FROM HOUNDS TO HORSES TO HOUSECATS; THE SCIENCE OF SEMIOCHEMICALS AND ITS APPLICATIONS TO VETERINARY MEDICINE

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Chemical communication was probably the first form of communication to evolve in animals and remains one of the most important means of communication used by the majority of animal species today.[1] Primates have lost some of their ability to communicate with each other via chemical means, most likely as they evolved better vision and a brain better equipped for speech. But even primates maintain some chemical communication, only the degree to which they do so is still somewhat controversial.[2] Even birds, a family of animals in which chemical communication has long been thought to be unimportant, have been confirmed to have a fully functioning olfactory system.[3] The role of chemical signaling on the social behavior of birds is becoming increasingly apparent and has the potential to fundamentally alter how we interpret bird behavior.[4]

WHAT ARE SEMIOCHEMICALS AND HOW DO THEY DIFFER FROM ODORS?

The term semiochemical simply refers to any of the chemicals used by animals for communication. The word "semio" taken from the Latin means "sign". Semiochemicals have evolved over thousands of years to enable animals to communicate within their species and between species. Pheromones are semiochemicals that evolved as a signal between organisms of the same species that elicit a particular reaction from the receiver.[1] Olfactory cues, or odors may also serve as semiochemicals but in many cases, they did not evolve to serve the function of communication between species. One of the most important differences to be aware of when thinking about semiochemicals and the pheromones is that pheromones are innate cues which do not require learning.[1] When an animal is born, it is born having the genetically predetermined, physiological capability of responding to the semiochemicals that are appropriate to its species. When a puppy is born and it snuggles against its dam's teats and perceives the canine appeasing pheromone for the first time, it immediately begins to feel calm and relaxed.

Conversely, olfactory cues are cues that are affected by our experiences. For example if your favorite grandmother wore a particular perfume, every time you smell that perfume, you might experience a sense of well-being, as you remember pleasant times with your grandmother. However, if you had an irritable, demanding school teacher that wore that identical perfume and frequently gave you bad grades or complained about your school work or behavior, then the smell of that very same perfume, might make you feel very uncomfortable whenever you smelled it. This is a very important difference between pheromones and olfactory cues! The puppy will never feel differently when exposed to appeasing pheromone, regardless of the experiences it might have in its presence because its responses to the pheromones specific to its species are innate or "hard wired". Olfactory cues, or odors, require learning. For example, odors associated with individual identification, called signature mixtures must be learned and are then used to recognize the other individuals in their social group.[1]

Semiochemicals, as opposed to olfactory cues are perceived primarily through the vomeronasal organ or VNO (also more commonly referred to as the Jacobson's organ). When animals perform the behavior known as flehmen, they are helping to open the duct to the VNO and to increase movement of molecules into the organ.[5] The VNO is a hollow, bi-lobed structure which lies above the oral cavity and has a duct that opens into the roof of the mouth in most mammals (it opens into the nostrils in horses). The inside of the organ is lined with sensory epithelium. When a semiochemical reaches this epithelium it triggers a nervous transmission to the accessory olfactory bulb via the vomeronasal nerve. From the olfactory bulb messages are then sent directly to the amygdala, the area of the brain primarily responsible for emotions such as fear, anxiety and well-being.

Although chemical communication may be difficult for humans to fully comprehend with our limited abilities, it is critically important to the social behavior of many species. Mankind has been using this knowledge for many years in both agriculture and pet care. As just one example, the Mediterranean fruit fly has been controlled by using sex pheromones as attractants to lure male fruit flies into traps. This method is still used today to monitor for the presence of the fruit fly in Florida.

APPLICATIONS FOR SEMIOCHEMICALS

Research into the use of semiochemicals continues to find ways in which they can be used to help solve problems. Semiochemical cues are naturally used by parasitic sea lice to identify and locate their host salmonid fish as well as to

avoid, unsuitable host species. A study in a fish farm in Scotland suspended polymer ribbons, impregnated with a semiochemical isolated from turbot (a species not typically chosen as a host by this species of sea lice) in pens where young salmon were being reared.[6] When the fish were exposed to sea lice, prevalence and parasite loads were consistently lower on the fish who were exposed to the non-host semiochemical cues.

Many insects have been shown to use pheromones referred to as aggregation or assembly pheromones to aid in migration, mate location and food or host location. Field trials have shown that aggregation pheromones can be used to attract questing ticks and combinations of the pheromones and insecticides can then be used to provide better control of ticks while using less insecticides overall and thus decreasing the impact of the insecticide on the environment.[7,8] Long term results of use of products like these would clearly benefit, the animal, the environment and the animal care taker.

Appeasing pheromones (also referred to as appeasines) are semiochemicals produced by nursing females from sebaceous glands located in the intramammary sulcus.[5] These pheromones are first secreted within 3-4 days after parturition and continue to be released until several days after weaning of the young. They have a calming or soothing effect on the young and animals have been shown to be capable of responding to the same way to this pheromone into adulthood. The first appeasine was identified in sows and they have since been identified in bitches, mares, cows, queens, ewes and does. All appeasines share the same chemical structure. This is composed of the same three fatty acids in the same ratios; oleic, palmitic and linoleic acids. The species specific part of the structure always begins with myristic acid in varying ratios with a variety of other fatty acids that differ by species. [5]

Synthetic analogues of appeasing pheromones are now available commercially for a variety of different species including the pig, the chicken, the horse, the dog and the cat. In pigs, the appeasing pheromone has already been shown to decrease post mixing aggression in weaned pigs. In addition, pigs exposed to the synthetic pheromone demonstrate increased weight gains as well as better feed to gain ratios when compared to control pigs in the initial 28 day post weaning period.[9]

A uropygial gland secretion has been isolated from hens with chicks that has a chemical pattern comparable to the appeasing pheromones in mammals. A synthetic analogue of this secretion has been demonstrated to reduce stress in chickens, particularly those raised under commercial farming conditions. Decreased stress was indicated in one study by decreased corticosterone levels and reduced heterocyte; lymphocyte ratios suggesting that the use of the synthetic secretion can be used to improve poultry welfare.[10]

Synthetic canine appeasing pheromones have been shown to reduce some of the signs of distress commonly shown by recently adopted puppies, such as the night time vocalizations that occur when puppies are first isolated. When puppies in puppy classes are exposed to pheromones they have been shown to demonstrate less signs of fear and anxiety and less signs associated with inadequate socialization than the control group of puppies. Canine appeasing pheromone has also been shown to reduce some of the signs of fear and anxiety associated with visits to the veterinary clinic.[11,12,13]

The newly available, feline appeasing pheromone has been shown to significantly decrease the signs of social conflict between cats in multi- cat household. With continued research, this pheromone may demonstrate other situations in which it will be effective at decreasing signs of fear and anxiety in cats.[14]

The equine appeasing pheromone, also recently available commercially, has been shown to help calm horses during transport and may aid horses in the performance of certain cognitive tasks.[15, 16]

A variety of different pheromones exist in animals, many of which have yet to be isolated and studied. It is known that pheromones serve a variety of different purposes for animal; they can communicate a state of alarm, as well as communicate a range of social and sexual information. Several different facial pheromones have been identified in the cat; [5] these pheromones are deposited in the environment when the cat rubs it face on objects, leaving behind a message that identifies objects and the environment as “safe.” The synthetic analogue of this pheromone is commercially available and has been shown to aid in reducing the incidence of urine marking behavior in cats[17]

SEMIOCHEMICALS IN PET BEHAVIOR MANAGEMENT

Traditionally many behavior problems in pets have been viewed strictly as behaviors that are unwanted by humans and change was required in order for the animal to remain acceptable as a pet. With a growing awareness that many unwanted problem behaviors in pets stem from anxiety or other situations where the behavior was simply an

expression of the pets' uncomfortable emotional state, the behavioral approach has changed from a focus on "the unwanted behavior" to a focus on "the emotional state". When the emotional state is changed from one of "fear and anxiety to one of calm relaxation, the unwanted behavior is highly likely to be replaced by behaviors that are more acceptable to the owners. It is well recognized that a pet in a state of fear or anxiety is not in a state where it can learn, or where it is likely to make behavioral choices that are acceptable to humans. When in a relaxed, emotionally balanced state, animals are better able to be taught to perform acceptable behaviors and are more able to make choices to perform those behaviors that humans may prefer.

One of the many benefits of using pheromone therapy when working with animals with problem behaviors is that they act quickly to change the emotional state of the animal. They do not require absorption into the blood stream nor metabolism by the animal to have an effect. This makes them very safe for any age of animal regardless of its state of health and safe to use with any other medication that an animal may be receiving. In addition, the ease of application of the pheromone products makes them easy and convenient to use thus ensuring client compliance.

Research into semiochemical communication continues to identify safe and effective uses for a variety of different synthetic semiochemicals in agriculture and companion animal care. Similar to any other form of therapy, semiochemicals may not solve every problem behavior faced by animal owners, but they provide us with a fast acting and easy-to-use tool that is worthy of incorporation into many behavior treatment plans.

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