG_23_06_07_08_09

How the Latest Railway Wildlife Protection Systems Work

Abstract: In order to effectively warn wild animals of the danger posed by a fast-moving train, knowledge of ethology—that is, the natural behavior of animals—is necessary. Understanding how animals' senses function and the instincts that guide their behavior allows for the selection of stimuli that will be interpreted as a warning of impending danger and will prompt the animals to move away from the tracks. This is how the acoustic system for protecting animals on railway tracks, developed in Poland, works.

Keywords: Railway lines; Wild animals; Prevention of train–wild animal collisions; Acoustic animal protection devices

Introduction

Attempting to control the behavior of wild mammals is impossible without taking into account the functioning and sensitivity of their sensory organs as well as understanding their psychology. The phenomena and processes described below form the basis of the effective method of deterring animals from railway tracks, which is used in the UOZ-1 system developed in 2003 for PKP PLK S.A. as an alternative to building fences and "green bridges."

A careful reading of the content of this article, based on the knowledge and experience of one of the world's foremost zoopsychologists—Professor Simony Kossak—will help to understand why this is so, and why many seemingly interesting theoretical solutions turn out to be completely ineffective in practical applications.

Sensory Organs

Numerous studies in the field of ethology (zoopsychology) are devoted to analyzing the functioning of the sensory organs of mammals. This involves examining the types and ranges of sensitivity of the organs of sight, hearing, smell, taste, and touch in various species. The most important ones are:

- Sense of Sight: The ability of mammals to perceive stationary material objects, the speed of moving objects, as well as to judge distances—and, consequently, to build a three-dimensional image of their surroundings—largely depends on the efficiency of the animal's vision. However, this is not the most important sense in mammals. The senses of hearing and smell are more important.
- Sense of Hearing: From the incoming sounds, certain components are extracted to which the animal is evolutionarily attuned. Although locating the source of a sound and judging its distance is generally less precise than with vision, mammals can locate sounds at least twice as accurately as humans.

Instinctive Behaviors

Instinctive forms of animal behavior have developed as a result of evolutionary changes—physiological, anatomical, and psychological—in response to signals from the environment. The set of innate behaviors is governed by three basic instincts: survival, feeding, and reproduction. The strongest of these is the imperative to take action to preserve life. Unlike reason, an extraordinary, "blind" force compels animals, in most life situations, to primarily strive to avoid death.

1. Animal Protection Equipment UOZ-1 on the E30 line, section Węgliniec – Bielawa Dolna source: NEEL

Innate releasing mechanisms, key stimuli

Knowledge about the capabilities of sensory organs, obtained through experiments based on training that involves associating any chosen stimulus with a reward or punishment, answers the question of whether a given animal's nervous system perceives the tested signals at all. Obtaining a positive answer is not sufficient to automatically apply the results to the behaviors of wild animals.

Animals do not respond to some signals from their natural environment. Among visual stimuli, the most important for animals are detecting the movement of an observed object and assessing distance. In contrast, the response to sound can be entirely independent of the accompanying image. For example, an alarm call or sound triggers a flight reflex, despite simultaneously receiving visual stimuli indicating a complete lack of threat. This occurs because a feature of instinctive behaviors is their dependence on one or at most a few stimulus signals called "key stimuli," extracted from stimuli unrelated to the threat signal. Natural sensory stimuli indicating the close presence of predators are signals that trigger a chain of reactions. These are, in order: increased vigilance, unease, fear, and flight. Usually, the first indication of the chain-like nature of the response to a stimulus is its sudden interruption. This means that under natural conditions, if the response occurred as a result of a mistake, the animal quickly stops reacting to successive repeated stimuli of the same type. Flight is a spontaneous behavior caused by the occurrence of a sequence of events consistent with a specific pattern, with particular organizational features (e.g., an alternating series of sounds, images, smells, vibrations, etc., accompanying the approach of an enemy or natural disaster). And in this very way, a human-made simulation of a real threat must work on animals.

Social and interspecies triggers

Holistically understood reception of stimuli not only triggers a reaction but also directs it depending on the characteristics of the environment. In the case of the flight reflex in open spaces, it always involves moving away from the source of signals, while for forest animals, it means quickly leaving the open area and seeking cover under vegetation. Many innate reactions are triggered by warning stimuli sent by more experienced, vigilant, or sensitive individuals. Many animal species emit different alarm calls: one upon seeing a predator that is not yet attacking but poses a potential threat, and another in the case of a sudden attack. The group response to the first is heightened vigilance; the response to the second is the rapid departure of all individuals from the source of danger or seeking suitable shelter.

In summary, it should be stated that a signal constituting a social or interspecies trigger, given by the most observant animal, elicits a reaction from subsequent individuals of the same or another species.

"Supernormal" key stimuli

When studying the releasing values carried by each sensory stimulus, we encounter the occurrence of its variable threshold values. This variability results from:

- changes in the intensity of other external stimuli,
- changes in the intensity of internal factors,
- both factors combined.

The only instinctive behavior that does not have a variable threshold value caused by internal factors (within the animal's body) is life preservation. The stimulus must signal actual danger, so reliably that habituation ("immunization," "desensitization") cannot occur.

Therefore, when developing a model of key stimuli, which should be the basis of any animal protection system based on effective control of their behavior, it is extremely important to prevent the internal motivation of animals to flee from decreasing over time. This can be achieved by:

- using "supernormal" stimuli that are more effective than natural signals, which by their nature are not always optimal (allowing predators to succeed in hunting and obtaining food),
- cooperation of causal factors, i.e., configuring key stimuli in terms of quality, intensity, and duration with the sequence of psychophysical reactions of the animal, as well as summing their influence in triggering motor responses of the repelled animals,
- the fact of an objectively existing "enemy" reliably appearing in a given place shortly after the animals receive a sequence of warning signals.

The use of models of key stimuli announcing a real threat, such as an approaching train (the ultimate verifier of the correctness of animals' psychophysical reactions), should result in an instinctive flight response, i.e., immediate departure from the tracks and their immediate vicinity. This is exactly how the UOZ-1 animal protection system works.

Reaction time, flight distance, attack distance

Reaction time is the time elapsed between the appearance of an alarming key stimulus and the animal's response. Its length depends on the species and external situation. In life-saving behaviors, the speed of the potential victim's reaction has a strict, evolutionarily developed relationship with the hunting behaviors and speed developed by the natural enemy (aggressor). The time needed by the aggressor to cover a certain distance separating it from the victim is instinctively known to the victim, so it adjusts its movement activity (i.e., the moment of initiating flight) to the situation.

Flight distance. The movement of a vehicle is fundamentally different from the movement of any natural enemy: from a great distance, it approaches at a uniformly high speed, while predators cover the long distance from potential victims in stages—initially walking, then slowly approaching using natural cover, and only after appropriately shortening the distance (attack distance) do they reach maximum speed.

Attack distance. At the same distance, the increase in threat from another animal is much slower than the increase in threat from a fast-moving vehicle. This is the reason for frequent collisions of animals with vehicles moving straight or suddenly emerging from around a bend at speeds greater than 60-70 km/h, and never with cyclists or horse-drawn carriages. In other words, a car or train covers a significant distance in such a short time that the nervous system of the "pursued" cannot keep up with issuing successive commands: "be careful," "don't cross the road, turn around!", "run away!". In this situation, a last instinctive attempt to save life may occur (classic behavior of a cornered rat): when it is too late for anything else, the "victim" accepts the challenge and defends its life with determination. There are known cases of a bison or moose attacking an approaching locomotive or car head-on.