Possible Relevance of Space Weather for Medicine

Influences of Altered Magnetic Fields on Biological and Clinical Phenomena

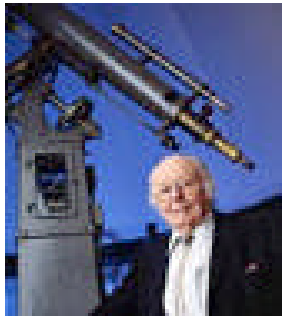
Authors

Sergio Ghione (1), Cristina Del Seppia (1), Lorena Mezzasalma (1) and Mauro Messerotti (2)

(1) CNR, Institute of Clinical Physiology, Pisa, Italy

(2) INAF, Trieste Astronomical Observatory, Trieste, Italy

What have these two scientists in common ?



Both claim to belong to the oldest science of mankind

Space weather, where does it matter for medicine ?

- Radiation hazards
  - Space medicine
  - Aviation medicine
- Geomagnetic disturbance
  - "Ground" medicine and physiology

The risks of correlating astronomical and medical data: an example

- Correlation between heart attacks and magnetic activity
  Malin & Srivastava Nature 277:646-648, 1979

  " Here we present data for which the correlation is particularly high, and can be demonstrated convincingly by standard statistical tests"

- Correlation between heart attacks and magnetic activity - a retraction
  Malin & Srivastava Nature 283: 111, 1980

  " We recently showed a significant correlation between geomagnetic activity and cardiac emergency cases… We have reexamined the hospital records … and are unable to reproduce the number abstracted earlier.
  We … apologise for publishing a misleading result."

ORIGINAL ARTICLE

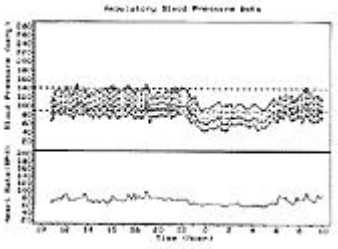
Do geomagnetic disturbances of solar origin affect arterial blood pressure?

S Ghione[1], L Mezzasalma[1], C Del Seppia[1] and F Papi[2]

[1]CNR Institute of Clinical Physiology, Pisa; [2]Department of Ethology, Ecology and Evolution, University of Pisa, Pisa, Italy

DATA SOURCE (1)

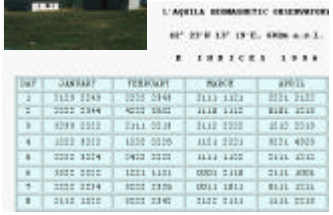
24h **blood pressure** and heart rate monitorings by means of two Spacelab recorders.



DATA SOURCE (2)

geomagnetic data

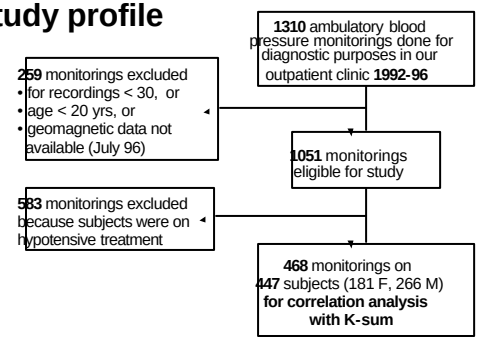
1. the 24h K-index (**K-sum**) provided by the nearest (287 km) geomagnetic observatory (L'Aquila, Italy lat. 42°23'N, long. 13°,19' E).
2. classification of "quietest" (Q) and "most disturbed" (D) days by the National Geophysical Data Center (NGDC, Boulder, Colorado) based on the global Kp index. (http://www.gfz-potsdam.de/pb2/pb23/GeoMag/niemegk/kp_index/quietdst/



Classification of Days

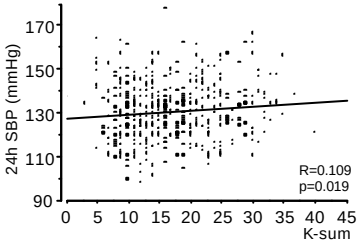
Month	Quietest Days										Most Disturbed Days				
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	D1	D2	D3	D4	D5
jan-92	27	19	7K	28A	6A	14A	18A	17A	15A	13A	24	29	30	23	22*
feb-92	12K	9A	8A	10A	13A	3A	6A	11A	21A	26A	16	20	23	17	19
mar-92	17	4	16A	10A	31A	7A	9A	3A	8A	5A	21	30	26	25	12
apr-92	1	8	6A	7A	19A	5A	4A	16A	2A	21A	10	12	11	14	17

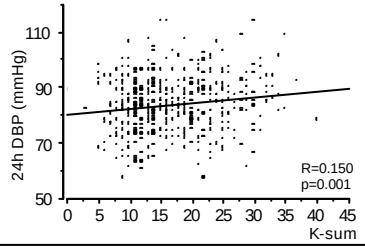
Study profile



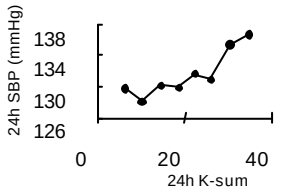
Correlation of 24 hr BP and K-sum

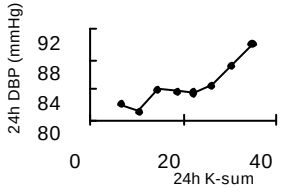
468 monitorings
447 subjects

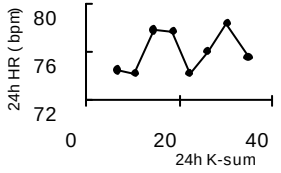




Average 24h systolic (SBP) and diastolic (DBP) and heart rate (HR) plotted in classes of increasing K-sum values





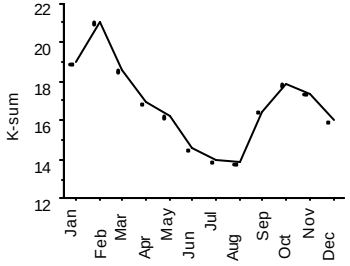


K-sum

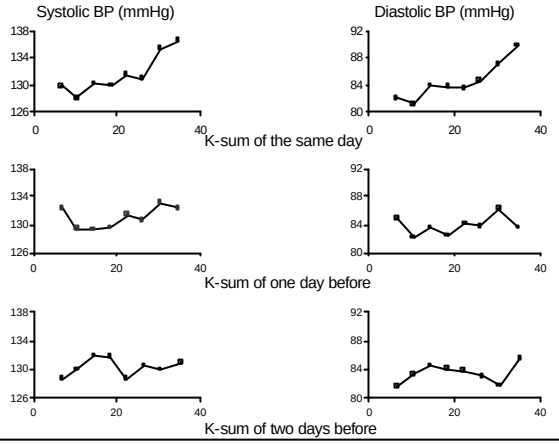
Range	Counts	Mean
1-8	41	6.6
9-12	110	10.4
13-16	100	14.5
17-20	69	18.7
21-24	64	22.3
25-28	44	26.0
29-32	30	30.3
33-40	10	34.8

Is the correlation season-mediated ?

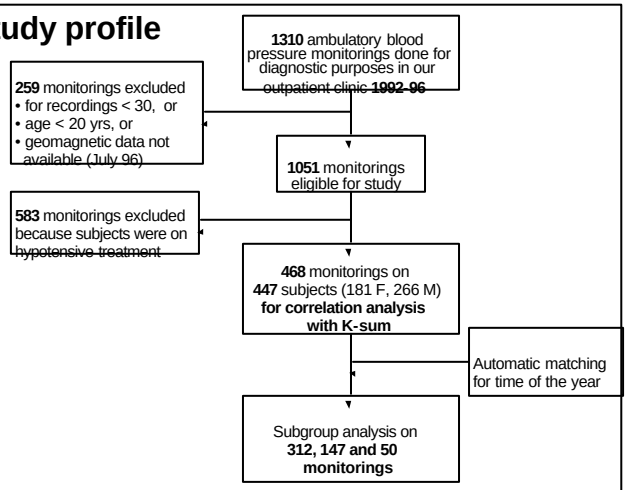
Monthly mean values of daily K-sum in the years 1992-1996



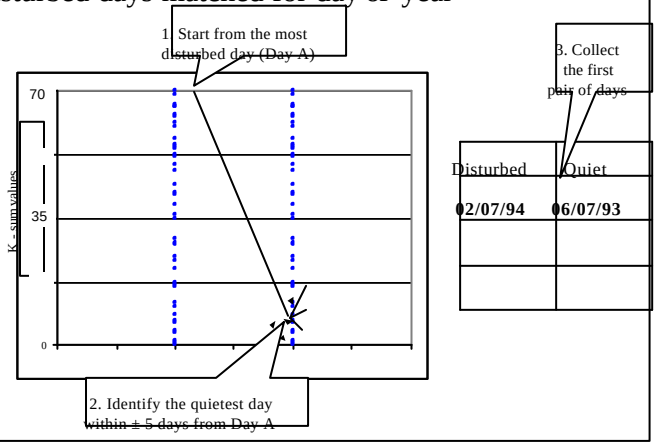
Relationship between 24h mean values of arterial blood pressure (BP) and K-sum values



Study profile



Procedure to obtain subgroups of quiet and disturbed days matched for day-of-year



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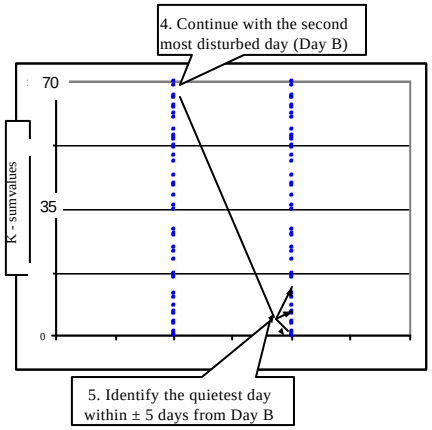
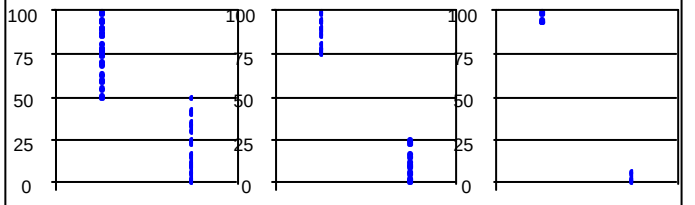


Disturbed	Quiet
02/07/94	**06/07/93**
23/01/96	**19/01/92**
...	...

Subgroups of quiet and disturbed matched days studied

Lower vs upper half | **25th vs 75th percentile** | **10th vs 90th percentile**



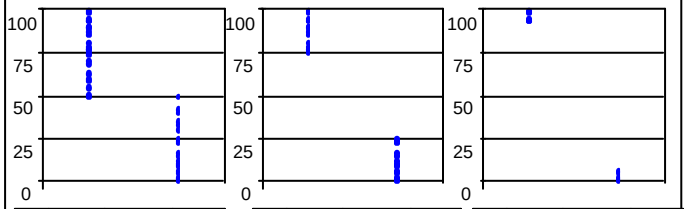
	Quiet	Disturbed
n. days	139	139
n. monit	154	158
K-sum	10±3	25±5

	Quiet	Disturbed
n. days	64	64
n. monit	71	76
K-sum	8±2	28±4

	Quiet	Disturbed
n. days	22	22
n. monit	25	25
K-sum	7±1	31±3

Subgroups of quiet and disturbed matched days studied

Lower vs upper half | **25th vs 75th percentile** | **10th vs 90th percentile**



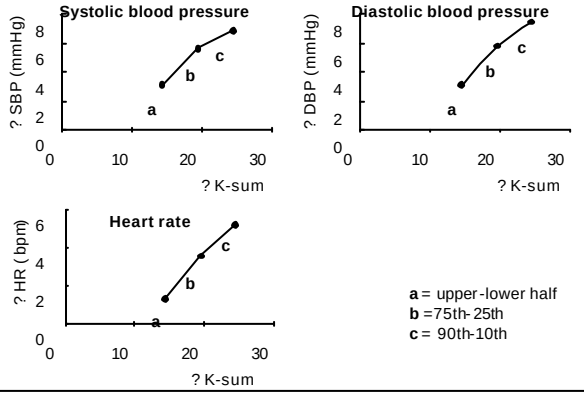
	Quiet	Disturbed	P value
SBP	129±14	132±13	0.034
DBP	82±9	85±10	0.006
HR	75±9	77±10	NS

	Quiet	Disturbed	P value
SBP	129±13	134±13	0.008
DBP	81±10	87±10	<0.001
HR	75±9	78±11	0.043

	Quiet	Disturbed	P value
SBP	128±13	135±11	0.050
DBP	81±10	89±10	0.011
HR	75±8	80±11	NS

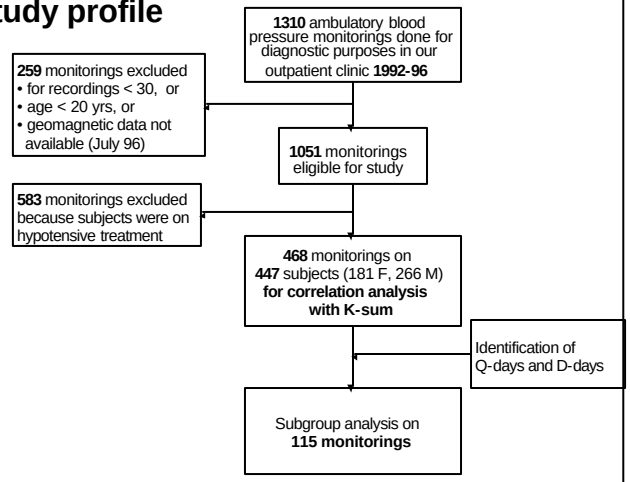
SBP= Systolic blood pressure (mmHg)
DBP= Diastolic blood pressure (mmHg)
HR= Heart rate (bpm)

The difference in blood pressure was proportional to the difference in K-sum



a = upper-lower half
b = 75th-25th
c = 90th-10th

Study profile



	Q-days	D-days	P-value
N. monitorings	58	57	
24h SBP (mmHg)	132.0±1.9	134.6±1.6	NS
24h DBP (mmHg)	83.7±1.2	87.8±1.2	0.021
24h HR (bpm)	74.6±1.2	78.8±1.6	0.042

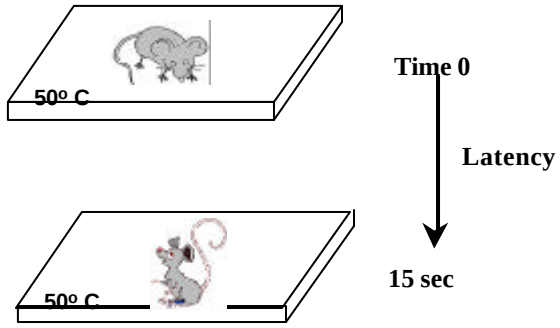
Conclusions

- Arterial blood pressure tends to be consistently higher in geomagnetically more disturbed days. A similar effect may be present for heart rate. These results confirm those of a similar smaller study.
- For extreme geomagnetic disturbance differences the expected effect on blood pressure is about 5 to 8 mmHg which is in the same order of magnitude of other factors such as salt, body weight, alcohol and temperature.

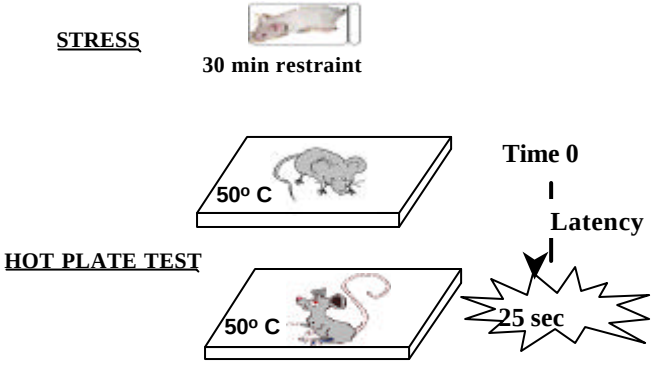
Why have people higher blood pressure (and perhaps heart rate) in disturbed days ?

- Perhaps: because they are more sensitive to stress
- Evidence in that direction comes from studies on the effect of magnetic fields on pain perception

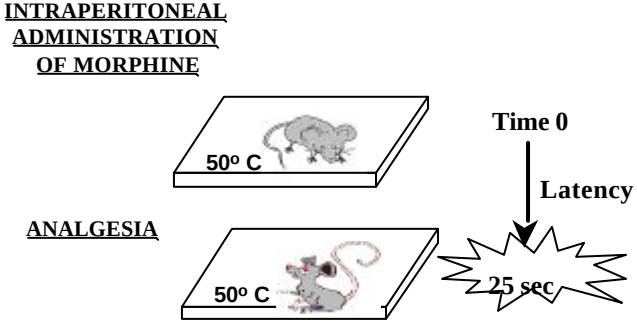
The “Hot Plate” Test



Stress-Induced Analgesia (SIA)

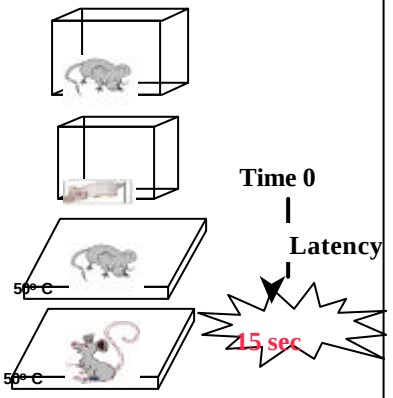


Opiate-Induced Analgesia



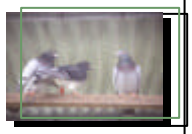
Experimental design

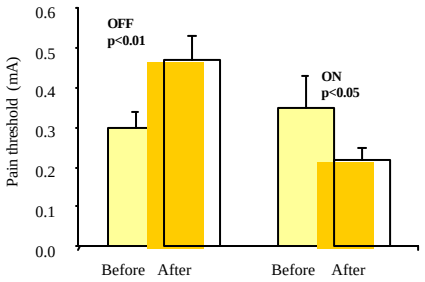
1. 90 min magnetic exposure
2. 30 min restraint stress (during exposure)
3. hot plate test



Exposure to various abnormal magnetic environment suppresses stress-induced opiate-mediated analgesia
(which is probably a coping mechanism)

Results in pigeons



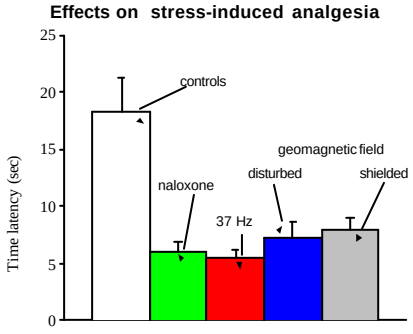


Del Seppia et al.

Bioelectromagnetics 1995

Pain threshold after restraint stress increases under sham exposure (OFF) and decreases under geomagnetic disturbance (ON) suggesting a suppression of stress-induced hypoalgesia

Results in mice

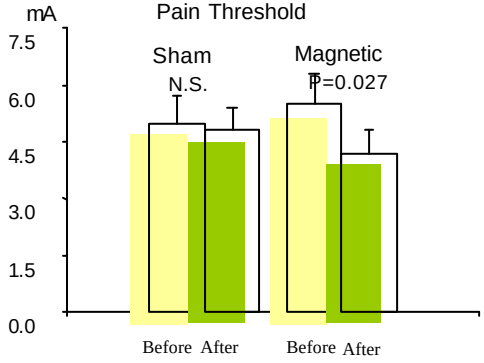


Del Seppia et al.

Life Sciences 2000

Pain threshold after restraint stress decreases under exposure to various abnormal magnetic conditions

Results in humans



Ghione et al

Bioelectrom. In press.

Cutaneous pain threshold to electrical stimulation decreases under magnetic exposure

Neuroscience Letters, 40 (1983) 321–325
Elsevier Scientific Publishers Ireland Ltd.

REDUCED NOCTURNAL MORPHINE ANALGESIA IN MICE FOLLOWING A GEOMAGNETIC DISTURBANCE

K.-P. OSSENKOPP[1]*, M. KAVALIERS[2] and M. HIRST[3]

Departments of [1]Psychology, [2]Zoology, and [3]Pharmacology and Toxicology, University of Western Ontario, London, Ontario N6A 5C2 (Canada)

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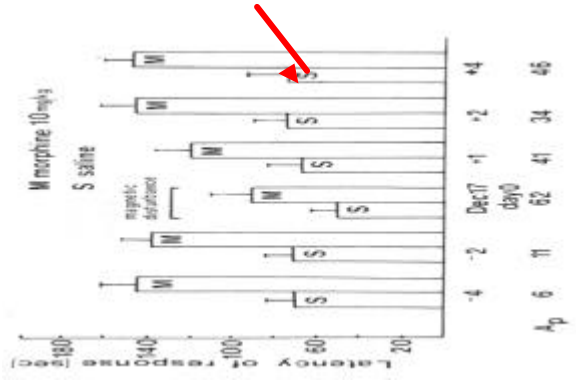

We cautiously propose that:

Exposure to various abnormal magnetic environment **including those produced by space weather** suppresses adaptive mechanisms involved in stress coping

Prospective well-planned studies are needed
But they require reliable space weather forecasts ...

Relevance in space medicine ?

Appropriate ability to efficiently cope stress is essential in manned spaceflight:, for obvious reasons:

- emergency situations
- social stress, crew tension, conflicts etc.

esa

Research project ASI (I/R/073/01 e I/R/325/02)

Study of the effects of exposure to a magnetic field simulating that experienced by the international space station (ISS) in its revolution around the Earth on psychophysiological parameters in the experimental animal and in humans

Please don’t ask me too difficult questions:
I’m sure I will not know the answer
and most probably
I will not even understand the question.

The secret of every biochemist

“When we are with biologists we talk about chemistry, when we are among chemists we talk about biology and when we are among ourselves we talk about GIRLS “