

VOLUME 103 NUMBER 3

The Linking Ring

MARCH 2023



ROB AND CAROL ALLEN

OFFICIAL PUBLICATION OF THE INTERNATIONAL BROTHERHOOD OF MAGICIANS

The International Brotherhood of Magicians

Founded in 1922 by
Len Vintus, Gene Gordon, and Don Rogers.

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THE LINKING RING (ISSN 0024-4023) is published monthly by the International Brotherhood of Magicians. Office of Publication, 13 Point West Blvd., St. Charles, MO, 63301, for members only. Annual dues, \$60.00, includes \$20.00 for 12 issues. PERIODICALS postage paid at St. Louis, MO and other places. ©2023 by the International Brotherhood of Magicians. All rights reserved under international and Pan-American conventions. Reproduction of THE LINKING RING magazine in whole or in part is forbidden without prior written permission. For airmail, address changes, and other official business, contact our International Executive Secretary (see above). POSTMASTER: Send address changes to THE LINKING RING, 13 Point West Blvd., St. Charles, MO 63301.

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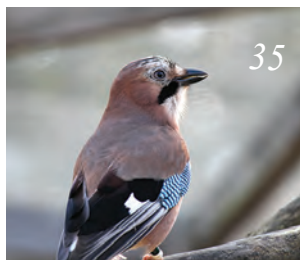
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Sleight of Wing

By Jason Goldberg

Dr. Nicola Clayton FRS (Fellow of the Royal Society, and the Professor of Comparative Cognition at the University of Cambridge, UK) makes it sound almost surprisingly easy to perform the French Drop with a worm. “Just pinch the top of the head and you can paralyze the worm.” Just another day for the team at Clayton’s Corvid Comparative Cognition Lab at the University of Cambridge, England.

You have probably seen the YouTube videos of people performing magic for animals at home or at the zoo. A treat disappears and the animal appears to look confused or surprised. The dog sniffs the person’s hands, the ape gapes and rolls on the floor, the goat is nonplussed and ignores it. But, what’s really going on? Can an animal actually perceive a magic effect as humans do? And if so, what can that teach us?

The lay community continues to find new ways to apply magic techniques in nontheatrical ways. For example, Dr. Stephen Macknik’s and Dr. Susana Martinez-Conde’s *Sleights of Mind*, and Dr. Gustav Kuhn’s *The Science of Magic*, explore what magic says about neuroscience and psychology. Dr. Kevin Spencer is researching the

physical and recreational therapy benefits of applying magic in medical settings. Christine Corcos edited the collection *Law and Magic* exploring issues ranging from hypnosis, to protecting secrets, to haunted houses and real estate. David Fisher’s *The War Magician* describes the efforts of Jasper Maskelyne and others to use deception to help the Allies win World War II. With the Corvid Lab, Clayton and her colleagues are taking magic applications in a new direction.

Clayton’s particular expertise is zoological. She studies corvids, which are birds that include crows, ravens, jackdaws, magpies, rooks, and jays. Her research lies in studying the cognitive abilities of animals and children. How do they think? What is their memory like, their imagination? We as a society have long assumed that only humans can plan for the future and think about the past, and that only people understand that other living beings have a separate mind. Clayton’s work challenges those assumptions, raising not only important questions about the evolution of cognition but also altering our understanding about what animals are thinking. Studying animals allows us to help better understand human memory

and consciousness, not to mention giving us a better understanding of how the natural world works.

Ask a magician when they got the magic bug, and most will tell you that they got it as a kid. Most biologists are no different. As a child, who hasn't played with bugs in the dirt, searched for tadpoles or salamanders, become entranced by a really big fish, or scoured the coastline for hermit crabs and seashells? Clayton's interest is the same. "I have been fascinated by birds since I was a kid. I wanted to know what it was like to think like a bird, to be a bird." She knew early on that she wanted to study bird psychology. When the time came for her to pursue university studies, she entered Oxford's Zoology Department, which has a large bird institute and had given her the opportunity to pursue her interests professionally. She earned her Bachelor of Arts in Zoology from Oxford in 1984, and her Ph.D. in bird song learning from St. Andrews in 1987. Today she is the Professor of Comparative Cognition and a University Teaching Officer in the Department of Psychology at Cambridge University, a Fellow of Clare College, Cambridge, and a Fellow of the Royal Society. In addition to her work as a biologist, Clayton also pursues dancing and choreography and serves as Scientist in Residence and Associate Artist at Rambert, a contemporary dance company in London, where her studies in birds have also influenced her interest in movement.

Why corvids and not other animals? Clayton replies, "Corvids possess sophisticated attentional mechanisms and are a suitable candidate for this line of research because they follow human gaze around particular objects and monitor human attentional states. Other animals, like chimpanzees, don't have the same attention span." Birds are easier to maintain in a lab and easier to work with. Plus, corvids have been observed using deception in the wild. Some corvids are pilferers, meaning they will watch where another bird hides food and then steal it later. Those same birds will relocate food they have themselves cached, or hidden, when

they think another bird watching them isn't looking anymore, suggesting they might be using similar deceptive techniques that magicians use. In addition, it's relatively simple to maintain a flock of birds for use in controlled experiments. Not to say that Clayton hasn't worked with other species. She has also published research studying the cognitive abilities of cephalopods, which are animals without a backbone that include octopi, cuttlefish, and squid. However, corvids are her main area of expertise.

Clayton's questions surrounding whether magic effects and visual illusions, as employed by magicians, might be used to study cognition in humans and other animals began once she met Professor Clive Wilkins MMC (Member of The Magic Circle). Clayton and Wilkins met through their shared interest in tango. In addition to her work as a scientist, Clayton is also an accomplished tango, salsa, ballet, and contemporary dancer, which has also given her a number of important insights into the courtship behavior of corvids and other species. For example, thinking about the synchronous leader-follower movements of her rooks as avian tango. Clayton and Wilkins quickly discovered another interest in science and magic. Wilkins says, "We quickly developed a symbiotic relationship in which she shared the things she knew as a scientist and a dancer, and I shared my understanding of the world through the eyes of an artist, writer, and magician. We discovered many things in common, as well as interesting anomalies and ideas new to both of us." Wilkins became the Artist in Residence in the Department of Psychology at Cambridge, which gave him and Nicky the opportunity to develop their collaboration further. During this period Clive has also written a series of novels, *The Moustachio Quartet*, investigating memory and mental time travel. Each novel focuses on an individual character, and the books can be read in any order, which alters the way in which the reader interprets how the events unfold. One of the novels, *Count Zapik*, deals with questions about memory and perception

through the life and times of a fictional magician and his beautiful assistant.

Clayton and Wilkins have worked together for almost thirteen years, and their efforts have taken shape in “The Captured Thought,” a collaboration which explores the subjective nature of memory and mental time travel, of perception and creativity. Clayton observes, “These are interesting questions because the use of magic effects to deceive animals could only be feasible if both human and animal spectators shared some analogous cognitive processes that capitalize on perceptual blind spots and cognitive roadblocks.” There were other links. Physically, corvids are built for deception. They have a secret pouch under their tongue that they can use to carry food, essentially giving them the means to perform sleight of beak. They can also use their wings to obscure the audiences’ view in interesting ways, hence sleight of wing.

Wilkins agrees. “I think the thing that brought Nicky and I together was a shared fascination and need to understand how minds make sense of the world, infinitely aware that the ways in which any of us see are often dangerously prejudiced and biased in so many ways. No two realities are the same, the people who you think see the world in the way that you do, can quite often be very much more eccentric and at variance to yourself than you realize. The question then arises, ‘What is right and what is true, and how could we even begin to test for these things?’”

One of the principles that Clayton, Wilkins, their students, and post-doctoral researchers study includes mental time travel. The principle is the same regardless of whether you are a biologist or a magician. As a magician, you build an expectation in the audience’s mind. The rings are solid, the card was shuffled back into the deck. We sometimes even make the audience remember things that don’t happen. When the

magic happens, we violate the audience’s expectations and create a magical moment of surprise. Animals such as corvids may have a similar capacity. The food a pilferer is seeking isn’t always where they thought it was because it’s been secretly moved without them knowing, thanks to a combination of sleight of beak and sleight of wing.



Clive and Nicky on stage.

How does the French Drop fit into this? In a scientific paper¹ published last year in the Proceedings of the National Academy of Sciences, Clayton and several authors studied whether humans and other animals differ in their attention and perception. Her team, led by Dr. Elias Garcia-Pelegrin, experimented with techniques from earlier studies that had successfully used magic to study human responses. Could the same be applied to animals? They used the French Drop, palming, and fast pass to determine whether Eurasian jays can detect a treat,

1. Garcia-Pelegrin E, Alexandra SK, Wilkins C, Clayton NS (2021) Exploring the perceptual inabilities of Eurasian jays (*Garrulus glandarius*) using magic effects. *PNAS* 118:35 <https://doi.org/10.1073/pnas.2026106118>

gauging their expectations of the outcome. Are the birds deceived when a tasty treat disappears and reappears somewhere else, and if so, what is their response? The tricks were selected because they each set up a different expectation in the spectator (whether human or bird) about whether an object (in this case, a worm, a treat that the birds like) has or has not been transferred from one hand to the other. Because of the way the tricks are performed, the spectator needs to have some understanding of how objects are transferred through the French Drop and palming, or at least what appears to be happening. One hand appears to physically transfer the worm to another hand. It relies on understanding the concept that a hand can give an object to another hand. That's easy for people, but it's not something a bird might be expected to follow because birds don't do this kind of action. The fast pass, however, does not raise the same preconceived notions because it only relies on speed. All animals, human and corvid alike, might be expected to understand that an object in motion (like a tossed worm) will stay in motion. Is the hand truly quicker than the eye? And what happens when that eye belongs to a hungry jay who almost certainly sees the world differently than we do?

The results from the research revealed that the birds do indeed perceive magic differently than human spectators. The French Drop and palming techniques, which rely on understanding hand manipulation and expectations of what the two hands are doing, did not deceive the birds, while the humans tested were indeed fooled most of the time. The birds simply followed the worm. The fast pass, however, fooled both people and the jays. As the authors concluded, "Magic effects can provide an insightful methodology to investigate perception and attentional shortcomings in human and non-human animals and offer unique opportunities to highlight cognitive constraints in

diverse animal minds." A video about the work can be found on YouTube.

The idea for the research combined Clayton's interest in science, dance, and birds. She was studying bird caching behavior, which is found in corvids. When a bird caches food, they hide it, and they use their memory to recover caches weeks to months later. When they do, the birds will go to great lengths to protect their food while pilfering from other birds. Notably, birds that pilfer are more likely to be the ones to recache their food if they think another bird is watching them. It's about more than knowing where the acorns are buried. The birds need to understand spatially where their food is stored and also what the perceptions of the other birds might be. If a bird believes another bird will steal their food, they will spend valuable energy re-hiding it. The question raised interesting ideas about the Theory of Mind, the capacity to understand others by ascribing mental states to them, and whether birds have their own perspectives on what's happening around them.

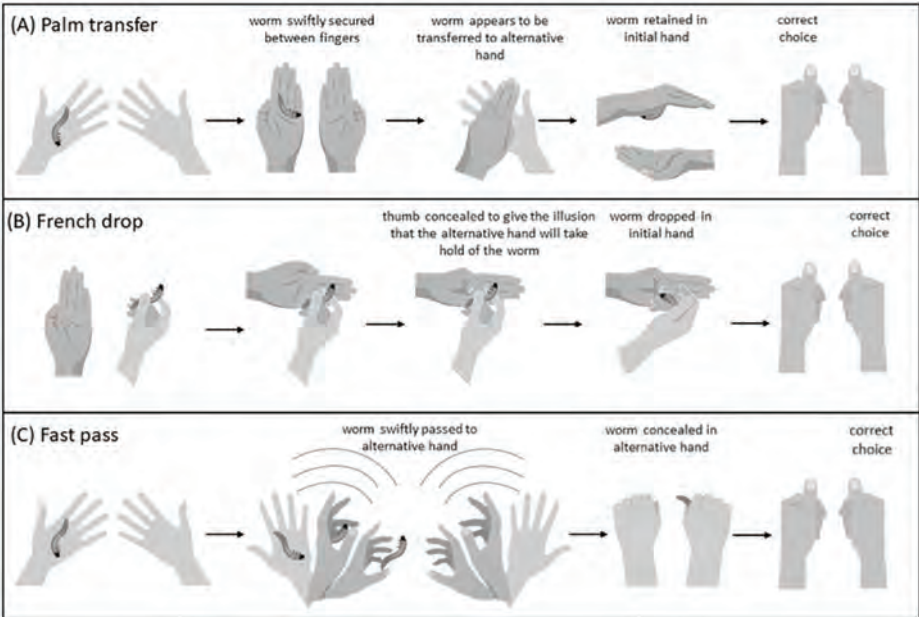
Other researchers in Clayton's lab are now exploring related areas. Lest you think the fast pass isn't really a trick, other work from the lab will convince you. For example, Dr. Alexandra Schnell, who was the lead author, published a paper² with Dr. Elias Garcia-Pelegrin, Dr. Maria Loconsole, Professor Clive Wilkins, and Professor Nicky Clayton last year that used a variation of the Cups and Balls. In the experiment, jays were tested to see what their responses would be when a treat hidden in a cup was switched, either for a less or more desirable food item. The less desirable treat was a peanut. The corvids in Clayton's lab will eat it, but they prefer worms or cheese. (Don't we all?) The team found a few interesting things. The birds readily accepted food that was consistent with their expectations. If the treat they saw first was a peanut, they would eat the peanut without hesitation. If the treat was a

2. Schnell AK, Loconsole M, Garcia-Pelegrin E, Wilkins C, Clayton NS. (2021) Jays are sensitive to cognitive illusions. *R. Soc. Open Sci.* 8: 202358. <https://doi.org/10.1098/rsos.202358>

worm or bit of cheese, they were more likely to check out the cup before eating the treat, rather, as the authors note, like a human discovering a £5 note had transformed into a £20. However, if the reverse happened, and the worm or cheese turned into a less desirable peanut, not only did the birds check out the treat longer, but the more socially dominant birds in the flock were more likely to reject the less valued treat altogether, much like a spectator might show disappointment when a £20 note turns into a £5. Biologically, a few things are going on here. First, the birds are demonstrating that they remember the content of hidden items; they remember what was in the cup before the switch. Second, they are more sensitive to the change from the trick if they perceive a loss in value in what they get. Cognitively, the team noted that jays might be using a combination of abilities such as memory, imagining the future, and evaluating expectations. In addition to shedding new light on corvid biology, the study showed that using cognitive illusions like the Cups and Balls can offer new

avenues for investigating animal psychological traits and may offer new ways to study animal behavior.

Studies like these reveal fascinating links between science and the arts, especially magic. Wilkins notes, “The toolbox and skills of an artist and scientist, although different, do highlight similarities, as well as discrepancies in the methods humans use to investigate their sense of being and the world around them.” As Clayton says, “Magic occurs in the mind of the audience. Although they rely on perception and attention, they also rely on mental time travel. You have to remember what you think you saw, which isn’t always what happens, and you need an expectation about where the object is. That provides the opportunity for talented magicians to generate surprise and fool the audience.” In addition to the psychological principles you expect, these are also biological principles because they’re not unique to humans. Other animals can form expectations, have memory and perceptual abilities, and have the capability to



Worm magic: The three sleight of hand techniques used in Garcia-Pelegrin E et al (2021). Proceedings of the Natural Academy of Sciences, 118 (24) e2026106118 (A) Palm transfer, (B) French drop, and (C) Fast pass. Reprinted with permission.

be fooled. As mentioned earlier, pilferers are more likely to move food when another bird isn't watching. They're using their expectations that their own food may be stolen, suggesting they're using their own past experience as a pilferer to make decisions rather than instinct. Magicians do the same thing when we use our own experience in practicing and performing from others to improve our own techniques.

A 2020 paper³ that Clayton and Wilkins co-authored with others in the Corvid Lab highlights additional links. “[T]he study of magic effects has started to gain attention from the scientific community ... [because of] ... what magic effects might reveal about the blind spots in our perception and roadblocks in our thinking ... [B]ecause magic effects capitalize on our ability to remember what happened and our ability to anticipate what will happen next, using magical frameworks elicits ways to investigate complex cognitive abilities such as mental time travel ... [T]he application of magic effects to investigate the animal mind can prompt the comparison of behavioral reactions among diverse species, in which magic effects might exploit similar perceptive blind spots and cognitive roadblocks.”

Like any magician, careful selection of tricks can make or break a good research project. Clayton and her team pick the tricks to use after long discussions, and rely on their respective expertise. For example, Schnell knows cephalopods, while Wilkins is the artist, painter, and magician, with a particular knowledge of illusions and problem-solving. They brainstorm what effects would be easy to do and could be done with the birds. As it turns out, the birds Clayton works with are magicians in more ways than one. “When I’m working with the birds, I need to keep a close eye on them because things can appear and disappear. I was filming with Clive at the London Film Studio, and the producer found a tame raven from another person. Clive had brought a lemon

as part of a Chop Cup routine. The raven was about to fly over and steal the lemon, but I grabbed the lemon before it disappeared!”

And about performing the French Drop with a worm. It’s a lot harder than it sounds. According to Garcia-Pelegrin, now an Assistant Professor with the National University of Singapore, “It took me three months of continuous practice to do so, to the dismay of my fiancée that had to spend three months with worms roaming all over our house!” There’s also a method. According to Clayton, “You squeeze the trigeminal nerve at the base of the head of the worm to paralyze it.” Surprisingly, this was a trick that Clayton learned from the birds in her lab. “I was observing experienced jays such as the late PsychoBird (a Californian scrub-jay who lived to be twenty-five) and Hoi (a Eurasian jay) doing just that. Why do they do it? Because the worm doesn’t decay, at least at the same rate, so the worm is edible for so much longer. By doing so, human experimenters don’t notice the birds had cached them because worms appear almost colorless. If you kill them, horrid noticeable black stuff oozes out of the worm. We didn’t know about the secret worm stashes until we installed a GoPro.” Clayton further wryly observes, “Maybe that’s why magicians in certain contexts (not about worms, of course) also say, ‘No video, please!’” And you thought asking your significant other to see another card trick was taxing.

It’s easy to see the results that the Corvid Comparative Cognition Lab and The Captured Thought have generated, and demonstrates the power of partnerships in practice. Clayton says, “The work I’ve done with Clive shows how integrated and interwoven our individual and mutual expertise improves our respective work and what an excellent example it is of the application of transferable skills in science, art and the performing arts.” The work has started to get some attention from the magic community. The Science of Magic Association and the

3. Garcia-Pelegrin E, Schnell AK, Wilkins C, Clayton NS. (2020) An unexpected audience. *Science* 369: 6510. <https://doi.org/10.1126/science.abc6805>



(above): Lisbon imagines his future.

(right): Wiggins wonders why light matters and how to use it serendipitously to conceal precious treasures from her audience of onlookers.



Magic Circle have taken note, not because Clayton's team is exposing methods, but rather using them to explore minds. Wilkins says, "We tell our audiences at lectures, after demonstrating some amazing illusion, that although everyone may want to know how the effect they have just seen works, the more important question is why it works. We explain the science behind their perception and memory of what occurred, citing a clever phrase, 'You don't remember what happened, what you remember becomes what happened.' We are very strict on protecting the methods magicians employ to achieve their effects. After all, magicians delight in the complexities of seeing and understanding, and we have no intention of stealing their thunder or lessening their effectiveness."

The scientific community has also taken note. The work cited in this column has been featured in highly prominent journals including *Science*, one of the premier publications for scientific research, indicating that other scientists consider the work both novel and valuable. The scientific community and the public have also come through to help rescue Clayton's lab. Earlier this year, funding for the lab was jeopardized because of budget cuts, but the scientific community and public rallied. Dr. Jonathan Birch, an Associate Professor with the London School of Economics and Political Science, initiated a letter signed by 358 scientists. In part, it

said, "To understand intelligence, cognition, and the mind, we must investigate the minds of other animals, not just humans. Animals that have followed a very different evolutionary path from our own, such as birds, are of special scientific importance . . . The international significance of the Cambridge Corvid Comparative Cognition Lab is hard to overstate. Its closure would be a grievous blow to the entire field of comparative psychology and a terrible loss to the sciences of mind and brain." With the outpouring of support, Clayton now has funding to keep the lab operating for the next five years. She gratefully said, "Every little bit helps. It's been heartwarming to see the response from both the public and the scientific community."

And what does Clayton think about those YouTube videos? She's open to the idea that animals may be responding as we think they are, but it's not certain. As she and her colleagues said in the 2020 article they wrote for the journal *Science*, "Without further investigation, it cannot be assumed that the animal audiences in the videos are amazed and surprised by the magic effect, akin to a human spectator. However, these encounters prompt investigation about the extent to which animals are susceptible to the same techniques of deception commonly used by magicians." In other words, the jury is still out, but it suggests unique opportunities for the scientific and magic community.

Clayton and Wilkins have a number of ideas of where to go next. Clayton says, “There are many more questions related to mental time travel. How do birds think about the future? We also want to investigate how birds respond to mirrors, their understanding of language, and of course there are other tricks we want to experiment with to study the birds’ cognition.” The work may also incorporate other animals, especially cephalopods. “They are colorblind, yet they have so many interesting ways in which they can change color. What’s going on there, and is there a link to black art magic effects? We are also thinking about similarities between fingers and feathers and how delving into the taxonomy of magic might help us find new ways to relate to birds.” Wilkins agrees, “We have on occasion used devices, gizmos, and mechanisms to test out our ideas, but most recently have stuck to psychological deceptions using ordinary and unprepared objects. These can be more easily tested on both humans and other animals using the same criteria for investigation. There is so much in the magician’s armory of effects that we might choose to use to build our experiments. It is after all one of the richest sources to mine for examples of how minds can be tricked by the realities that appear to unfold all around.”

Clayton and Wilkins are currently writing a book about their work together, as well as documenting Clayton’s research over a lifetime in science; a key component will be all the ways they have used magic to explore and investigate memory and perception in animals, including humans. Asked about what magicians might learn from her work, Clayton is thoughtful. “It’s a confirmation that this isn’t something only human magicians do. Animals use these techniques too. We’re not alone. What you’re doing as a beautiful part of your performing art can also provide a beautiful methodology about how minds work. Some magicians just enjoy performing, and others are interested in philosophy, and many are fascinated by both of these things. Magic really is a powerful tool for understanding the mind. We’re showcas-

ing why it’s delightful.” As a recent student of Clayton’s, Dr. Garcia-Pelegrin agrees. “Working in this research was the perfect amalgamation of all my interests, I think this is why this collaboration with Nicky and Clive has worked so well. We all come from different backgrounds and avenues but share the same drive and passion to uncover the intricacies of both magic and animal cognition. Magic is a craft that is very hard to access for psychologists because it requires years of obsession and meticulous training to perform, and much more than that if you want to master it, so it is understandable that until now no one had translated the science of magic to animal cognition research. It requires a very specialized team that cannot only understand psychology and animal behavior, but also craft new avenues of investigation and perform these tricks to non-human audiences, which definitely has its challenges.”



Promotional shot of Clive and Nicky.

The work at the Clayton Corvid Comparative Cognition Lab has opened new research questions about animals’ intelli-

gence, imagination, memory, and sociality. People and birds have completely different brains, so studying them raises powerful questions about how and why intelligence evolved. Making one more link, Clayton comments, “How can birds have these abilities when they don’t have a six-layered cortex? Magic is an extension to that. It has wonderful parallels even down to lighting, shade, and angles and secret pockets. I am

interested in parallels between the natural caching and cache protection behavior of the jays and magic effects for humans on one level, and what magic reveals in the mind of the audience be they jays or humans, in other words how it allows us to investigate the blind spots in seeing, the roadblocks in thinking, with and without words. It’s lovely to see how the use of magic effects is helping us uncover and explore these questions.”

Professor Nicky Clayton can be reached at nsc22@cam.ac.uk. Professor Clive Wilkins can be reached at cw567@vam.ac.uk. Contributions to the Corvid Lab can be made through <https://www.philanthropy.cam.ac.uk/civicrm/contribute/transact?reset=1&id=4252>. Please visit Dr. Clayton’s website at <https://www.psychol.cam.ac.uk/ccl>, Professor Wilkins’ website at <https://www.psychol.cam.ac.uk/people/clive-wilkins>, or their joint site at The Captured Thought at <https://thecapturedthought.com/>. Jason Goldberg is an Associate Editor for The Linking Ring. A full-time biologist, he also performs magic for *Homo sapiens* at several Smithsonian museums in Washington, D.C.

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