

POSTER PRESENTATION

Open Access

Receptor guanylyl cyclase-G is a novel thermosensor in Grueneberg ganglion neurons involved in coolness-induced ultrasonic distress calls in mice

Ying-Chi Chao¹, Heinz Breer², Yuh-Charn Lin¹, Chih-Cheng Chen¹, Joerg Fleischer², Ruey-Bing Yang^{1,3*}

From 6th International Conference on cGMP: Generators, Effectors and Therapeutic Implications Erfurt, Germany. 28-30 June 2013

Background

In mammals, detection of ambient temperatures is mainly mediated by thermosensory neurons residing in the dorsal root ganglion (DRG) and trigeminal ganglion (TG) [1-3]. Recently, neurons in the Grueneberg ganglion (GG) of the murine nasal vestibule have been found to be activated by cool temperatures [4,5]. Unlike coolness-sensitive cells in the DRG and TG, neurons in the GG lack the TRPM8 channel [6] which is considered as a principal detector of cold [1-3]. Therefore, GG neurons are supposedly endowed with a so far unknown thermosensor. Interestingly, coolness-sensitive GG neurons express signaling elements associated with cyclic guanosine monophosphate (cGMP), including the cGMP-activated ion channel CNGA3 and receptor guanylyl cyclase-G (GC-G) [6-8]. Recent observations suggest that cGMP signaling is crucial for thermotransduction in the GG [8]. However, whether GC-G directly acts as a temperature sensor remains elusive.

Materials and methods

A combination of biochemical and molecular biology methods, Ca²⁺ imaging as well as behavioural studies comparing wild-type and GC-G-knockout mice was used to elucidate the molecular and biological function of GC-G in sensing cool temperatures.

Results

We show that GC-G is a thermosensory receptor that can be maximally stimulated by cool temperatures of about

15°C in both *in vivo* cellular cGMP accumulation assays and *in vitro* GC assays with a purified recombinant protein. Cells co-expressing GC-G and CNGA3 respond to cool temperatures via a rapid influx of calcium. Furthermore, we found a marked coolness-induced expression of the activity-dependent gene *c-Fos* in GG neurons of wild-type neonatal pups but not in GC-G-knockout conspecifics. Consistent with these findings, coolness-elicited ultrasonic vocalizations were significantly impaired in GC-G-knockout compared to wild-type pups.

Conclusion

Our data suggest that GC-G is a novel thermosensory protein and that GG activation via GC-G by coolness is critical for the generation of ultrasound calls by isolated pups to elicit maternal care.

Authors' details

¹Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan. ²Institute of Physiology, University of Hohenheim, Stuttgart, Germany. ³Institute of Pharmacology, School of Medicine, National Yang-Ming University, Taipei, Taiwan.

Published: 29 August 2013

References

1. Bautista DM, Siemens J, Glazer JM, Tsuruda PR, Basbaum AI, Stucky CL, Jordt SE, Julius D: **The menthol receptor TRPM8 is the principal detector of environmental cold.** *Nature* 2007, **448**:204-208.
2. Colburn RW, Lubin ML, Stone DJ Jr, Wang Y, Lawrence D, D'Andrea MR, Brandt M, Liu Y, Flores CM, Qin N: **Attenuated cold sensitivity in TRPM8 null mice.** *Neuron* 2007, **54**:379-386.
3. Dhaka A, Murray AN, Mathur J, Earley TJ, Petrus MJ, Patapoutian A: **TRPM8 is required for cold sensation in mice.** *Neuron* 2007, **54**:371-378.
4. Mamasuew K, Breer H, Fleischer J: **Grueneberg ganglion neurons respond to cool ambient temperatures.** *Eur J Neurosci* 2008, **28**:1775-1785.

* Correspondence: rbyang@ibms.sinica.edu.tw

¹Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan
Full list of author information is available at the end of the article

5. Schmid A, Pyrski M, Biel M, Leinders-Zufal T, Zufall F: **Grueneberg ganglion neurons are finely tuned cold sensors.** *J Neurosci* 2010, **30**:7563-7568.
6. Fleischer J, Mamasuew K, Breer H: **Expression of cGMP signaling elements in the Grueneberg ganglion.** *Histochem Cell Biol* 2009, **131**:75-88.
7. Liu CY, Frase SE, Koos DS: **Grueneberg ganglion olfactory subsystem employs a cGMP signaling pathway.** *J Comp Neurol* 2009, **516**:36-48.
8. Mamasuew K, Michalakis S, Breer H, Biel M, Fleischer J: **The cyclic nucleotide-gated ion channel CNGA3 contributes to coolness-induced responses of Grueneberg ganglion neurons.** *Cell Mol Life Sci* 2010, **67**:1859-1869.

doi:10.1186/2050-6511-14-S1-P14

Cite this article as: Chao et al.: Receptor guanylyl cyclase-G is a novel thermosensor in Grueneberg ganglion neurons involved in coolness-induced ultrasonic distress calls in mice. *BMC Pharmacology and Toxicology* 2013 **14**(Suppl 1):P14.

**Submit your next manuscript to BioMed Central
and take full advantage of:**

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.biomedcentral.com/submit

