News Release
Kao Corporation

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FOR IMMEDIATE RELEASE

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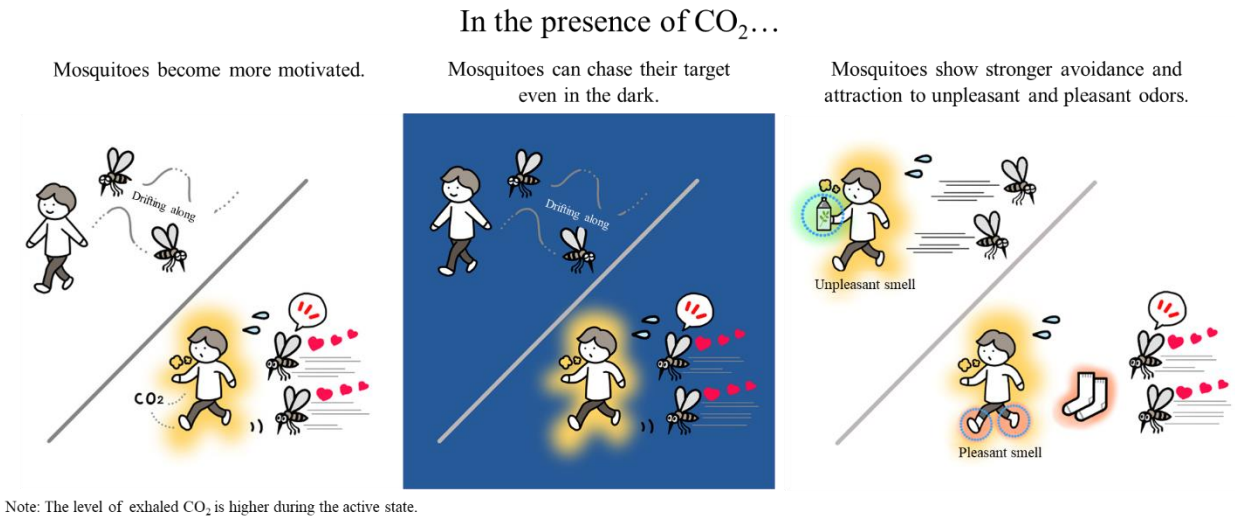
Virtual Reality Experiments Reveal that CO_2 Sharpens Mosquitoes' Senses

Kao Corporation's (hereinafter referred to as "Kao") Human Health Care Products Research Laboratory has conducted experiments in collaboration with the Laboratory for Circuit Mechanisms of Sensory Perception at RIKEN Center for Brain Science and found, using a virtual reality device[*1] designed for mosquitoes, that the presence of CO_2 enhances mosquitoes' responses to various visual cues and odors. These findings are expected to help us better understand the conditions in which mosquitoes are more likely to bite humans and provide important insights for developing effective countermeasures.

The results of these experiments were published in *Scientific Reports* on 20 August 2025.[*2]



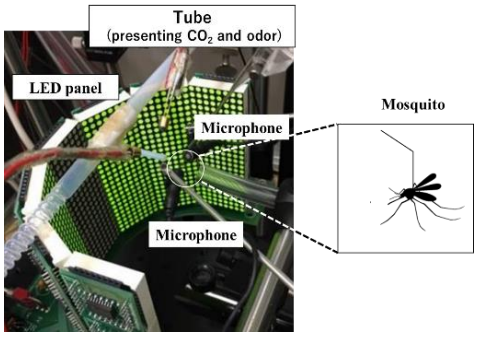
Note: The level of exhaled CO_2 is higher during the active state.

*1 Kao News Release dated June 5, 2024: Advancing Towards Safe and Effective Topical Mosquito Repellents Against Dengue

*2 Kato-Namba A., Ohta K., Nakagawa T., Kazama H., Context-dependent effects of carbon dioxide on cross-modal integration during mosquito flight. Scientific Reports, DOI: 10.1038/s41598-025-13427-z

Background

Mosquitoes are equipped with sophisticated sensory systems and use them in sequence to reach humans from a distance: they activate their flight behavior by sensing CO_2 in human breath, approach their target by using visual and olfactory cues, and land on the skin upon detecting its heat. Kao is currently collaborating with RIKEN to study mosquito behavior using a virtual reality device. In their most recent experiment, researchers investigated how CO_2, a sensory cue that initially prompts mosquitoes to identify humans, affects mosquitoes' visual and olfactory behaviors.



A virtual reality device developed by Kao and RIKEN

1. CO_2 increases motivation to pursue moving objects.

A mosquito was placed in a virtual reality device and shown a single black bar simulating a human figure, which moved in sync with the mosquito's motions. Because mosquitoes are attracted to dark colors, it naturally tracked the moving bar. However, when exposed to CO_2, their tracking behavior became more precise.

Previously, CO_2 was thought to act as a trigger for mosquitoes to detect humans from a distance before approaching them using visual cues. However, our study suggests that mosquitoes continue to detect CO_2 even after spotting a human, and that CO_2 helps maintain their motivation to pursue the target.

2. CO_2 enables mosquitoes to track rapidly moving and low-contrast objects.

In another experiment, mosquitoes were shown moving stripes. Normally, the mosquitoes would track the pattern only at a certain speed. However, when exposed to CO_2, they were able to track faster-moving stripes. Additionally, they could also track low-contrast (low brightness) stripes that are normally hard to follow.

These results suggest that CO_2 increases mosquitoes' sensitivity to visual cues.

3. CO_2 enhances attraction to pleasant odors and avoidance of unpleasant odors.

Mosquitoes in the virtual reality device flew toward the odor of human socks, an attractive smell for them. However, in the presence of CO_2, mosquitoes flew more directly toward the odor. On the other hand, in response to linalool, an odorant found in herbs and other plants that repels mosquitoes, they showed stronger avoidance behavior when CO_2 was present.

These results suggest that CO_2 amplifies both attraction and aversion to specific odors.

Summary

This study revealed that CO_2 significantly enhances the sensitivity of mosquitoes to visual and olfactory cues. CO_2 strengthens mosquitoes' behavior of both chasing the target and avoiding unpleasant stimuli. The study also suggested that CO_2 may make it easier for mosquitoes to chase humans even at dusk when visibility is poor. These findings are expected to help us better understand when and how mosquitoes bite, and provide important knowledge for devising effective prevention strategies.

Researchers' Comments

・Aya Namba, Researcher at the Kao Human Health Care Products Research Laboratory

Our findings open up possibilities for developing new materials and combinations of materials that can more effectively attract or repel mosquitoes. We believe that this will reduce the risk and health damage caused by mosquito bites, which will help "protect future lives." We will continue our research to gain a deeper understanding of mosquito behavior.

・Hokto Kazama, Team Director of the Laboratory for Circuit Mechanisms of Sensory Perception at the RIKEN Center for Brain Science

By constructing a virtual reality device tailored to mosquitoes, we were able to accurately present various combinations of sensory stimuli such as CO_2, visual cues and odors, and discover new aspects of mosquito behavior. This setup allows us to observe mosquito behavior with high spatiotemporal resolution, and in the future, could be combined with neural activity recordings. We look forward to further advancing this research.

About Kao

Kao, a Japan-based manufacturer of personal care and household products, cosmetics, and specialty chemicals creates high-value-added products and services that provide care and enrichment for the life of all people and the planet. Through its brands such as *Attack* laundry detergent, *Bioré* and *Jergens* skin care products, *Laurier* sanitary products, *Curél*, *SENSAI*, and *MOLTON BROWN* cosmetics, and *Oribe* hair care products, Kao is part of the everyday lives of people across Asia, the Americas, Europe, the Middle East, and Africa. Combined with its chemical business, which contributes to a wide range of industries, Kao generates about 1,630 billion yen in annual sales. Kao employs about 32,600 people worldwide and has more than 130 years of history in innovation. As an enterprise that provides products people use on a daily basis, the Kao Group takes responsibility to actively reduce the environmental footprint of its products throughout the product lifecycle. This is laid out in Kao's ESG strategy, the Kirei Lifestyle Plan, which launched in 2019.

Please visit the Kao Group website for additional information.

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