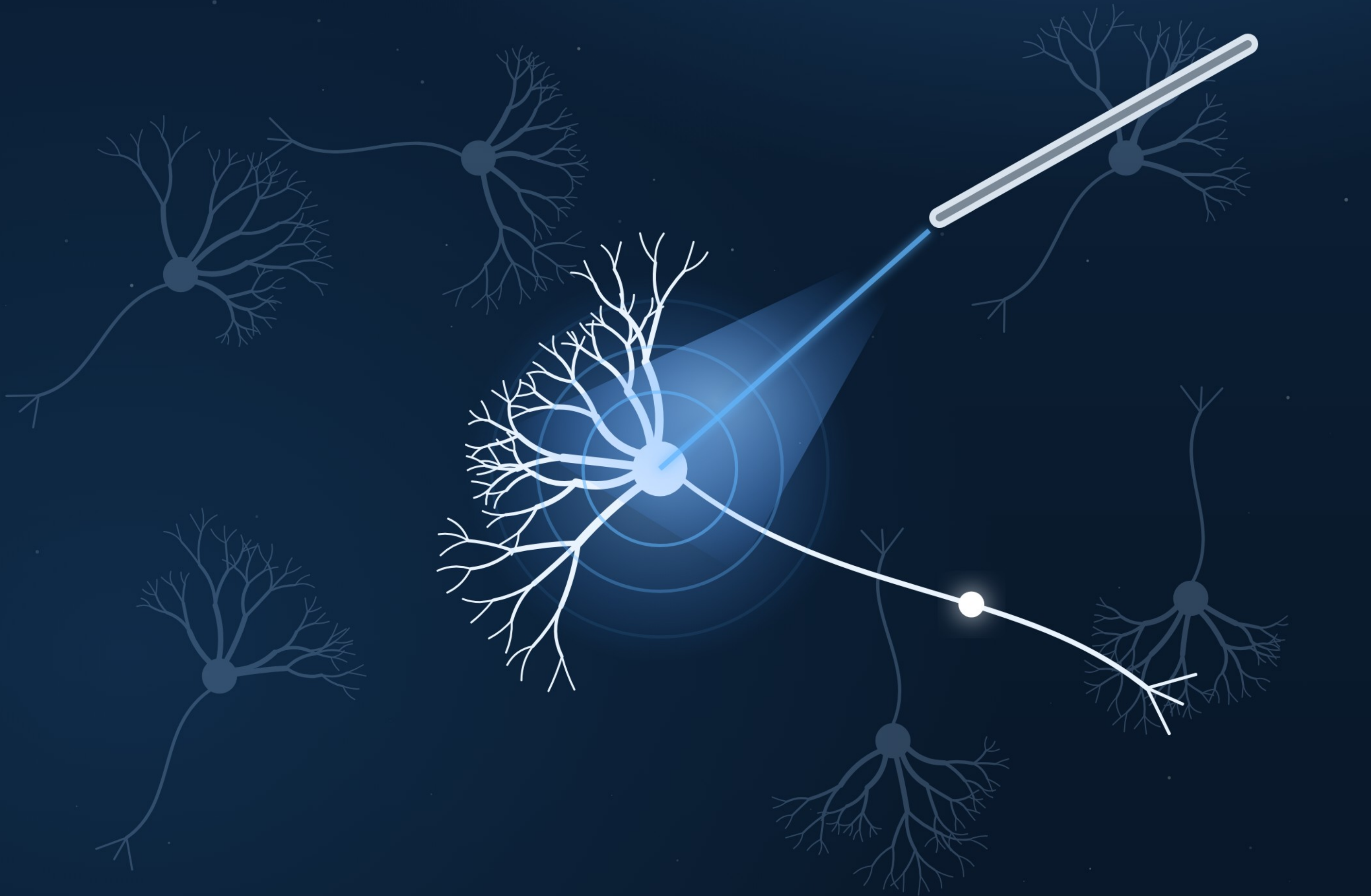


Switching brain cells on and off with light

A light-sensitive protein from algae became a precise tool for testing which brain circuits drive behaviour and disease, and is now being tried to restore some sight.



Light control of neurons changed brain research

Channelrhodopsins and optogenetics

Stanford University, Humboldt-Universität zu Berlin and 1 other

Health and medical research

RESEARCHERS	Karl Deisseroth, Peter Hegemann, Georg Nagel
RESEARCH	2000 to 2026
IMPACT	2000 to 2026
SOURCES	26 in the report
GENERATED	10 October 2026

PROBLEM

RESEARCH

IMPACT

PATHWAY

Scientists could watch the brain, but could not switch chosen cells on or off



electrodes



drugs



only the cells you choose?

1. THE CHALLENGE

Brain and vision disorders cause vast illness and cost, but researchers lacked precise tools to test which cells and circuits actually drive behaviour and disease. Electrical stimulation was not cell specific, and drugs were often too slow or diffuse.

2. THE RESEARCH

The work identified channelrhodopsin-1 in 2002 and channelrhodopsin-2 in 2003, then showed in 2005 that channelrhodopsin-2 could trigger millisecond firing in mammalian neurons. It grew into a toolkit of engineered opsins, targeted delivery and optical hardware.

PROBLEM

RESEARCH

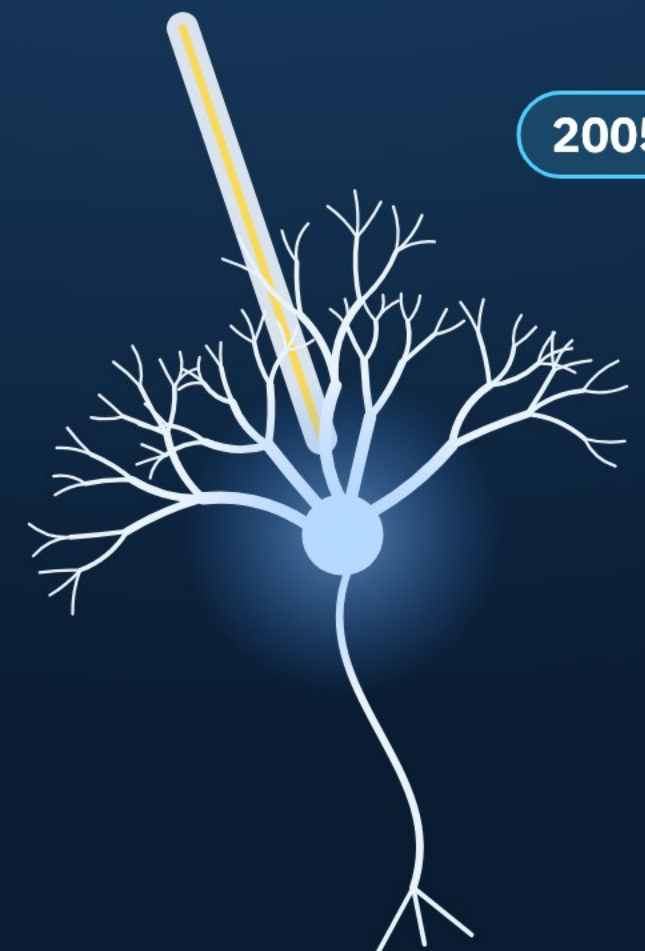
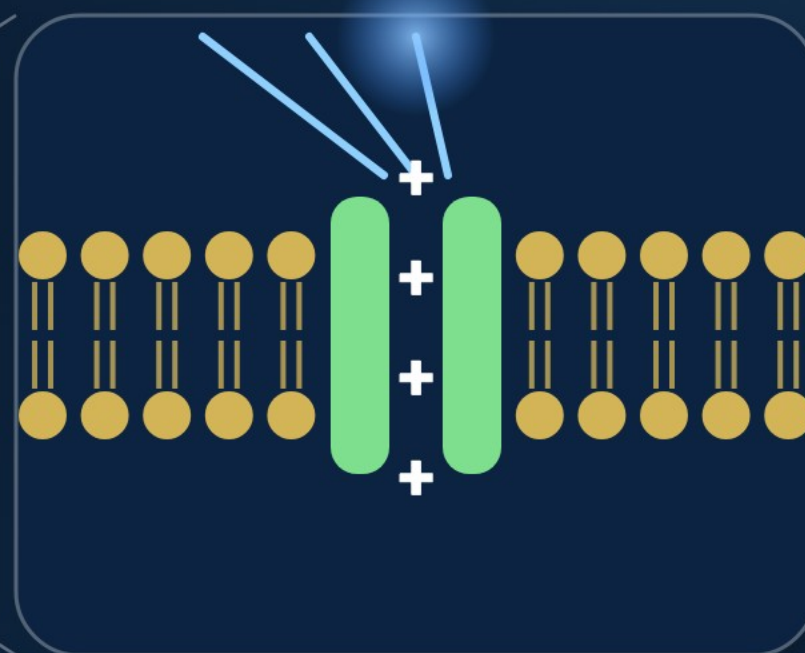
IMPACT

PATHWAY

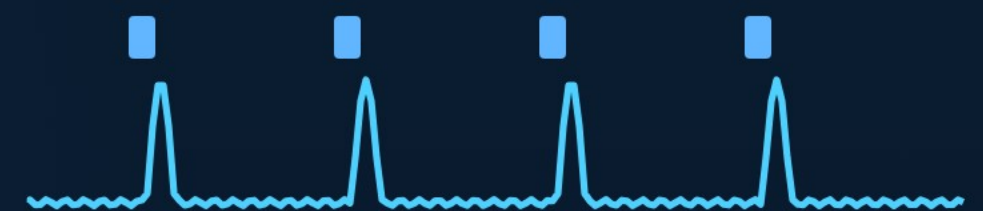
A light switch found in green algae, built into brain cells



2002 · 2003



2005



SUMMARY

1. THE CHALLENGE

Brain and vision disorders cause a heavy burden of illness and cost, but researchers lacked precise tools to test which cells and circuits actually drive behaviour and disease. Electrical stimulation was not cell specific, and drugs were often too slow or diffuse.

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3. IMPACT DELIVERED

Optogenetics let neuroscience move from correlation to causal testing and spread rapidly, with 14,572 publications between 2006 and 2025. It mapped circuits for sleep, fear, anxiety, depression and movement, and early trials showed measurable visual responses in retinitis pigmentosa.

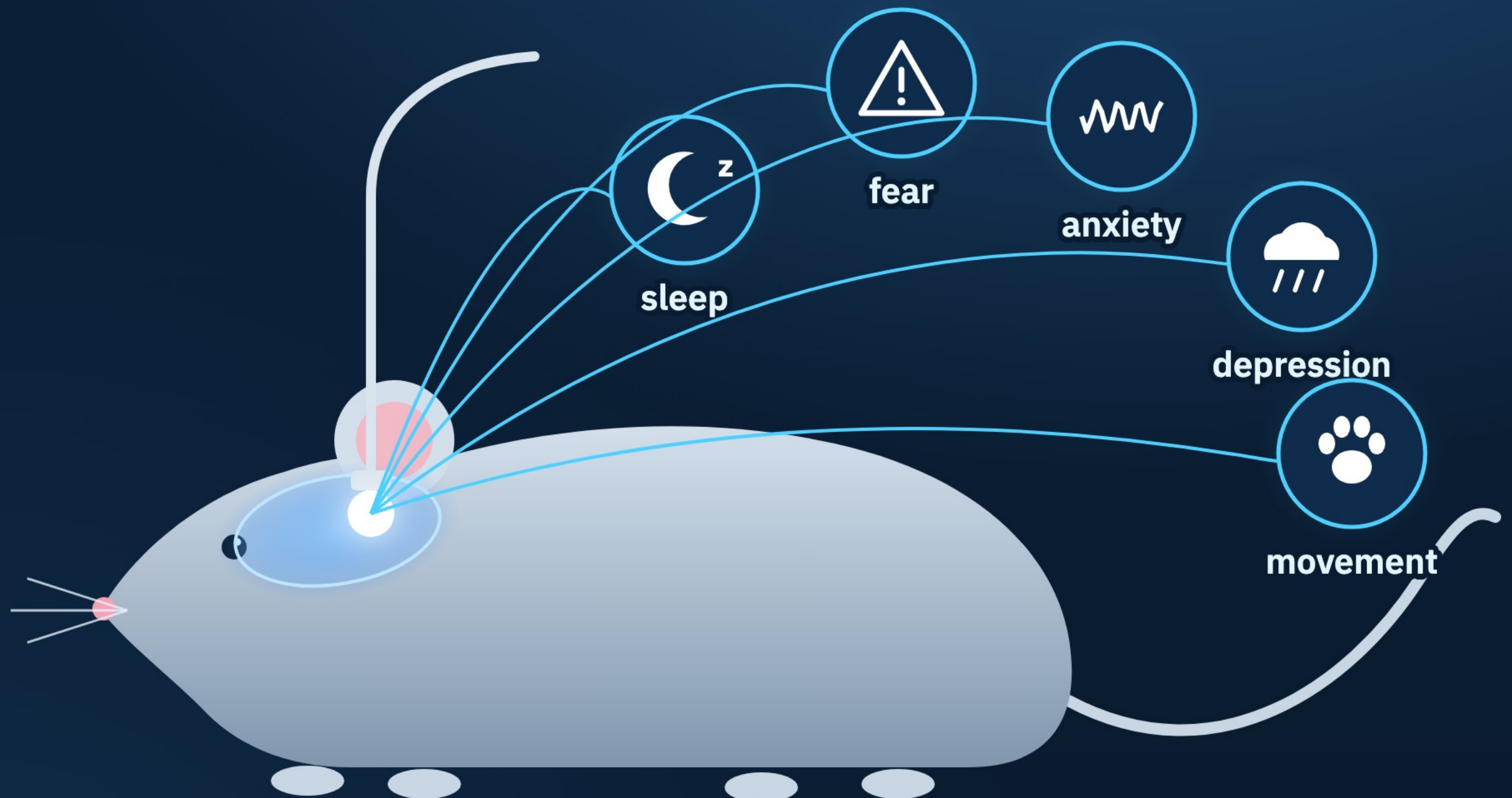
PROBLEM

RESEARCH

IMPACT

PATHWAY

Light revealed which brain circuits drive behaviour



SUMMARY

2. THE RESEARCH

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4. EXPECTED IMPACT

The clearest next impact is further vision restoration, where human results already lower uncertainty about feasibility. The method is also likely to guide more selective neuromodulation and circuit-based drug design for brain disorders, even where light itself is not the final therapy.

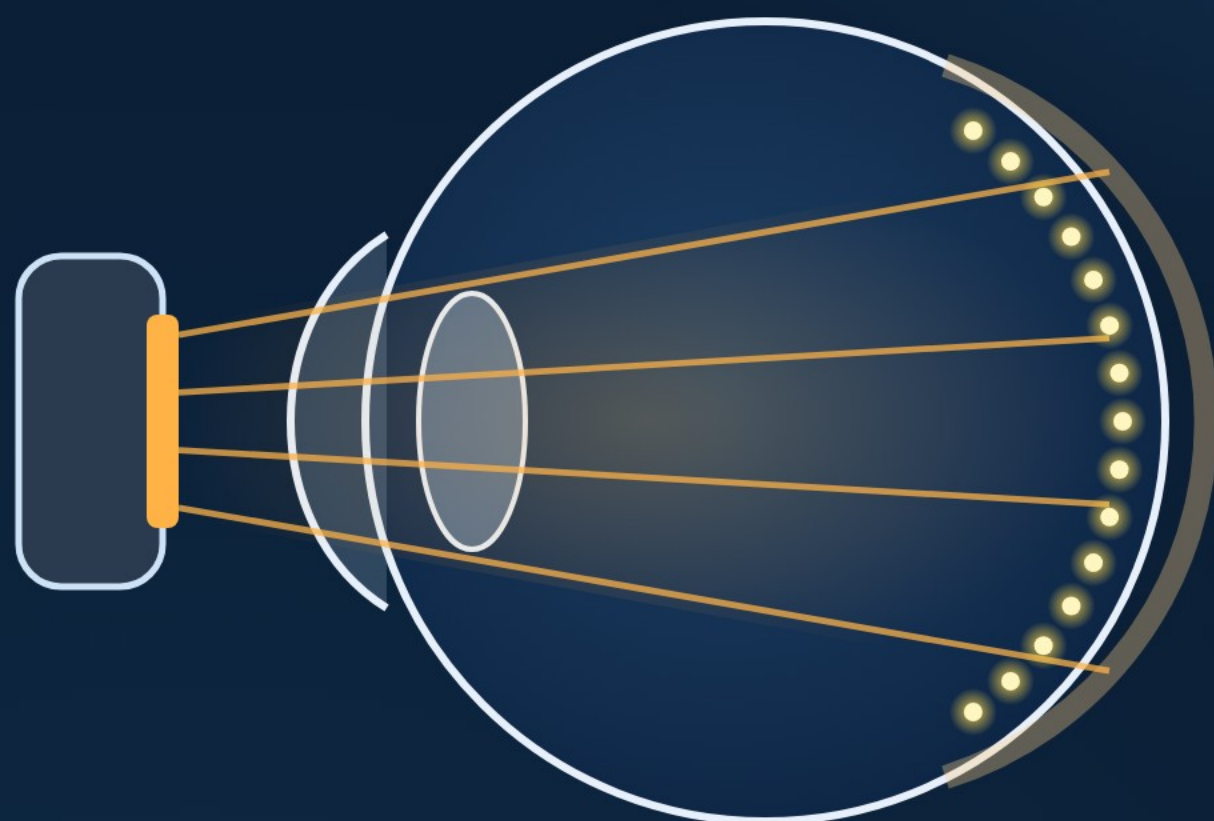
PROBLEM

RESEARCH

IMPACT

PATHWAY

First signs of light sensitivity restored in people with advanced retinitis pigmentosa



light sensitivity



visual tasks



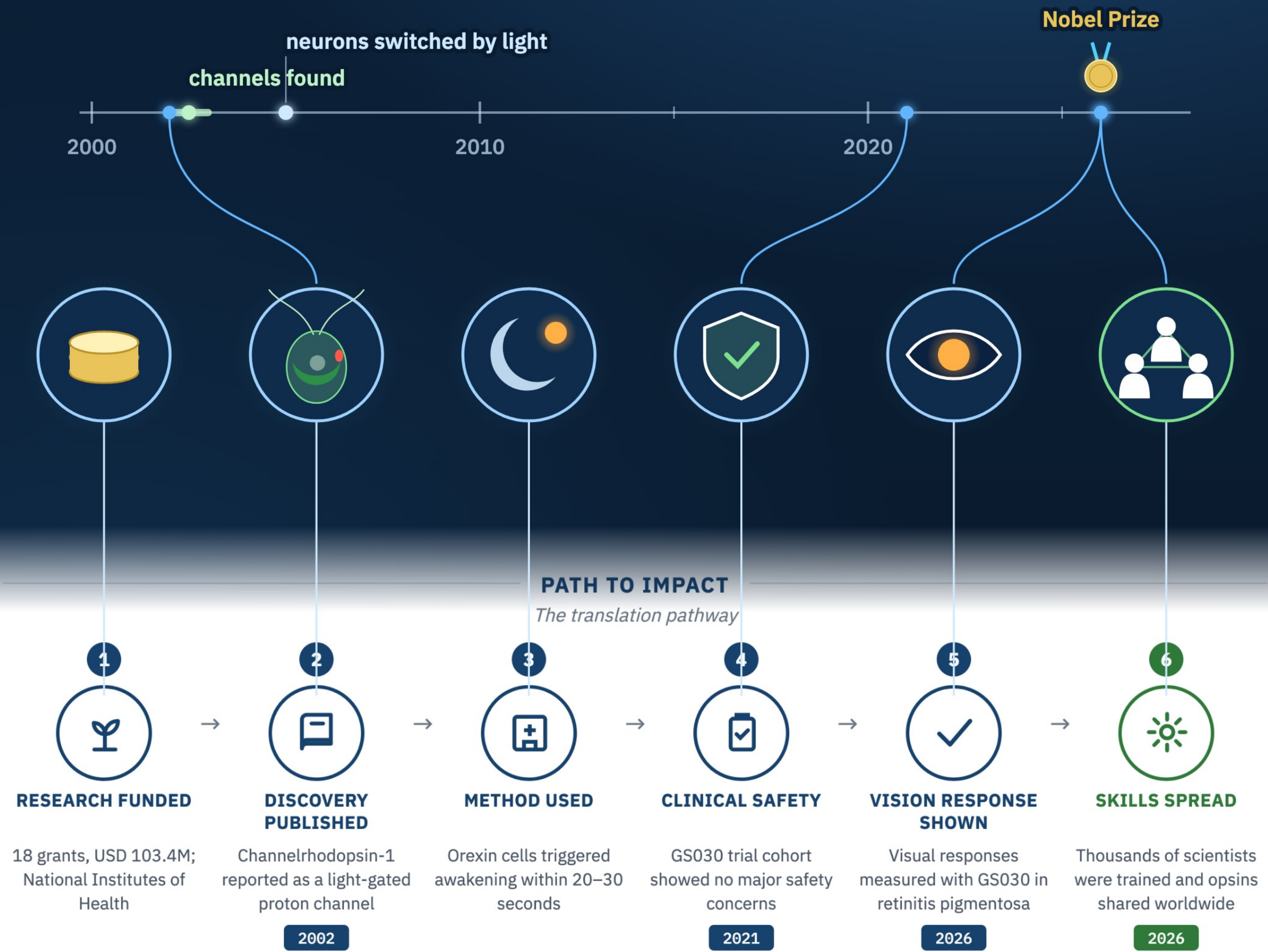
HEALTH GAINS

- 6 of 10 participants gained meaningful light sensitivity
- 4 of 8 participants improved on behavioural vision tasks
- About 70% had mild inflammation that resolved with corticosteroids

FOLLOW-UP

- OpenAlex records follow-on grant value
- One NIH R01 awarded 23,005,638
- One NIH P50 awarded 17,967,385

From a protein in algae to a clinical trial



VALUE DELIVERED



All of it on one page: the impact infographic

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PATH TO IMPACT

The translation pathway

1



RESEARCH FUNDED

18 grants, USD 103.4M; National Institutes of Health

2002

2



DISCOVERY PUBLISHED

Channelrhodopsin-1 reported as a light-gated proton channel

2002

3



METHOD USED

Orexin cells triggered awakening within 20–30 seconds

2021

4



CLINICAL SAFETY

GS030 trial cohort showed no major safety concerns

2021

5



VISION RESPONSE SHOWN

Visual responses measured with GS030 in retinitis pigmentosa

2026

6



SKILLS SPREAD

Thousands of scientists were trained and opsins shared worldwide

2026

VALUE DELIVERED



HEALTH GAINS

- 6 of 10 participants gained meaningful light sensitivity
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FOLLOW-ON FUNDING

- OpenAlex records USD 103,379,959 in follow-on grant value
- One NIH R01 award brought USD 23,005,638
- One NIH P50 award brought USD 17,967,385



CAUSAL CIRCUIT INSIGHTS

- Fear-memory neurons were reactivated to induce freezing
- Amygdala projections were shown to control anxiety
- mPFC stimulation reversed depression-like deficits in mice

RESEARCH IMPACT AT A GLANCE



6

light sensitivity responders

New England Journal of Medicine



4

behavioural task responders

New England Journal of Medicine



23.4k

attributed citations

ResearchImpact AI publication analysis



USD 103.4M

recorded grant value

OpenAlex awards registry