

What do ants and light rays have in common when they pass through lenses?

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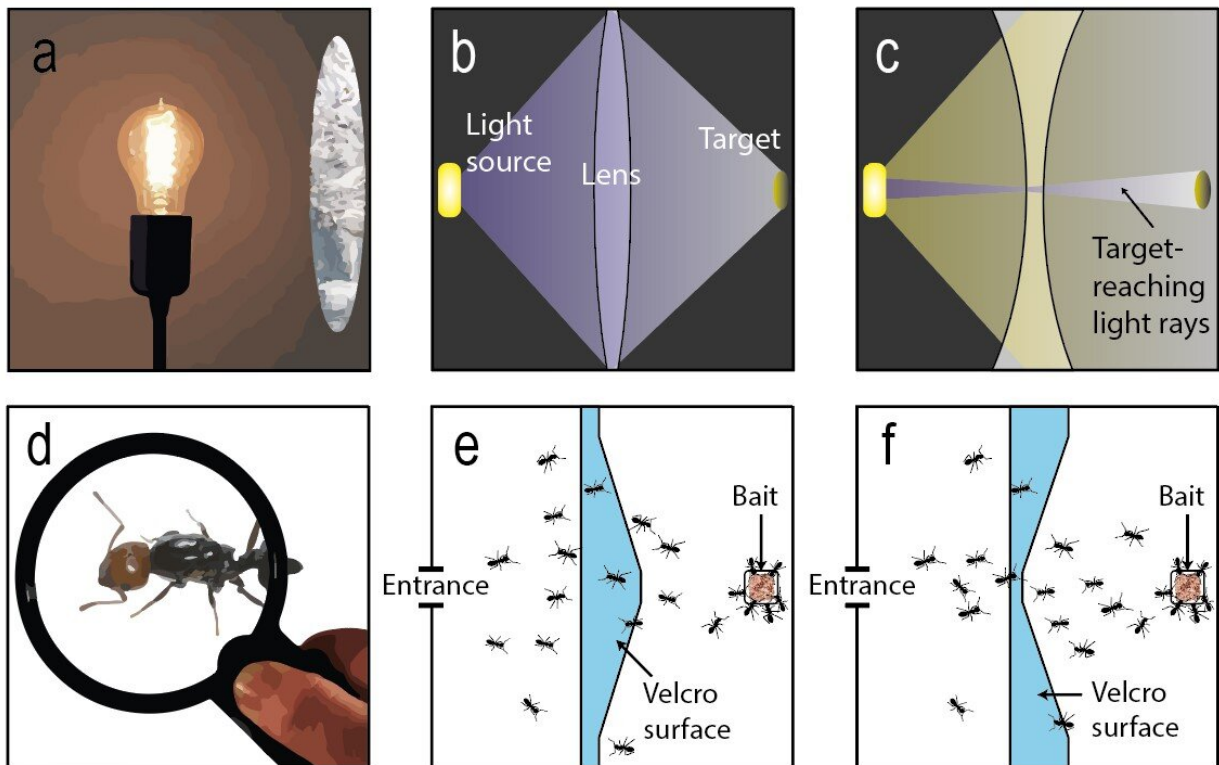


Figure 1. Similarities between dispersion of light and dispersion of ant trails across convex and concave lenses between light sources and target, or nest and food source. Light rays that originate from the light source and pass through a lens (a) to reach the target can travel through the wider area of the convex lens (b) compared to the concave lens (c). Ants (d) travelling between their nest and food source behave in a generally similar manner: they disperse more across the convex (e) than that across the concave "lens" (f) made of Velcro that slows ants down. The underlying hypothetical reason for this similarity is the tendency to reduce travel time by the both, the light and the ants. Credit: Choi J, Lim H,

Song W., Cho H., Kim HY, Lee SI, Jablonski PG. [(b, c, e, f are adapted and modified from Choi et al. (2020))
(<https://www.nature.com/articles/s41598-020-65245-0>)

Light and foraging ants seem totally unrelated, but they have one thing in common: They travel along time-reducing paths. According to Fermat's principle about the refraction of a ray of light, the light bends when it meets matter with different refractive indices and travels through time-minimizing paths. Recently, similar behavior was reported in foraging ants in a lab setting: Ants bend their travel paths when they enter a substrate that slows them down. But would the ants behave similarly as the light passing through convex or concave lenses when they travel through impediments with lens-like shapes? A multidisciplinary team of researchers from Seoul National University (SNU) and DGIST in Korea composed of ecologists and an engineer conducted experiments in the field to find out if the ants behave similarly to light.

The study involved the following reasoning: Laws of optics predict that [light](#) rays reach the target on the other side of a convex [lens](#) by crossing the convex lens nearly everywhere; the crossing points can be quite far from the center of the lens (Fig. 1b). On the other hand, light rays crossing the concave lens can reach the target only when they pass through the points near the center of the lens (Fig. 1e)

The researchers asked whether [ants](#) also show similar trends when they cross lens-shaped impediments made of Velcro tape during their foraging trips. On the Velcro "lens," the ants cannot walk as fast as they can on a normal, flat surface. The researchers put these "lenses" between the nest entrance and the food source near several colonies of the Japanese carpenter ants and observed what happened. It turned out that the trails of ants crossing the "convex lens" diverged away from the

center more than they did on the "concave lens." This means that more ants avoided the thick central part of convex impediment, and more ants walked through the narrow central part of concave impediment. This suggests that ants tend to avoid the parts of impediments that considerably slow them down.

This general similarity to the behavior of light crossing through convex and [concave lenses](#) is consistent with the idea that foraging ants, like light rays, use time-reducing paths. "I studied math and physics as an undergraduate, and this has helped me to come up with this research idea after I was exposed to the wonders of the behavior of ants by my lab mate, Dr. Woncheol Song," says Ph.D. candidate Jibeom Choi, who conducted the experiments and created a mathematical model of ant behavior.

Collaboration between a behavioral ecologist, Prof. Piotr Jablonski (Laboratory of Behavioral Ecology and Evolution, SNU) and a theoretical engineer, Prof. Hoyoung Kim (Microfluids & Soft Matter Laboratory, SNU), additionally highlights the multidisciplinary merit of this study. "This is an example of synergistic effect of multidisciplinary collaboration; by crossing the boundaries between disciplines, we have a fuller understanding of the natural world," says integrative ecologist Prof. Sang-im Lee (Laboratory of Integrative Animal Ecology, DGIST), who has been actively pursuing multidisciplinary research at SNU and DGIST, and has been involved in research on ants for years.

There are, however, remaining questions to be resolved. As pointed out by authors themselves, the behavior of individual ants on the Velcro impediment and its borders has not been thoroughly investigated and it may contribute to the observed pattern. Therefore, further studies should focus on the behavior of individual ants at the edges between different substrates.

More information: Jibeom Choi et al, Trails of ants converge or diverge through lens-shaped impediments, resembling principles of optics, *Scientific Reports* (2020). [DOI: 10.1038/s41598-020-65245-0](https://doi.org/10.1038/s41598-020-65245-0)

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