Fact-Checked Science

PAPER CHECK · MAGNETIC FIELDS AND THE BRAIN

Mole-rats notice a missing magnetic field: a sensory finding, not a brain in failure

A Max Planck team kept Ansell’s mole-rats, subterranean rodents with a magnetic compass, in a near-zero magnetic field for 72 minutes and mapped which brain regions switched on [1 ll. 152–158]. Seven regions tied to stress, fear and arousal were more active than in animals given a changing field, and in a second test the animals avoided a near-zero zone [1 ll. 172–183][1 ll. 234–248]. S0 News presented the preprint, with two others, as evidence that when the field goes “the brain stops working right”, and that Earth is entering such a field [2 00:02:13]. We checked four of the episode’s statements and two of the paper’s own claims against the preprint, which is not peer reviewed.

By Fact-Checked Science · Published October 21, 2026

OUR ANALYSIS marks our own reasoning, and the verdicts are our assessment. Everything else comes from the numbered sources; for the preprint [1], l. and ll. give the line numbers printed in the margin of its PDF, and Fig. a figure or one of its panels.

A sensory finding about mole-rats, stretched into a brain in failure

OUR ASSESSMENT

<1 µT

The near-zero field, about 2% of Earth’s field in Germany, measured with a fluxgate magnetometer that resolves 1 nT [1 ll. 156–157][1 ll. 432–434]

72 min

One exposure, after a 10-minute near-zero baseline that both groups received; nothing longer and nothing repeated [1 ll. 155–158][1 ll. 467–469]

7

Regions tied to stress, fear, anxiety and arousal with more c-Fos than in the changing-field group, in up to 10 animals per group [1 ll. 172–183]

THE CLAIMS

FALSE

“Low field strength like we’re entering as Earth’s magnetic field is tanking.”

The episode, introducing the three hypomagnetic papers [2 00:02:15]

The field in the experiment was below 1 µT, about 2% of Germany’s [1 ll. 156–157]. Earth’s surface field is 23–67 µT [3 Table 1], and its dipole has weakened by about 9% since 1840 [4 p. 1]; only at the trough of the Laschamp excursion, about 41,000 years ago, did it fall to 2–5% of today’s [6 §4.2][7 §3]. The preprint never mentions Earth’s field changing. See section 6.

MISREAD

“...all hit the wild surge in reactive oxygen species and brain impact, neurogenesis, hippocample activity, and the locus curerilius.”

The episode; “hippocample” and “locus curerilius” are the transcript’s renderings of hippocampal and locus coeruleus [2 00:02:19]

The preprint measured no reactive oxygen species, mitochondria, blood chemistry or neurogenesis, and never mentions the locus coeruleus. Its one sentence on reactive oxygen and neurogenesis cites mouse studies by a Beijing group [1 ll. 341–343][14][15], the group behind the third paper the episode showed [19]. See section 4.

OVERSTATED

“...all showed that when you take away the magnetic field, the brain stops working right.”

The episode [2 00:02:32]

After 72 minutes without a field, seven regions tied to stress, fear and arousal held more c-Fos, a marker of recent neural activity, than in animals given a changing field [1 ll. 172–183]. Total activity did not differ (p = 0.19), and neither did behaviour [1 ll. 158–164]. The authors call it “a mild aversive effect” and a possible “novelty response” to a missing cue [1 ll. 185–186][1 ll. 291–293]. See section 3.

UNSUPPORTED

“And these effects are compounding the longer the situation unfolds.”

The episode [2 00:02:43]

The preprint tested one exposure of 72 minutes after a 10-minute baseline [1 ll. 155–158][1 ll. 467–469], and 20-minute behavioural trials [1 l. 571]; nothing was repeated and no time course was measured. It cites other groups’ 72-hour and eight-week mouse studies but ran none [1 ll. 339–343]. See section 2.

PARTLY TRUE

Absence of the Earth’s magnetic field activates stress-related brain circuits

The preprint’s title and abstract [1 ll. 1–2][1 ll. 31–35]

The seven regions were more active than in the changing-field group, after a permutation-corrected voxel analysis and post-hoc tests [1 ll. 165–183]. But no group sat in Earth’s normal field during the stimulation, and both began with 10 minutes of near-zero field, so activation relative to the normal field is inferred; the authors say so and call for a static-field control [1 ll. 365–377]. Two of the seven regions are above p = 0.05 before adjustment, though all seven pass the preprint’s false-discovery-rate procedure (our analysis). See section 2.

TRUE

Mole-rats avoid entering a zone with a near-zero magnetic field

The preprint’s abstract [1 ll. 35–38]

Fifteen animals spent less time at an object inside a 1.45 µT zone than at one in the 44.71 µT background (paired t(14) = 4.62–4.67, p = 0.0004), with no preference in sham or doubled-field controls [1 ll. 225–245]. On our reading of the 46 avoidance indices printed in the supplement, that is about 30% less time, which the occupancy medians read from Figure 5F also give; 12 of 15 animals went in the expected direction, and our re-run reproduces the tests [1 Suppl. Fig. 7][1 Fig. 5F]. See section 2.

1 · THE EXPERIMENT

Twenty mole-rats, one 72-minute exposure, and a field about 50 times weaker than Germany’s

The animals are Ansell’s mole-rats, *Fukomys anselli*, subterranean African rodents with a magnetic polarity compass that works in total darkness [1 ll. 60–66][9]. Ten were given a changing magnetic field and ten a near-zero field, in darkness, after three days of habituation; their brains were then mapped for c-Fos, a protein neurons make shortly after they fire [1 ll. 50–52][1 ll. 152–158].

The animals

Adults of both sexes from colonies in Bonn and Essen, randomly assigned to the two groups; experimenters scoring outcomes were blinded “where feasible” [1 ll. 387–391]. Two cohorts were run in different years by different experimenters, 5 changing-field and 6 near-zero animals in the first and 5 and 4 in the second, and pooled to give 10 per group [1 ll. 477–482].

The supplement lists them: 13 males and 7 females, aged 111 to 752 weeks, about 2 to 14 years, with body weights of 63–158 g for the 19 whose weight is recorded [1 Suppl. Table 2].

The two fields

A three-axis coil in a Faraday cage cancelled the local field; two further windings carried the same current either in parallel, producing a field that swung between 20 and 70 µT with a new direction every 30 seconds, or in opposition, producing nothing. Heat and vibration were therefore the same in both conditions [1 ll. 420–431][1 ll. 469–476].

The residual field in the near-zero condition was below 1 µT, measured with a fluxgate magnetometer that resolves 1 nT; the preprint puts that at about 2% of Earth’s field in Germany [1 ll. 432–434][1 ll. 156–157].

The timeline

DAYS 1–3

Habituation

Thirty minutes a day in the chamber, in Earth’s field, under infrared light [1 ll. 462–467].

DAY 4, MINUTES 0–10

Near-zero baseline for all

Every animal began with ten minutes in the near-zero field [1 ll. 467–469].

MINUTES 10–82

Changing field or near-zero field

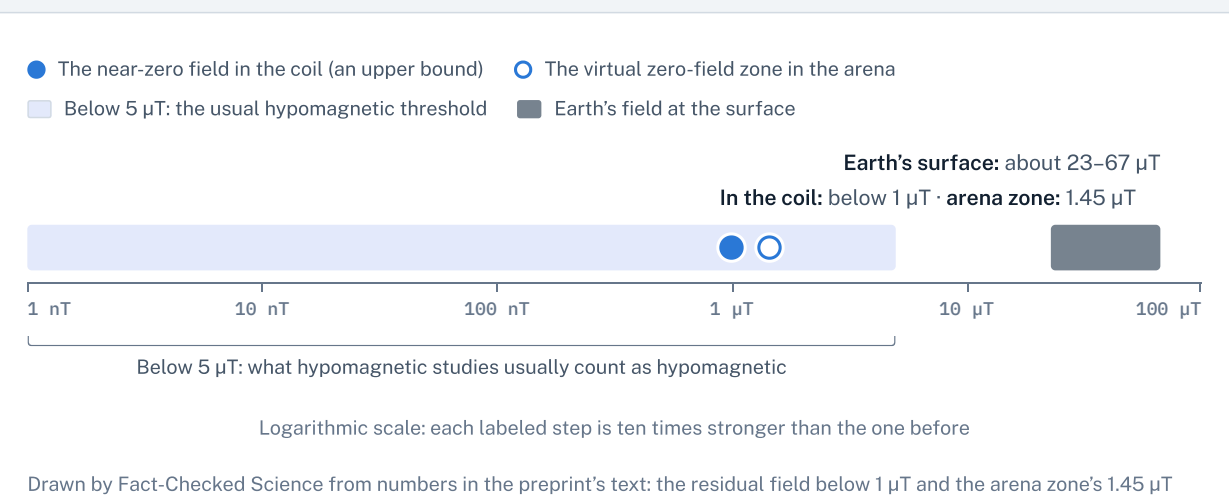
Seventy-two minutes of the changing field, or of the near-zero field for the control group [1 ll. 155–158][1 ll. 469–476].

THEN

Brain collection

Anaesthesia and perfusion; the right hemisphere was cleared, imaged and registered to a new 3D atlas [1 ll. 485–490]. Behaviour had been scored for the first 40 minutes, the window in which most of the c-Fos was induced [1 ll. 557–560].

How weak is 1 µT?



Drawn by Fact-Checked Science from numbers in the preprint’s text: the residual field below 1 µT and the arena zone’s 1.45 µT [1 ll. 156–157][1 ll. 225–228]; no figure of the preprint is reproduced. The 5 µT threshold is the definition used in the fruit-fly study we checked earlier [18 p. 1316]. Earth’s surface field: the World Magnetic Model report [3 Table 1]. The changing field, 20–70 µT, spans Earth’s own range [1 ll. 469–471].

IN THE COIL

<1 µT

the residual field after the local field was cancelled; about 2% of Germany’s, the preprint says [1 ll. 156–157][1 l. 434]

AT EARTH’S SURFACE

23–67 µT

the field’s approximate range around the globe [3 Table 1]. The arena’s background in Bonn measured 44.71 µT [1 ll. 225–226].

EARTH’S FIELD IS STRONGER BY

OUR ANALYSIS

23–67×

at least: 23,000 nT ÷ 1,000 nT = 23; 67,000 ÷ 1,000 = 67. Against the arena’s 44.71 µT, about 45 times; the preprint’s “2%” implies about 50.

The second experiment: a virtual zero-field zone

The arena

An 80 cm track with a round end at each side, on a non-magnetic table inside a 2 m coil system in an aluminium cabin that shields sound, vibration and oscillating fields [1 ll. 435–448][1 ll. 566–567]. A camera tracked each animal, and the coils adjusted the field to its position, so that one end of the track became a zone of near-zero field: 44.71 µT at the centre of the arena, 1.45 µT (range 1.08–4.88) in the zone, by 1,186 measurements [1 ll. 222–228].

A novel object, a plastic 96-well plate, sat at each end; the measure was how much of each 20-minute trial the animal spent near either object [1 ll. 228–233].

The controls

Three experiments, with 15, 15 and 16 animals and no animal tested twice within an experiment [1 ll. 571–572]. In the sham, the coils carried the same changing currents but cancelled nothing, so the field stayed at Earth’s; in the third, the zone’s field was doubled to about 90 µT [1 ll. 448–453][1 l. 320]. A lockable box hid the switch between real and sham settings; sex and trial order were counterbalanced [1 ll. 453–455][1 ll. 574–575].

C-FOS MAPPING

10 + 10

animals in the changing-field and near-zero groups, from two cohorts pooled; two regions have 9 in one group [1 ll. 477–482][1 ll. 180–183]

BEHAVIOUR DURING EXPOSURE

20

videos scored by an observer blind to the condition: walking, escaping or digging, resting, other [1 ll. 553–557]

PLACE PREFERENCE

15 / 15 / 16

animals in the near-zero, sham and doubled-field experiments [1 ll. 571–572]

FIELD MEASUREMENTS

473 + 713

readings at the arena centre and in the zone, with a three-axis fluxgate sampling at 400 Hz [1 ll. 225–228][1 ll. 596–597]

2 · WHAT THEY FOUND

More activity in stress and arousal regions, no change overall, and avoidance of the zero-field zone

The near-zero field was meant as the neutral control. Instead it produced the larger and more widespread response, concentrated in subcortical regions the authors describe as “canonically associated with stress, fear, and anxiety” [1 ll. 172–175][1 ll. 270–272].

TOTAL C-FOS CELLS

No change

medians of 144,022 and 181,327 per hemisphere in the changing-field and near-zero groups; U = 32, p = 0.19 [1 ll. 158–162][1 Fig. 3C]

BEHAVIOUR DURING EXPOSURE

No change

no difference between the groups in any scored category; walking declined over time in both [1 ll. 162–164][1 Suppl. Fig. 4]

REGIONS MORE ACTIVE IN THE NEAR-ZERO FIELD

7

three amygdala nuclei, the bed nucleus of the stria terminalis, the periaqueductal grey, the substantia innominata and the nucleus accumbens [1 ll. 172–183]

The seven regions, and one that went the other way

REGION	HIGHER IN	U	N	ADJUSTED P (THE PREPRINT)	UNADJUSTED TWO-TAILED P OUR ANALYSIS
Posterior basolateral amygdala (BLAp)	Near-zero field	22	10 and 10	0.012	0.036
Central amygdala (CeA)	Near-zero field	14	10 and 10	0.003	0.005
Lateral amygdala (LA)	Near-zero field	24	10 and 10	0.015	0.052
Bed nucleus of the stria terminalis (BNST)	Near-zero field	12	10 and 10	0.003	0.003
Periaqueductal grey (PAG)	Near-zero field	24.5	9 and 10	0.026	about 0.09–0.10
Substantia innominata (SI)	Near-zero field	17	10 and 10	0.006	0.012
Nucleus accumbens (ACB)	Near-zero field	17	10 and 9	0.009	0.022
Dorsal subiculum, in the hippocampal formation	Changing field	11	10 and 10	0.003	0.002

U statistics, sample sizes and adjusted p-values from the preprint’s results, which describe Mann–Whitney tests with a false-discovery-rate correction at Q = 5% [1 ll. 165–183][1 ll. 629–633]. The last column is our exact two-tailed Mann–Whitney p-value for each reported U, before any adjustment; the periaqueductal grey’s U of 24.5 implies tied ranks, to which the exact distribution does not apply, so its value is approximate. Parts of the superior colliculus were also higher in the changing field [1 ll. 363–364], and the preprint’s Figure 3F marks voxels higher in the near-zero group in the cortex, hippocampus, entorhinal cortex, striatum and thalamus as well, which it does not count among the stress regions [1 Fig. 3F].

OUR ANALYSIS

For six of the seven regions the adjusted p-value is smaller than the unadjusted one (the seventh, the bed nucleus, is equal to three decimals), which cannot happen under the original Benjamini–Hochberg procedure. It is what GraphPad Prism’s two-stage procedure of Benjamini, Krieger and Yekutieli gives: Benjamini–Hochberg q-values over the eight region tests, scaled by the procedure’s estimate that only two of the eight null hypotheses are true, reproduce every reported value to rounding (0.012, 0.003, 0.015, 0.003, 0.026 once the periaqueductal grey’s tie is allowed for, 0.006 and 0.009, and 0.003 for the subiculum). So the preprint’s statistics are internally consistent, its region tests were two-tailed, and all eight pass at Q = 5%; the preprint names only “the False Discovery Rate (FDR) method (Q = 5%)” [1 ll. 627–633]. Before any adjustment, the lateral amygdala (p = 0.052) and the periaqueductal grey (about 0.09–0.10) are above 0.05, and pass only because the two-stage procedure raises their thresholds fourfold; the other five hold.

These region tests are checks on clusters the permutation-corrected voxel analysis had already picked out, run to confirm that the clusters correspond to real differences in the raw cell counts [1 ll. 542–552]. They guard against registration artefacts; they are not independent evidence. The headline pattern, more c-Fos in the amygdala, the bed nucleus, the substantia innominata and the accumbens, survives on the unadjusted values.

The zero-field zone was avoided, by about 30% of the time

Occupancy and avoidance in the three place-preference experiments

ZONE COMPARED WITH EARTH’S FIELD	N	PAIRED TEST (THE PREPRINT)	AVOIDANCE INDEX: MEAN, AND ANIMALS ABOVE ZERO OUR ANALYSIS	ONE-SAMPLE TEST (THE PREPRINT)
Near-zero, 1.45 µT	15	t(14) = 4.62 or 4.67, p = 0.0004	0.18; 12 of 15	t(14) = 4.635, p = 0.0004
Sham: same currents, Earth’s field	15	t(14) = 1.23, p = 0.240	0.04; 10 of 15	t(14) = 1.040, p = 0.3159
Doubled, about 90 µT	16	t(15) = 0.518, p = 0.612	−0.02; 10 of 16	t(15) = −0.287, p = 0.7784

Paired tests from the preprint’s results [1 ll. 234–245] and its Figure 5 legend [1 ll. 260–264], which give the near-zero test as t(14) = 4.67 and 4.62 respectively; one-sample tests from its Supplementary Figure 7 [1 Suppl. Fig. 7]. The means and counts are ours, from the 46 avoidance indices printed on that figure, and the last column is our one-sample t-test of them.

OUR ANALYSIS

How big is the avoidance?

The preprint defines the index with an equation that is an image in every version, and says its values run from 0 to 1 [1 ll. 587–591]; the printed values run from −0.60 to 0.45, which fits the usual $(C - T) \div (C + T)$, the difference between time at the control object and time at the test object over their sum. On that reading a mean of 0.18 means about 30% less time at the object in the near-zero zone than at the other, and three of the 15 animals went the other way. Read by eye from the preprint’s Figure 5F, median occupancy fell from roughly 37% of the trial to about 25%, a drop of about a third that supports the figure independently of the index’s formula [1 Fig. 5F].

What the authors make of it

Mole-rats “actively and specifically avoid near-zero magnetic field anomalies, which is in line with the finding of activated stress-related brain areas after forced exposure to HMF” [1 ll. 245–248]. Doubling the field did not make the object more attractive, unlike the strong magnets of an earlier study, which the authors attribute to the much weaker field used here [1 ll. 314–323].

3 · STRESS CIRCUITS

A marker of recent activity, in regions that also respond to novelty and arousal

c-Fos is the product of an immediate-early gene, used for decades to map which neurons were recently active [1 ll. 50–52]. The preprint counted c-Fos-positive cells across one hemisphere and compared the two groups voxel by voxel, so “activates” means more cells carrying the marker in the near-zero group than in the changing-field group [1 ll. 488–490][1 ll. 530–541].

In the authors’ words

HMF is the preprint’s abbreviation for the near-zero hypomagnetic field and CMF for the changing field.

> *“Taken together, these findings show that the HMF, intended as a baseline control stimulus, activated core brain circuits that coordinate stress and defensive responses in the absence of obvious behavioural changes, indicating that HMF exposure exerted a mild aversive effect.”*
>
> Zhang et al. (2026), results [1 ll. 183–186]

> *“We did not observe differences in behaviour between the treatment groups, however, pointing towards a mild form of anxiety or novelty response, known to activate similar circuits in other rodents.”*
>
> Zhang et al. (2026), discussion [1 ll. 291–293]

> *“Taken together, these findings thus suggest that mole-rats perceive the absence of an Earth-strength magnetic field as a novel, unexpected sensory deprivation.”*
>
> Zhang et al. (2026), discussion [1 ll. 323–324]

What the authors conclude

That the near-zero field “appears to constitute a biologically salient sensory perturbation” rather than the absence of a stimulus, and that the activation pattern is consistent with the animals detecting the absence of the field through their magnetoreceptors [1 ll. 272–276]. Activation of the substantia innominata and the periaqueductal grey, they add, indicates the animals were aroused [1 ll. 290–291].

Their model has the missing field either activating intensity-sensitive receptors or randomly firing compass cells, which through unknown relays reach the stress, arousal and anxiety circuits: “This leads to mild stress and corresponding avoidance behaviour” [1 Fig. 6 legend]. They also raise, as “speculative”, a link between the periaqueductal grey and the pain relief reported in mice kept in shielded boxes [1 ll. 343–353][17].

OUR ANALYSIS

What was not measured

No stress hormone, heart rate or other physiological sign of stress was recorded, and the animals’ behaviour during exposure did not differ [1 ll. 162–164]. The regions named are also engaged by novelty and arousal, as the authors say, and the preprint’s own alternative is that a familiar chamber became perceptually novel when a constant cue vanished [1 ll. 298–311].

The comparison group was not in Earth’s field but in a field that changed every 30 seconds, after the same ten minutes of near-zero field. For the regions that went the other way the authors write that they “cannot tell whether these areas responded with increased activity to CMF or were inhibited by HMF” [1 ll. 365–366]; the same ambiguity applies to the seven. That is why they conclude that a near-zero field “cannot be considered a neutral control condition” and that future experiments should use the Earth’s static field instead [1 ll. 372–375].

The species has a specialised magnetic sense [9][11]. The preprint’s title and abstract say “a mammal”; its last sentence says the field “constitutes a biologically significant sensory stimulus in mammals” [1 ll. 381–382], a step beyond one species.

4 · WHAT THE EPISODE SAID

Three papers in one breath: most of the words belong to the other two

The presenter introduced the preprint with two other hypomagnetic papers, a Research Square preprint on blood flow in six volunteers [20] and a conference abstract on mice from a Beijing group [19], and described all three at once [2 00:02:13]. Here is what the mole-rat preprint can and cannot carry.

> *“Up next we’ve got a triple on hypomagnetic fields. Low field strength like we’re entering as Earth’s magnetic field is tanking, all hit the wild surge in reactive oxygen species and brain impact, neurogenesis, hippocample activity, and the locus curerilius. Each looks at different subjects, different specific markers, but all showed that when you take away the magnetic field, the brain stops working right. The mitochondria aren’t working right. The waste removal system isn’t working right. The chemical army in your blood isn’t working right. And these effects are compounding the longer the situation unfolds.”*
>
> S0 News, October 20, 2026, from the automatically generated transcript [2 00:02:13–00:02:47]

THE EPISODE SAID	WHAT THIS PREPRINT SHOWS	WHERE THE WORDS MAY BELONG
“a triple on hypomagnetic fields”	Accurate: the near-zero field is below 1 µT [1 ll. 156–157].	All three.
“Low field strength like we’re entering as Earth’s magnetic field is tanking”	Nothing: the preprint never mentions Earth’s field changing, pole shifts, excursions or reversals. It calls the field “a constantly available cue” and “this normally constant environmental stimulus” [1 l. 19][1 ll. 379–380].	None of them. See section 6.
“the wild surge in reactive oxygen species ... neurogenesis”	Not measured. One sentence notes that long-term exposure “affects hippocampal neurogenesis and learning in laboratory mice, and researchers linked this effect to reactive oxygen species levels”, citing two Beijing mouse studies [1 ll. 341–343][14][15].	The Beijing abstract, which reports impaired neurogenesis and higher reactive oxygen species in the hippocampus of mice after long exposure [19].
“hippocample [hippocampal] activity”	In part, the other way round: the one hippocampal-formation region the preprint names, the dorsal subiculum, held *more* c-Fos in the changing field than in the near-zero field [1 ll. 166–171]. Its Figure 3F marks hippocampal voxels in both directions [1 Fig. 3F].	The Beijing abstract, on hippocampal neurogenesis [19].
“the locus curerilius [locus coeruleus]”	Never mentioned.	Not in the abstracts of the other two papers either [19][20].
“when you take away the magnetic field, the brain stops working right”	Seven stress- and arousal-related regions more active than in the changing-field group; total activity and behaviour unchanged; “a mild aversive effect” [1 ll. 158–164][1 ll. 183–186].	None as worded. The Beijing abstract reports cognitive dysfunction in mice [19].
“The mitochondria aren’t working right”	Not measured; the word does not occur.	The Beijing abstract, on oxidative phosphorylation in neural stem cells [19].
“The waste removal system isn’t working right”	Not measured; nothing on clearance or inflammation.	Possibly the Beijing abstract’s “chronic neuroinflammation” [19]; otherwise unclear.
“The chemical army in your blood isn’t working right”	Not measured; “blood” appears once, about capillaries in the atlas template [1 Suppl. Fig. 2].	The Research Square preprint, on heart rate, blood pressure and skin blood flow in six volunteers [20].
“these effects are compounding the longer the situation unfolds”	No time course: one 72-minute exposure and 20-minute trials [1 ll. 155–158][1 l. 571].	Neither of the others tests it either: the Beijing abstract speaks of “extended periods” and the Research Square preprint of simulated isolation [19][20].

The passage continues: “I’m sure it’s just a coincidence that America is losing protection from Earth’s magnetic field the fastest in this ongoing pole shift. And we appear to be losing our damn minds. But from San Antonio to Shanghai, there is no escaping this eventually” [2 00:02:47]. That concerns Earth’s field, not the preprint; our pages When Earth’s magnetic field falters and When is the next magnetic excursion due? cover the decline and the excursions.

5 · STRENGTHS AND LIMITATIONS

A careful unbiased screen, with no Earth-field control and a single short exposure

Our assessment of the design. The preprint is version 1 on bioRxiv, posted October 11, 2026, and has not been peer reviewed; its data and code are available from the authors on request, with the code promised publicly after publication [1 ll. 641–649].

OUR ANALYSIS

Strengths

- **An unbiased whole-brain screen,** with a new 20 µm atlas built from 43 hemispheres and validated by tracing the retina’s known projections [1 ll. 121–137].
- **Two cohorts, in different years with different experimenters,** pooled with the cohort as a factor in the voxel analysis [1 ll. 477–482][1 ll. 532–535].
- **Cluster-based permutation correction** of the voxel maps (2,000 permutations), and back-projection of each cluster into the raw images to count cells [1 ll. 535–552].
- **Identical currents, heat and vibration** in the two conditions, by wiring the stimulation coils in parallel or in opposition [1 ll. 426–431].
- **Blinded scoring and switching:** a blinded observer for behaviour [1 ll. 553–556], a lockable blinding box for the arena’s coils [1 ll. 453–455], and counterbalanced sex and trial order [1 ll. 574–575].
- **Sham and doubled-field controls** in the place-preference test, both null [1 ll. 236–241].
- **Measured fields,** with a 1 nT fluxgate in the coil and 1,186 readings in the arena [1 ll. 432–434][1 ll. 225–228].
- **The atlas is public** through the BrainGlobe Atlas API [1 ll. 647–649].

Limitations

- **No Earth-field group in the c-Fos experiment.** The comparison is near-zero against changing, and both groups began with ten minutes of near-zero field; the authors themselves call for a static-field control [1 ll. 467–469][1 ll. 372–377].
- **Ten animals per group,** with wide spreads in the region counts and several near-zero animals at the level of the changing-field group [1 Fig. 4]; two regions have nine in one group, unexplained [1 ll. 180–183].
- **Post-hoc region tests,** adjusted by a two-stage false-discovery-rate procedure the preprint does not name; two of the seven regions are above p = 0.05 before adjustment (section 2).
- **One exposure of 72 minutes.** Nothing about repeated or longer exposure, and no time course.
- **No physiological measure of stress,** and no behavioural sign of it during exposure [1 ll. 162–164]; “stress” rests on which regions held more marker.
- **One species with a specialised magnetic sense,** and a final sentence that generalises to mammals [1 ll. 381–382].
- **A wide age range,** about 2 to 14 years, and 13 males to 7 females, with neither age nor sex analysed [1 Suppl. Table 2].
- **Supplementary Table 1,** the voxel counts by region, is a broken image in the PDF and on bioRxiv, so the counts behind Figure 3F cannot be checked.
- **Not peer reviewed,** with data on request only [1 ll. 641–649].

Slips in the preprint

- The near-zero paired test is t(14) = 4.67 in the results [1 l. 235] and 4.62 in the Figure 5 legend [1 l. 261]; the avoidance-index test is 4.62 in the text [1 ll. 243–244] and 4.635 in Supplementary Figure 7 [1 Suppl. Fig. 7].
- The sham paired test is “t (14) = 0.123, p = 0.240” in the results but 1.23 in the legend; 0.123 would give p ≈ 0.90, so the text is the typo [1 ll. 238–239][1 l. 261].
- A placeholder survives in the methods: “(blocking/permeabilization buffer composition: (specify detergents, DMSO, glycine, serum))” [1 ll. 493–494].
- The abstract and results give 72 minutes; the methods give 82, including the ten-minute baseline [1 l. 157][1 ll. 467–469].
- The avoidance index is said to run from 0 to 1, but the printed values reach −0.60 [1 ll. 589–591][1 Suppl. Fig. 7]; “86.3%%” in a supplementary legend [1 l. 716]; and Supplementary Table 1 is a broken image.

6 · A FIELD LIKE WE’RE ENTERING?

The laboratory field is about 2% of Earth’s; Earth’s dipole has lost about 9% since 1840

The episode called the near-zero field “low field strength like we’re entering as Earth’s magnetic field is tanking” [2 00:02:15]. The preprint makes no such connection: a search of its text finds no pole shift, excursion, reversal, decline or weakening, and it treats the field as a constant [1 l. 19][1 ll. 379–380].

EARTH’S FIELD TODAY

23–67 µT

at the surface, around the globe [3 Table 1]; the preprint’s near-zero field is below 1 µT [1 ll. 156–157]

THE DECLINE

About 9%

how much weaker Earth’s axial dipole, the main part of the field, is than in 1840 [4 p. 1], a loss of about 5% per century on average [5]

THE LASCHAMP TROUGH

2–5%

of today’s dipole, about 41,000 years ago, in recent global field models [6 §4.2][7 §3]; the excursion’s main phase lasted about 700 years [8 p. 141]

OUR ANALYSIS

Earth’s field at the surface is 23 to 67 times the preprint’s upper bound of 1 µT, and the field in Bonn, where the arena background measured 44.71 µT [1 ll. 225–226], is about 45 to 50 times the laboratory field. A field as weak as the laboratory’s, 2 to 5% of today’s, is what global models reconstruct for the trough of the Laschamp excursion, not for anything the present decline of about 9% since 1840 approaches [4 p. 1][6 §4.2][7 §3]. Our page on the field’s decline finds no sign that an excursion is due within centuries.

Even at a Laschamp-like trough, the comparison would be between a 72-minute exposure of a species with a magnetic compass and a change lasting centuries. The preprint says nothing about either.

7 · RELATED WORK

Where the preprint sits, and where the episode’s other words come from

The peer-reviewed studies the preprint builds on or cites, from their abstracts.

The same species, the opposite direction

A 2010 c-Fos study of Ansell’s mole-rats found that changing and shielded magnetic fields each *suppressed* c-Fos in the head-direction and entorhinal–hippocampal systems compared with the natural field, and, in inactive animals, in the dorsal subiculum [10]. The preprint’s finding that the subiculum held less c-Fos in the near-zero field than in the changing field is compatible with this, though the earlier study compared each field with the natural one, not with each other; the preprint notes only that both regions had been reported to react to magnetic stimuli in the species [1 ll. 366–368], and the earlier study is its reason for calling the hippocampus part of the navigation circuit [1 ll. 69–74]. The first brain region tied to magnetoreception in a mammal, the superior colliculus, was found in the same species in 2001 [11].

Anxiety in mice after 72 hours

Adult male mice kept for 72 hours in a near-zero field showed more anxiety-related behaviour in open-field and elevated-maze tests [13]; the preprint calls this the most comparable finding to its own [1 ll. 339–341].

The Beijing mouse studies

Male mice kept long-term in a near-zero field had impaired hippocampal neurogenesis and learning, which correlated with a *reduction* in reactive oxygen species in neural stem cells and was reversed by raising them [14]; after eight weeks, the same group reported cognitive impairment and higher reactive oxygen species in the hippocampus as a whole [15]. These are the preprint’s references 46 and 47, and their authors wrote the conference abstract the episode showed as its third paper [19].

A review, and an analgesia effect

The field’s standard review reports that across the literature “the measured correlations of the HMF effect with HMF magnitude and inhomogeneity and type and duration of exposure are statistically absent” [16]. Mice placed in a shielded box for an hour a day showed opioid-related pain relief that peaked on days 4–6 and then returned to baseline [17], the finding behind the preprint’s speculation about the periaqueductal grey [1 ll. 343–353]. The same whole-brain approach, applied to pigeons by an overlapping team that includes the preprint’s senior author, found vestibular, not stress, circuits [12].

8 · CONCLUSIONS

A good question about a sense, answered in part; nothing about failing brains

The authors conclude

That mole-rats perceive the absence of the Earth’s magnetic field; that removing “this normally constant environmental stimulus” activates stress-related brain circuits and triggers active avoidance; and that the field is therefore a biologically significant sensory stimulus, so a near-zero field cannot serve as a neutral control in magnetoreception studies [1 ll. 372–382].

OUR ANALYSIS

Our conclusion

A careful preprint about how a magnetic sense works. Its avoidance result stands up, with the right controls, as a modest effect; its c-Fos result shows more activity in stress and arousal regions than in a changing field, which is not the same as more than in Earth’s field, as the authors acknowledge. Nothing in it concerns Earth’s changing field, reactive oxygen species, mitochondria, blood or the passage of time, and nothing in it shows a brain that stops working. It deserves to be read for what it is.

Where our assessment could be wrong

Abstracts for the related papers

We read the preprint in full, with its figures and Supplementary Table 2, but only the abstracts of the related studies, including the two other papers the episode showed.

The adjusted p-values

Our reproduction assumes that the family was the eight region tests and that Prism scales its two-stage q-values by its estimate of true nulls, as its documentation implies; the raw counts behind the periaqueductal grey’s tie are not public. The unadjusted and adjusted values are different quantities, and we present both.

Readings of figures

The avoidance indices are printed on Supplementary Figure 7 and were copied, not estimated; the occupancy medians are our readings of Figure 5F by eye.

Our starting point

We came to this preprint through an episode that cited it for a catastrophe claim, which could prime us toward scepticism. To limit that, we rated the preprint’s own claims against its own statistics and the episode’s against the preprint’s text.

What would settle it

01
A third group kept in Earth’s static field during the stimulation, as the authors propose, to show which direction the activation runs.

02
A physiological measure of stress alongside the marker: corticosterone, heart rate or a behavioural test after exposure.

03
Repeated or longer exposures, a second species, peer review, and public data and code.

None of these would bear on the episode’s claims about Earth’s field, which the preprint does not address.

Prepared by Fact-Checked Science from the text, figures and Supplementary Table 2 of Zhang et al. (2026), bioRxiv 2026.10.04.756554v1, CC BY-NC 4.0 [1]. No figure of the preprint is reproduced or redrawn; the chart and the tables use numbers from its text and its supplementary table, and two occupancy values read from its Figure 5F are marked as such. The assessment is our own and has not been reviewed by the authors.

Sources

Bracketed numbers refer to this list. For the preprint [1], l. and ll. give the line numbers printed in the margin of its PDF (1–915), Fig. a figure or one of its panels, and Suppl. Fig. and Suppl. Table its supplementary figures and tables. For the episode [2], the time is a position in the video. For the other sources, § gives a section, p. a page and Table a table. Links checked October 21, 2026.

1 Zhang, L., Lam, B. Y. K., Saeedi, A., Webb, L.-M., Felder, A. A., Sirmpilatze, N., Tyson, A. L., Hamauei, B., Shirdhankar, R. N., Wolf-Kümmeth, S., Grijseels, D., Amini, N., Begall, S., and Malkemper, E. P. (2026). Absence of the Earth’s magnetic field activates stress-related brain circuits in a mammal. bioRxiv preprint 2026.10.04.756554, version 1, posted October 11, 2026; not peer reviewed. CC BY-NC 4.0. We read the PDF, whose margin carries line numbers 1–915, the HTML and XML versions, all 13 figures and Supplementary Table 2; Supplementary Table 1 is a broken image in every version.

2 SpaceWeatherNews (S0) (October 20, 2026). Magnetic Pole Shift Brain Impact, Volcano Warning | S0 News Oct.20.2026. YouTube video. Quoted from the automatically generated transcript; times are positions in the video.

3 Chulliat, A., Brown, W., Nair, M., Gomez Perez, N., Young, L.-Y., Watson, C., Boneh, N., Beggan, C., Meyer, B., and Paniccia, M. (2025). The US/UK World Magnetic Model for 2025–2030: Technical Report. NOAA National Centers for Environmental Information.

4 Finlay, C. C., Aubert, J., and Gillet, N. (2016). Gyre-driven decay of the Earth’s magnetic dipole. *Nature Communications* 7, 10422. CC BY 4.0.

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6 Korte, M., Brown, M. C., Panovska, S., and Wardinski, I. (2019). Robust characteristics of the Laschamp and Mono Lake geomagnetic excursions: results from global field models. *Frontiers in Earth Science* 7, 86. CC BY 4.0.

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12 Nordmann, G. C., Balay, S. D., Kapuruge, T. N., Numi, M., Leeb, C., Nimpf, S., Malkemper, E. P., Landler, L., and Keays, D. A. (2026). A global screen for magnetically induced neuronal activity in the pigeon brain. *Science* 391(6790), 1155–1160.

13 Ding, H.-M., Wang, X., Mo, W.-C., Qin, L.-L., Wong, S., Fu, J.-P., et al. (2019). Hypomagnetic fields cause anxiety in adult male mice. *Bioelectromagnetics* 40(1), 27–32.

14 Zhang, B., Wang, L., Zhan, A., Wang, M., Tian, L., Guo, W., and Pan, Y. (2021). Long-term exposure to a hypomagnetic field attenuates adult hippocampal neurogenesis and cognition. *Nature Communications* 12, 1174. CC BY 4.0.

15 Tian, L., Luo, Y., Zhan, A., Ren, J., Qin, H., and Pan, Y. (2022). Hypomagnetic field induces the production of reactive oxygen species and cognitive deficits in mice hippocampus. *International Journal of Molecular Sciences* 23(7), 3622. CC BY 4.0.

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17 Prato, F. S., Robertson, J. A., Desjardins, D., Hensel, J., and Thomas, A. W. (2005). Daily repeated magnetic field shielding induces analgesia in CD-1 mice. *Bioelectromagnetics* 26(2), 109–117.

18 Reed, J., Fromhold, M., Moisoi, N., Mather, M., and Chakrabarti, L. (2026). Hypomagnetic fields modulate lifespan, physical ability and mitochondrial metabolism in a *Pink1* model of neurodegeneration. *Aging* 18(1), 1316–1330. CC BY 4.0. Checked on our page Does removing Earth’s magnetic field change how fruit flies age?

19 Ren, J., Luo, Y., Zhang, B., Tian, L., Guo, W., and Pan, Y. (2026). The Effects of Extremely Low Geomagnetic Field Intensity on the Mammalian Central Nervous System. EGU General Assembly 2026, abstract EGU26-15577; a conference abstract, not peer reviewed.

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METHOD

How this was checked

On October 21, 2026, we checked every statement, number, quotation and citation on this page against its source: the preprint’s full text in its PDF, HTML and XML versions, all 13 of its figures and its Supplementary Table 2, the bioRxiv and Crossref records of the preprint, the abstracts of the related papers listed here, the World Magnetic Model report and the sources our pages on the field’s decline already use, and the episode’s transcript, about 110 items in all. Every field strength, duration, sample size, U statistic, t statistic and p-value on this page is the preprint’s, with the line where it appears; the transcript is quoted verbatim with the time of each passage. The check found no error in the preprint’s numbers, only the slips listed in section 5. A fresh reviewer then read the built page against the sources, about 230 items, and recomputed our statistics. That check corrected our account of the preprint’s adjusted p-values, which reproduce as the q-values of GraphPad Prism’s two-stage false-discovery-rate procedure, with six of seven rather than five below the unadjusted values; a reversed field ratio; our reading of the 2010 mole-rat study; the basis of the “about 30% less time”; the author list of the pigeon study, which shares the preprint’s senior author; and ten smaller points, from a line locator to one missing body weight. The change log lists them.

The verdicts and the items tagged “Our analysis” are our own assessment, built on the cited sources: the field ratios, the exact Mann–Whitney p-values we computed from the U statistics the preprint reports, our re-run of the avoidance-index tests from the 46 values printed in its Supplementary Figure 7, the occupancy values we read by eye from its Figure 5F, and our reading of which of the episode’s words fit which of the three papers it showed.

We re-ran what the preprint’s reported statistics allow: the exact two-tailed p-value for each reported Mann–Whitney U, the p-value for each reported t, the one-sample t-tests of the printed avoidance indices, which reproduce the preprint’s results (ours t = 4.60, 1.02 and −0.27; the preprint’s 4.635, 1.040 and −0.287), and the adjusted p-values of the eight region tests, which reproduce to rounding as the q-values of Prism’s two-stage false-discovery-rate procedure (section 2). The raw imaging data are available only on request, and Supplementary Table 1 is a broken image in every version, so the counts behind the voxel analysis and the tie behind one U statistic could not be checked.

This page was researched and written with Claude, an AI assistant made by Anthropic, and then re-checked against its sources in a separate verification pass.

The verdicts on this page

FALSE	The evidence contradicts the claim.
OVERSTATED	Has some basis but claims much more than the evidence supports.
MISREAD	Cites a real source but gets wrong what it says.
UNSUPPORTED	No evidence we could find backs it up, though it hasn’t been strictly disproven.
PARTLY TRUE	Part of the claim holds up and part doesn’t.
TRUE	The evidence supports the claim.

All ten verdicts, and how we check

CORRECTIONS

Corrections and changes

If we get something wrong, we fix it and record the change below with the date. If a correction changes a verdict, the log says what the old verdict was.

Change log

Oct 21, 2026	Published on factchecked.science after a full check against the sources. Built from the preprint’s full text, its 13 figures and its Supplementary Table 2, the bioRxiv and Crossref records, the abstracts of the related papers, the World Magnetic Model report, the sources our pages on the field’s decline use, and the episode’s transcript; the verification report lists every item checked and what could not be verified. No figure of the preprint, which is licensed CC BY-NC 4.0, is reproduced or redrawn: the chart and tables use only numbers from its text and supplementary table. A fresh reviewer’s check of the built page corrected the account of the adjusted p-values, which reproduce as the q-values of GraphPad Prism’s two-stage false-discovery-rate procedure (six of seven, not five, lie below the unadjusted values, and all eight tests pass at Q = 5%); a reversed field ratio in section 6; the comparison with the 2010 mole-rat study, which compared each field with the natural one; the basis of “about 30% less time”, now backed by the occupancy medians; the nine authors of the pigeon study, which shares the preprint’s senior author; and ten smaller points: a line locator, the cohort sizes by group, one missing body weight, the cabin’s shielding, the periaqueductal grey’s tied U, two quotations marked as starting mid-sentence, a figure-legend locator, the Research Square title’s spelling, and the stat on group sizes.

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