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More than light detectors: the magic of your eyes' pupils

New research reveals pupils detect quantity

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Around a decade ago, groundbreaking research found that pupils don't only detect light. Now, a new Nature Communications study finds they can perceive the amount of objects in a person's field of vision.

The mechanisms we use to sense quantity are located in our pupils.

This is the result of a study conducted by the School of Psychology

burr.html] from the Universities of Sydney and Florence.

"Equally spontaneously, we perceive the number of items before us.

"This ability, shared with most other animals, is an evolutionary fundamental: it reveals immediately important quantities, such as how many apples there are on the tree, or how many enemies are attacking.

"Information about numbers is so important that it is thought most species have a dedicated `number sense'."

Given the importance of the spontaneous perception of quantity, the scientists asked if it may be revealed by a primitive, automatic physiological response.

The pupil light reflex is probably the most automatic physiological response: it constricts in light and dilates in darkness.

"Recent research from our laboratory shows that pupil size is also regulated by cognitive and perceptual factors," said senior author Professor Paola Binda from the University of Pisa.

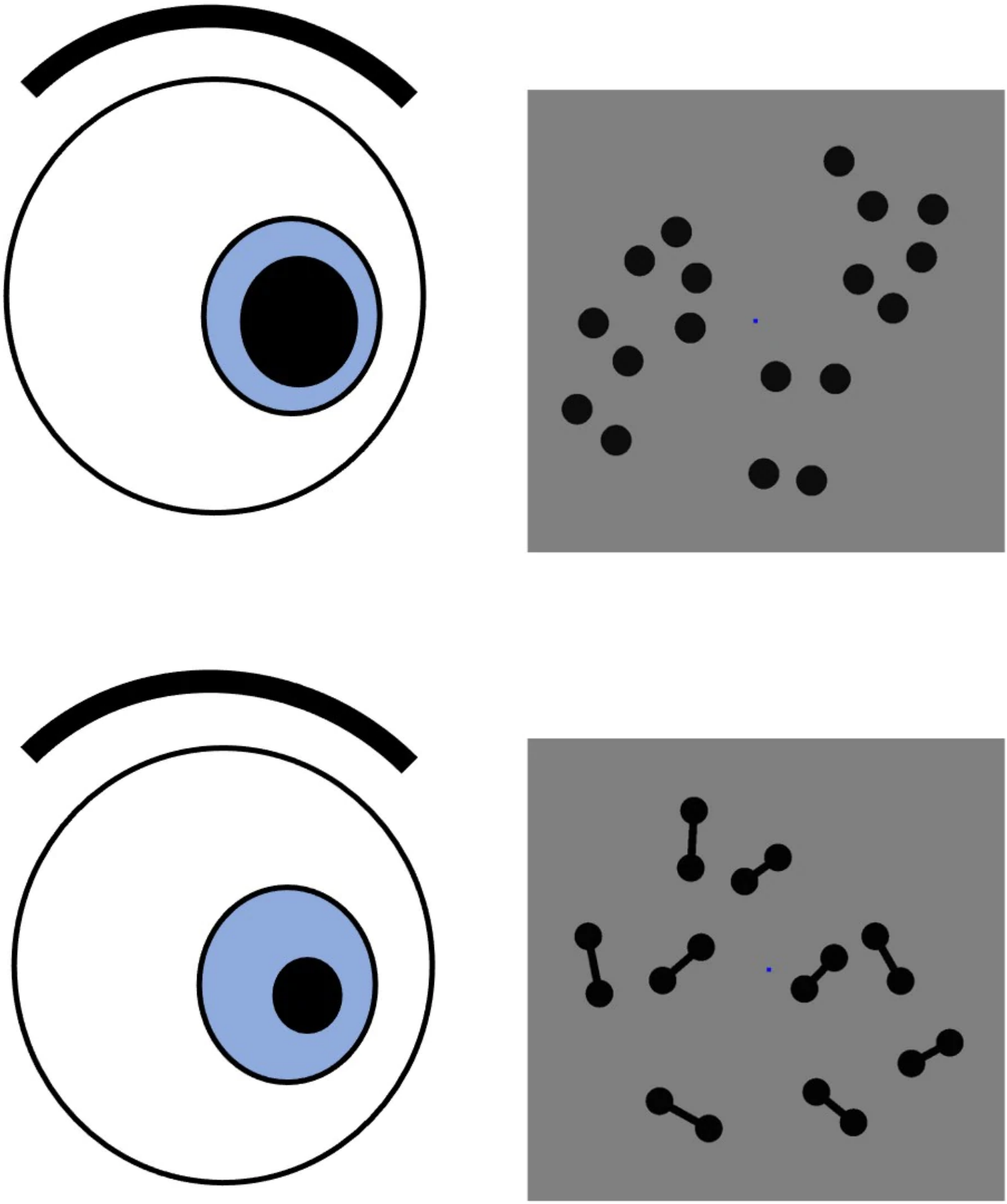

Figure 1.

Connecting the dots into dumbbell shapes causes the dots to appear fewer (although they are the same number), a well-known illusion.

The participants observed the patterns passively, without paying special attention to the number of objects in them, or any other attribute.

Even though the number of pixels (black or white) were the same for all patterns, the diameter of participants' pupils varied according to the perceived number of dots; they were greatest when the perceived number was high, and least when it was low.

"This result shows that numerical information is intrinsically related to perception," said Dr Elisa Castaldi from Florence University.

"This could have important, practical implications.

"For example, this ability is compromised in dyscalculia which is a dysfunction in mathematical learning, so our experiment may be useful in early identification of this condition in very young children.

"It is very simple: subjects simply look at a screen without making any active response, and their pupillary response is measured remotely."

The research results from a network of excellence between the Universities of Sydney, Pisa and Florence, and the National Research Council of Pisa.

It was financed by two European Research Council grants, a Marie Curie Fellowship, and an ARC Discovery Grant.

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Researcher

Professor David Burr

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