Social regulation of gene expression

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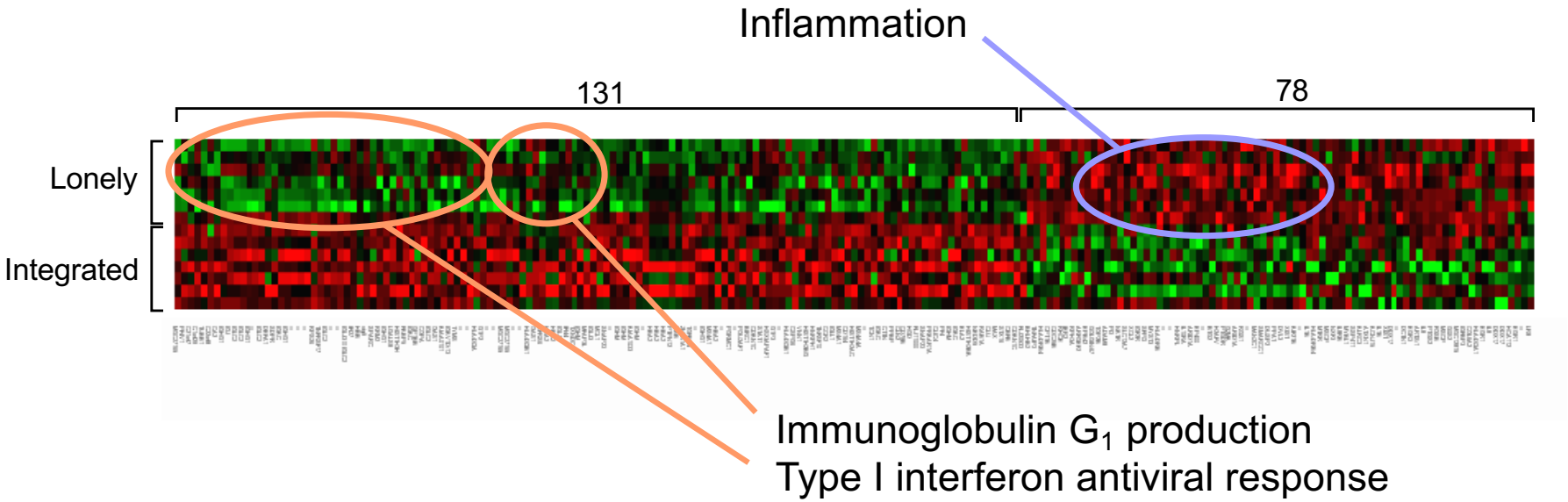
UCLA School of Medicine
Division of Hematology-Oncology

Social isolation



Cole et al., Genome Biology, 2007

Low SES

Social loss / bereavement

Post-traumatic stress

Cancer diagnosis

Social threat

Loneliness

Social instability

Chronic stress

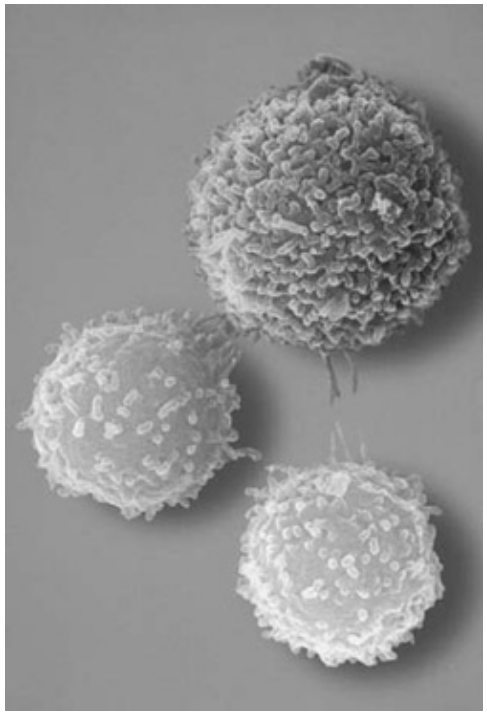
Low social rank

Caregiving for seriously ill

Anxiety

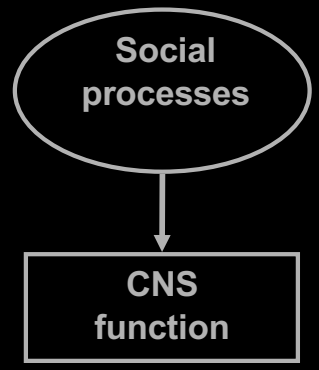
Early life adversity

Social instability

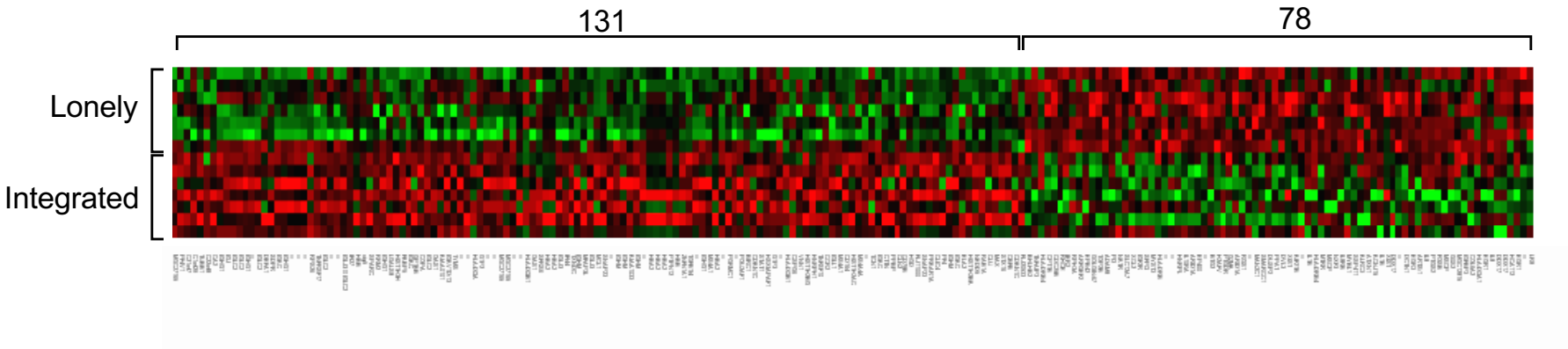


Cole et al., PNAS, 2012
Tung et al., PNAS, 2012
Cole et al., PNAS, 2015

Social signal transduction

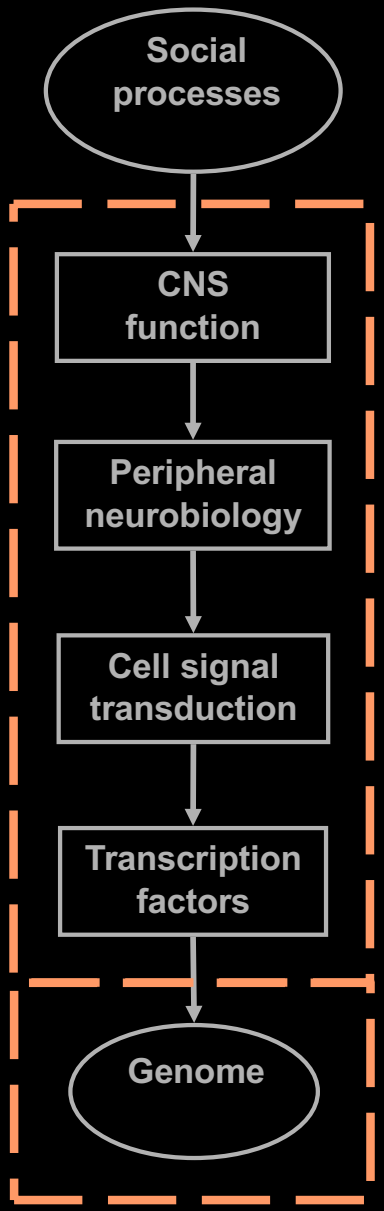


Social isolation



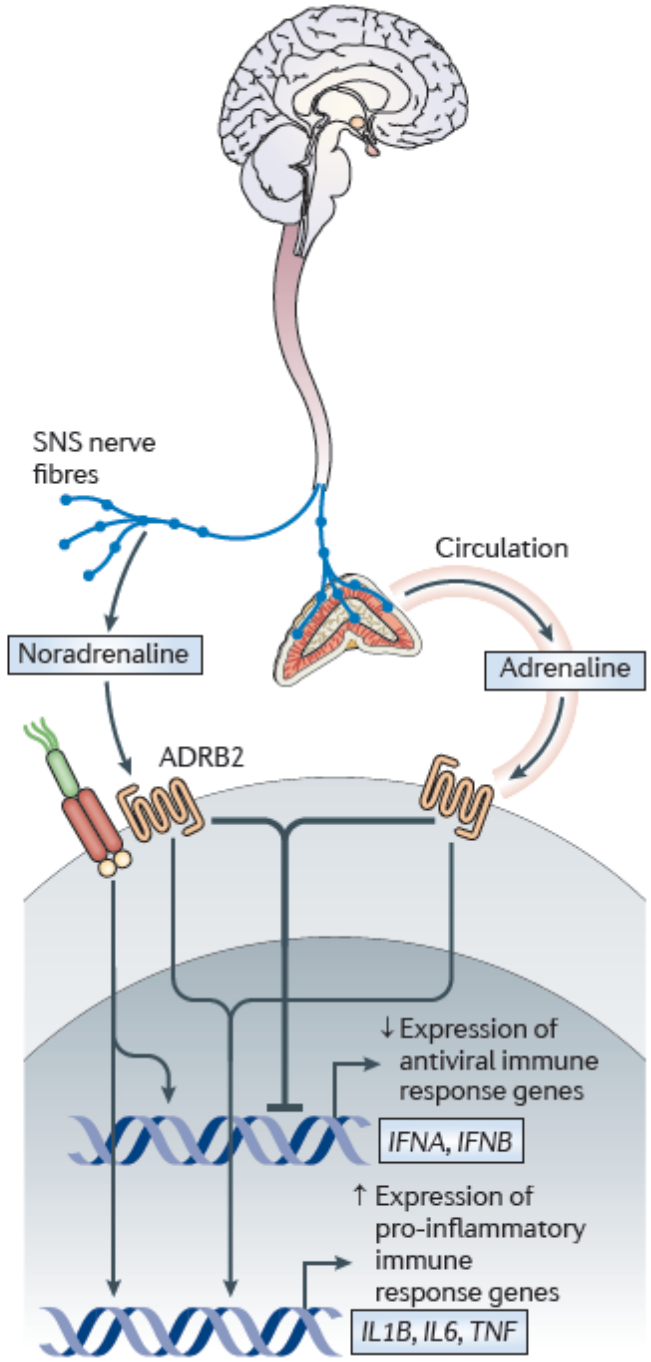
Cole et al., Genome Biology 2007

Social signal transduction

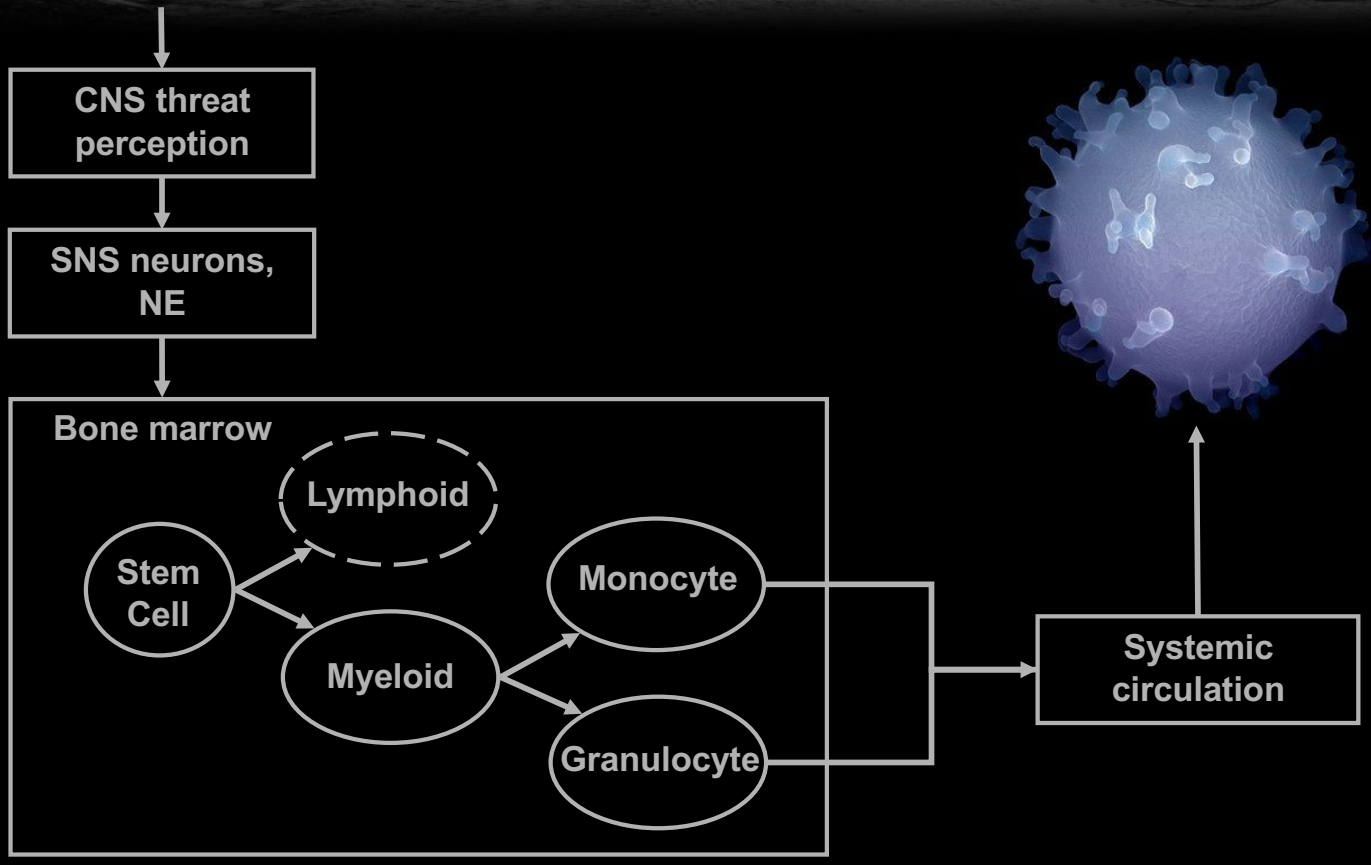


Simple questions

1. Which gene modules are sensitive to social processes?
2. Which transcription control pathways mediate those effects?

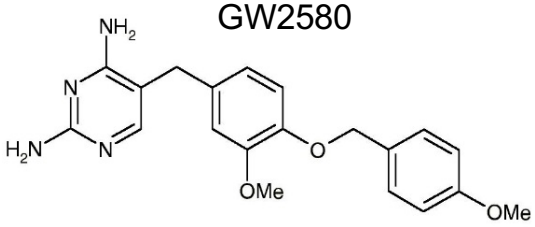


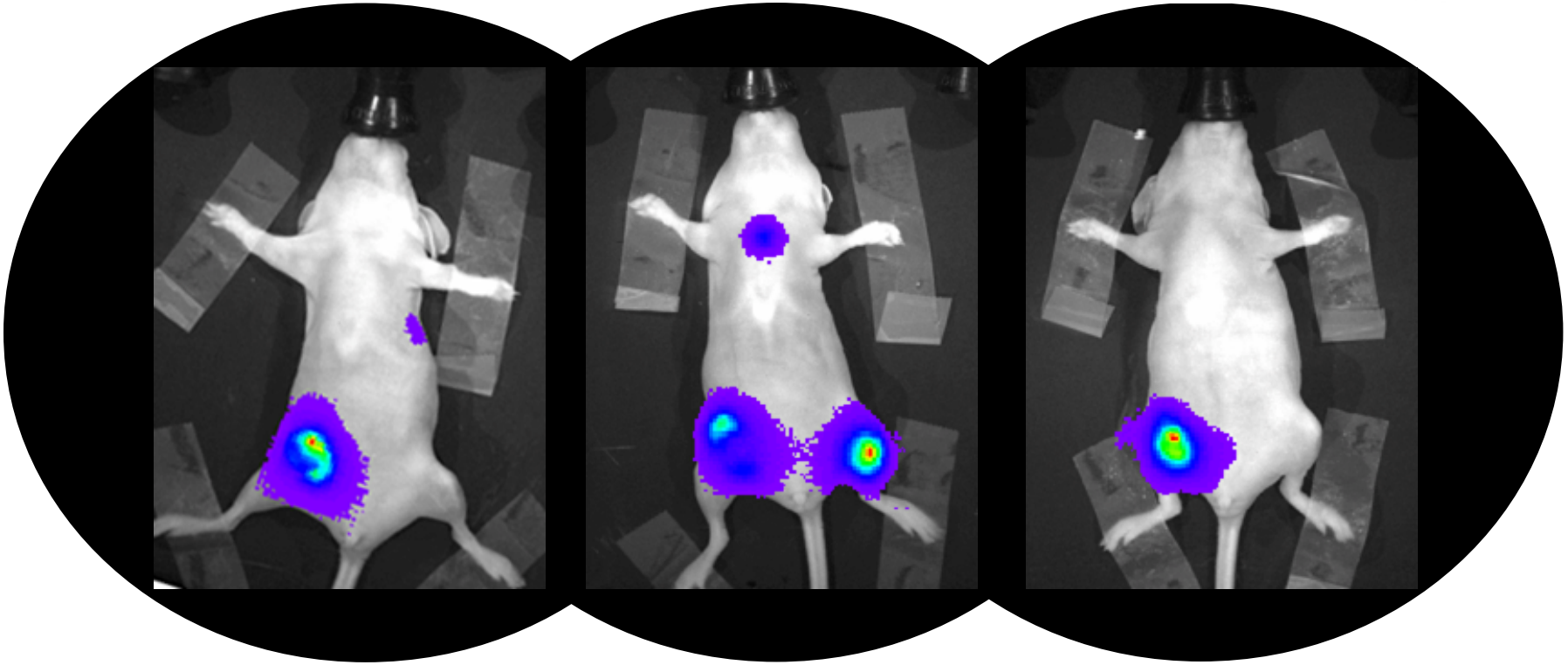
Irwin & Cole, Nature Reviews Immunology, 2011

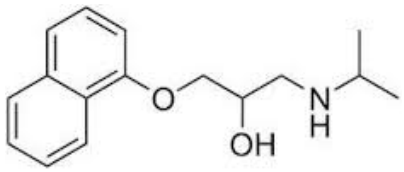


Cole et al., PNAS, 2011
Powell et al., PNAS, 2013
Heidt et al., Nature Medicine, 2014
Cole et al., PNAS, 2015

GW2580

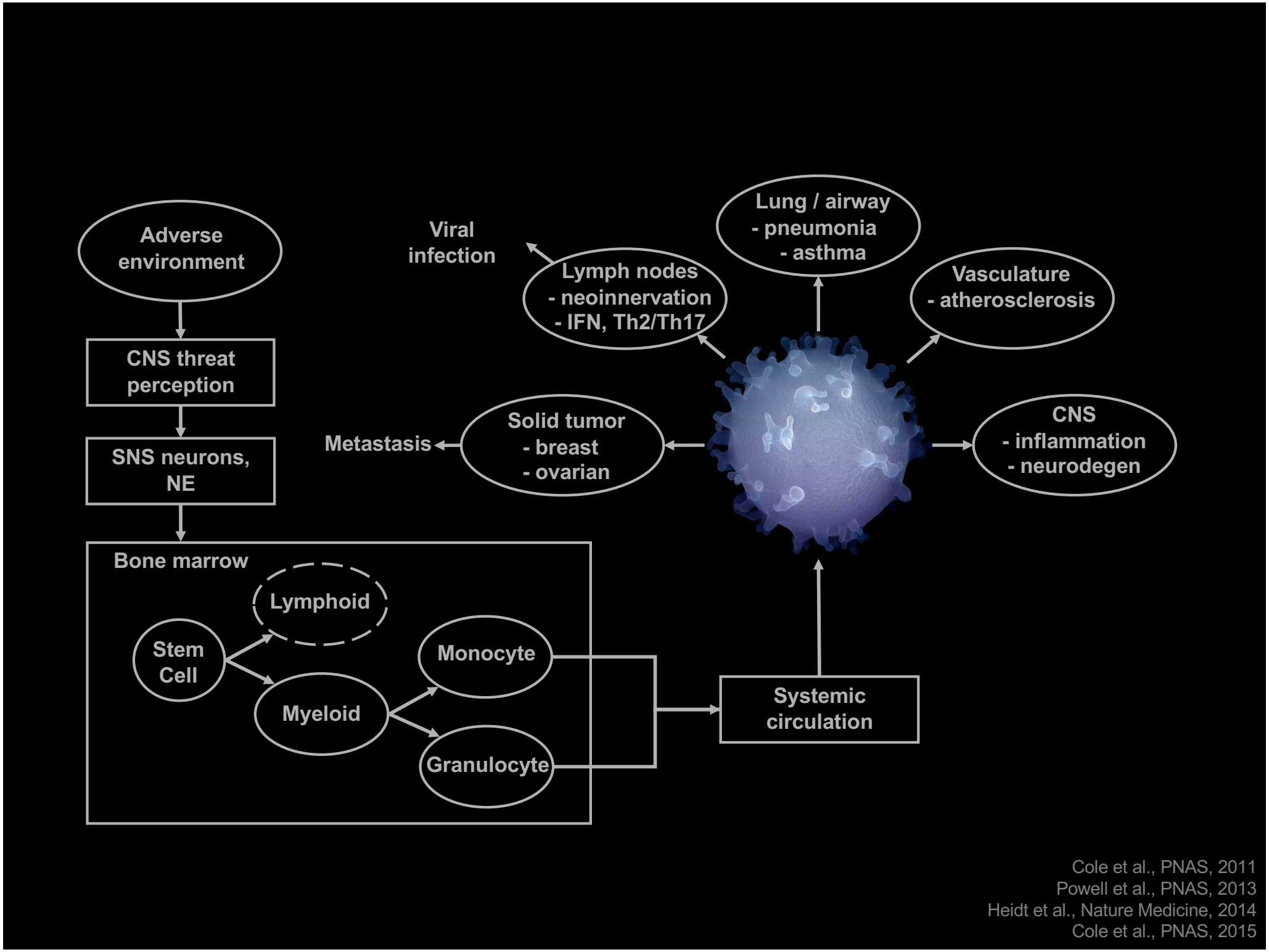






propranolol

Sloan et al., Cancer Research, 2010
Cole et al., Nature Reviews Cancer, 2015



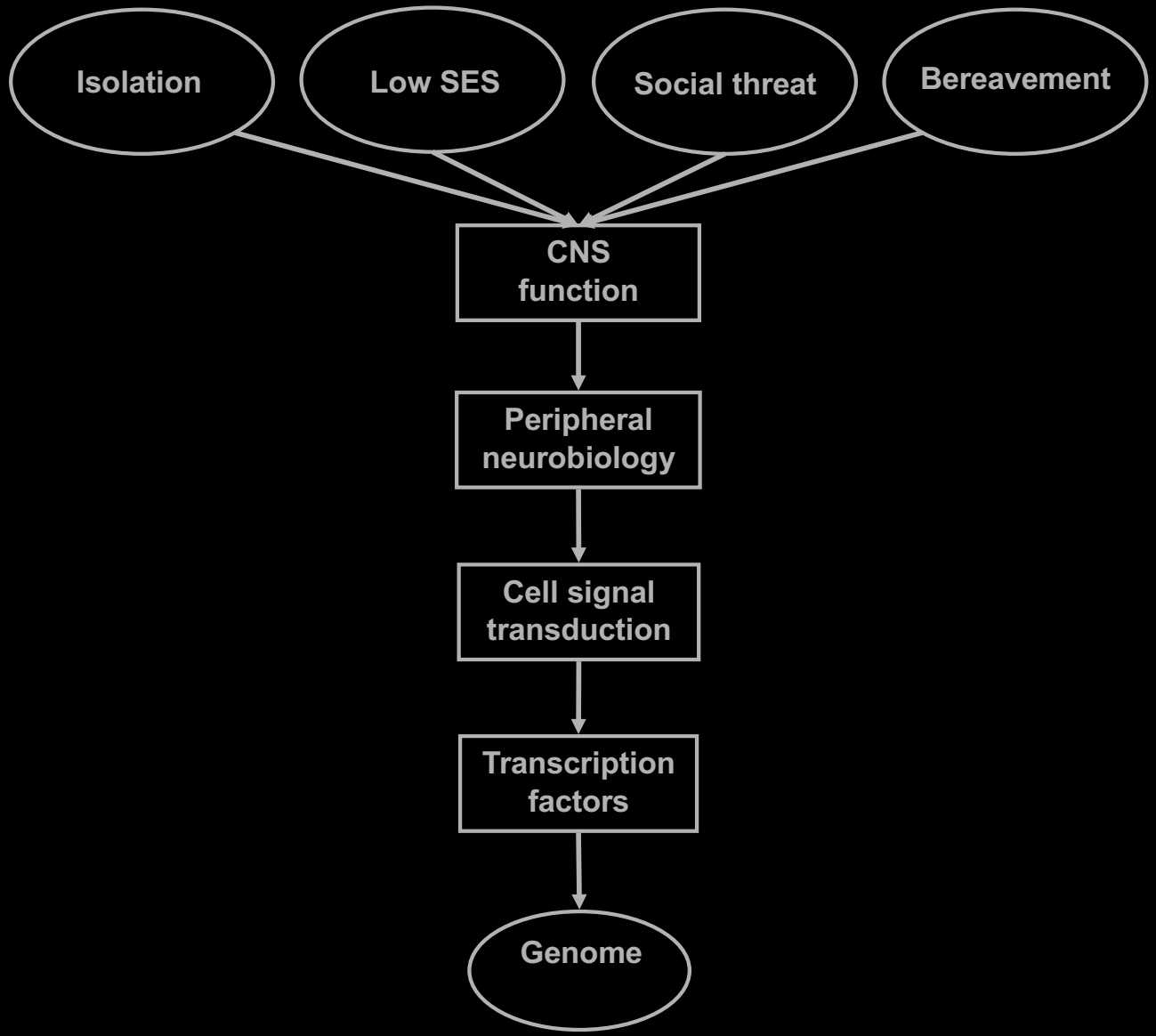
Cole et al., PNAS, 2011
Powell et al., PNAS, 2013
Heidt et al., Nature Medicine, 2014
Cole et al., PNAS, 2015

Central nervous system

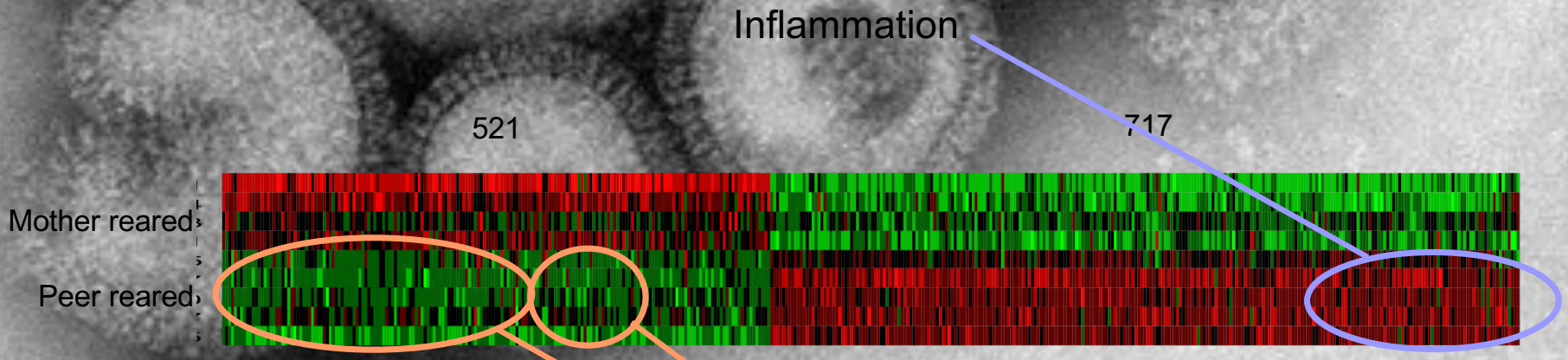
Leukocyte

Irwin & Cole, Nature Reviews Immunology, 2011
Cole, PLoS Genetics, 2014

Social signal transduction



CTRA – conserved transcriptional response to adversity



Immunoglobulin G_1 production
Type I interferon antiviral response

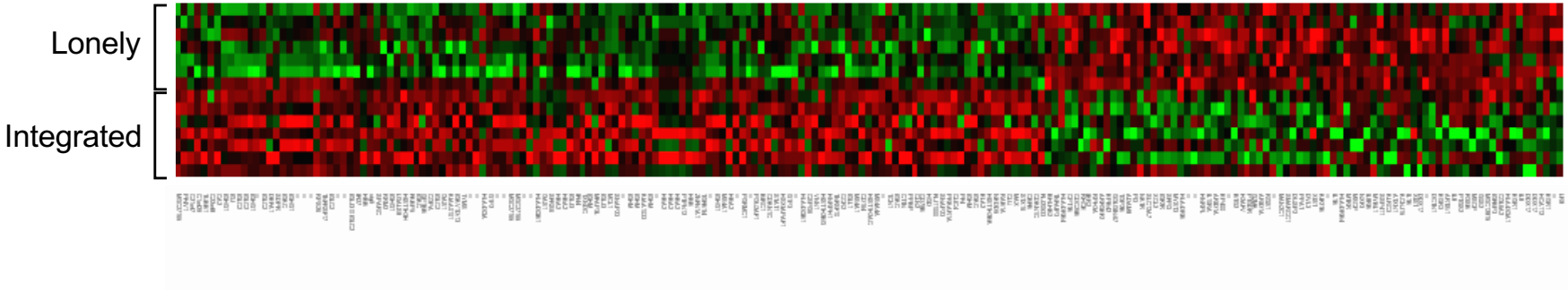
Irwin & Cole, Nature Reviews Immunology, 2011
Cole, PLoS Genetics, 2014

2 “social genomic programs” in immune cells

safe/attached

danger/isolated

How not to live



How should we live?

Hedonic

How often do you feel **happy**?

How often do you feel **satisfied**?

Keyes MHC-SF - Hedonic

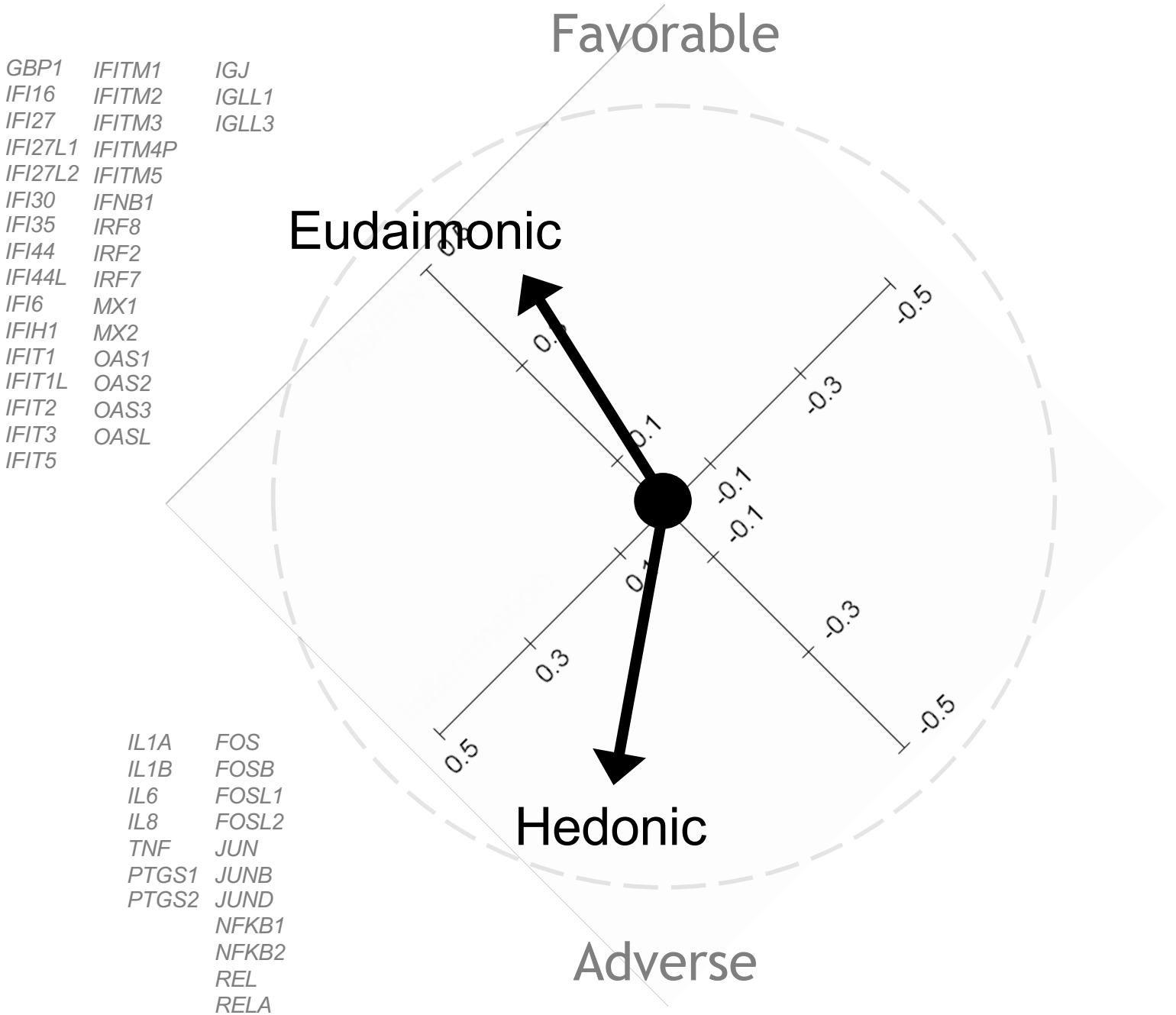
Eudaimonic

Life has **direction** and **meaning**?

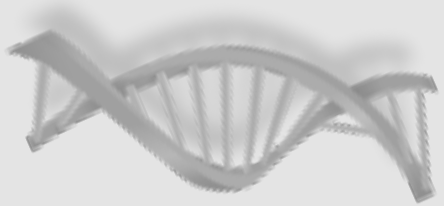
Grow and become a **better person**?

Keyes MHC-SF – Eudaimonic

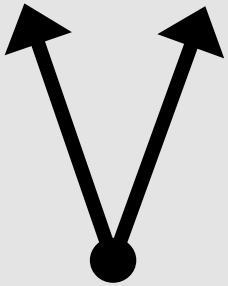
Fredrickson et al., PNAS, 2013



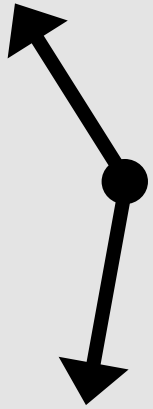
Fredrickson et al., PNAS, 2013



Eudaimonic Hedonic

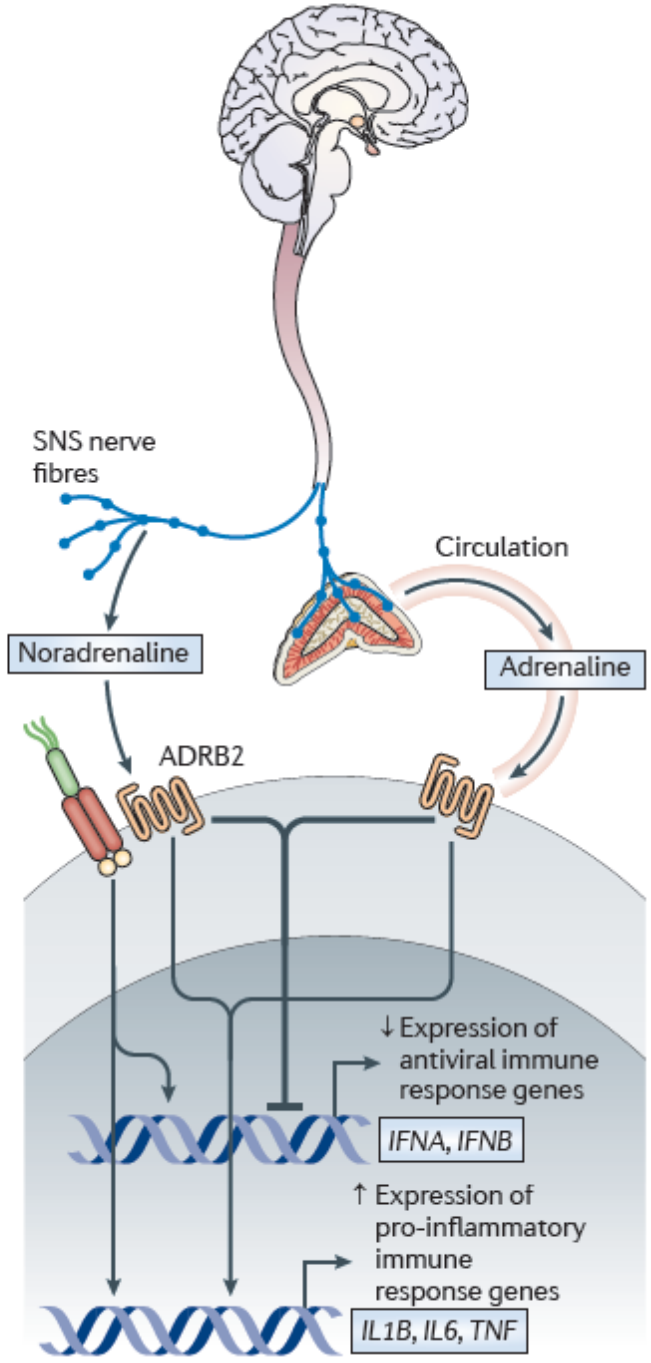


Eudaimonic

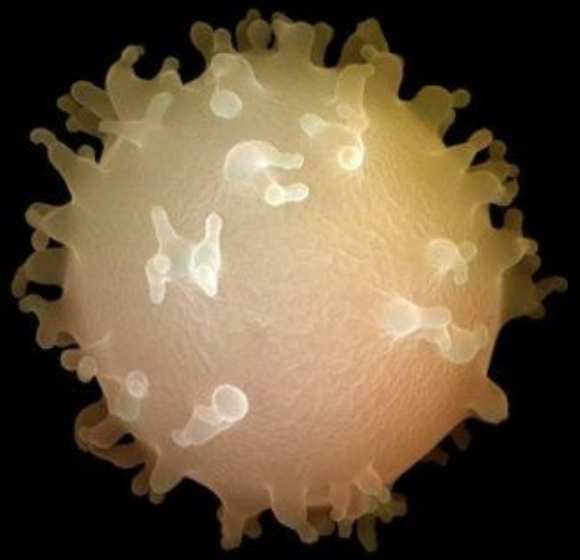


Hedonic

Goetz et al., Psychological Bulletin, 2010
Porges, Int J Psychophysiology, 2001
Porges, Psychophysiology, 1995



Cultivating positive leukocytes



Cognitive-behavioral

Antoni et al. (2012) Biological Psychiatry 71:366–372
Laudenslager et al. (2016) Journal of Behavioral Medicine, ePub.

Mindfulness

Bower et al. (2015) Cancer 121:1231-1240

Yoga

Bower et al. (2014) Psychoneuroendocrinology, 43:20-29

Tai Chi

Irwin et al. (2014) Journal of the National Cancer Institute Monographs, 2014:295-301

Mindfulness

Creswell et al. (2012) Brain, Behavior, & Immunity 26:1095-1101

Relaxation response / mindfulness

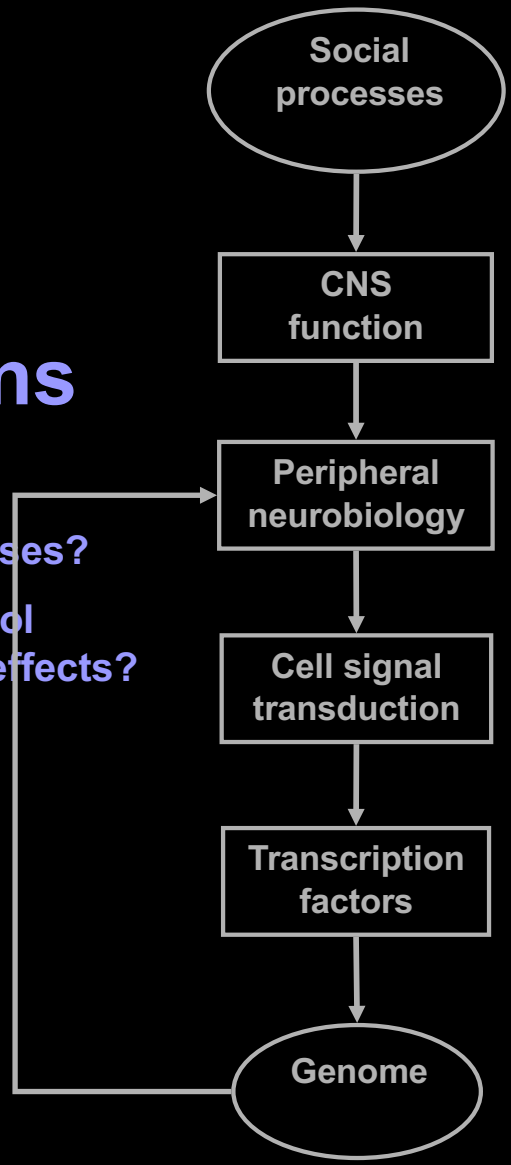
Bhasin et al. (2013) PLoS ONE, 8:e62817

Yogic meditation

Qu et al. (2013) PLoS ONE, 8:e61910
Black et al. (2013) Psychoneuroendocrinology, 38:348-55

Cole, American Journal of Public Health, 2013
Cole, PLoS Genetics, 2014

Social signal transduction



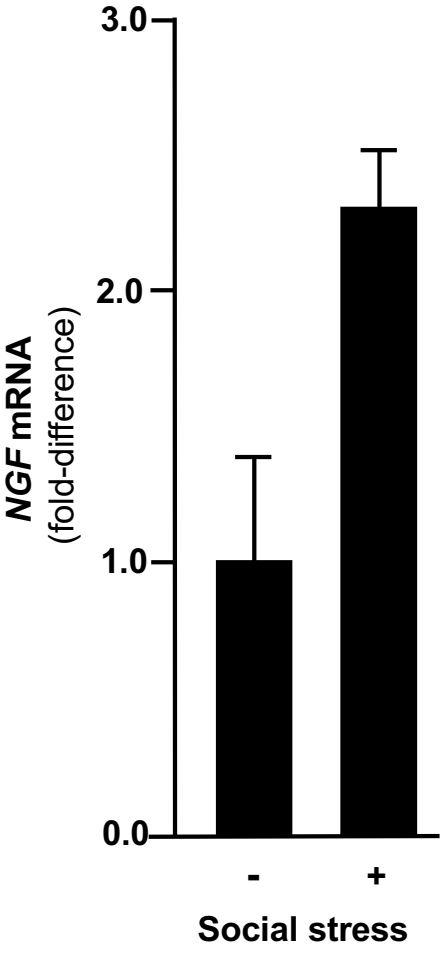
Simple questions

1. Which gene modules are sensitive to social processes?
2. Which transcription control pathways mediate those effects?

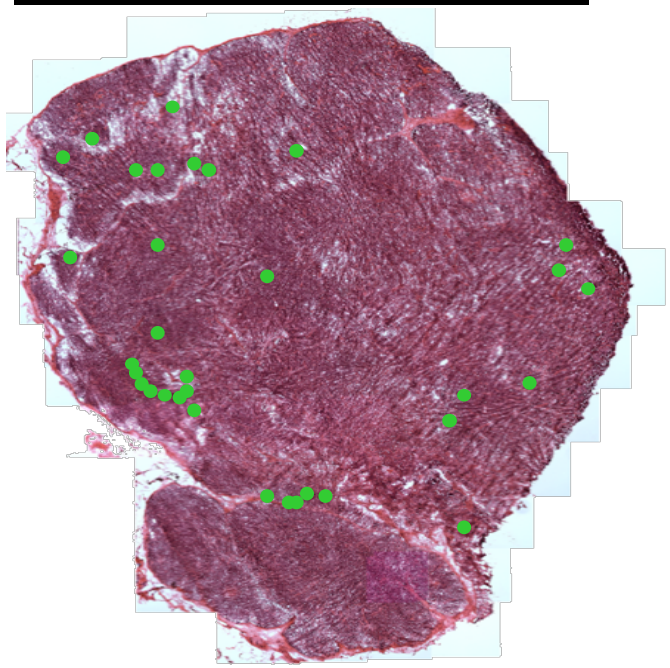
Not-so-simple questions

1. Recursive persistence and environmental embedding

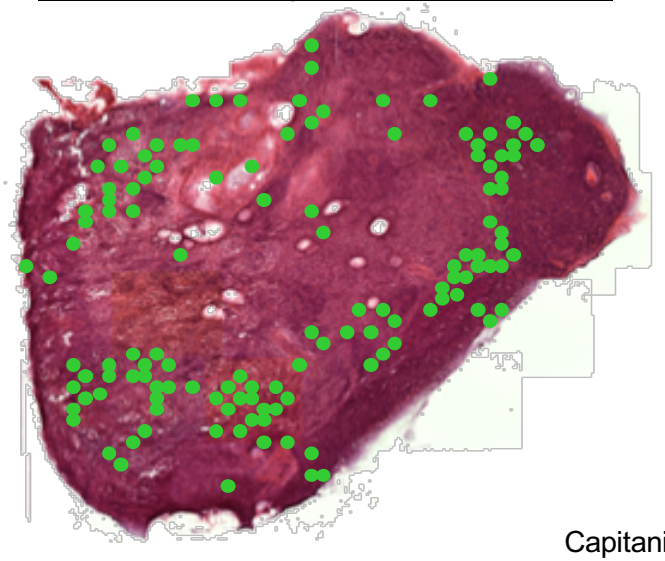
NGF expression



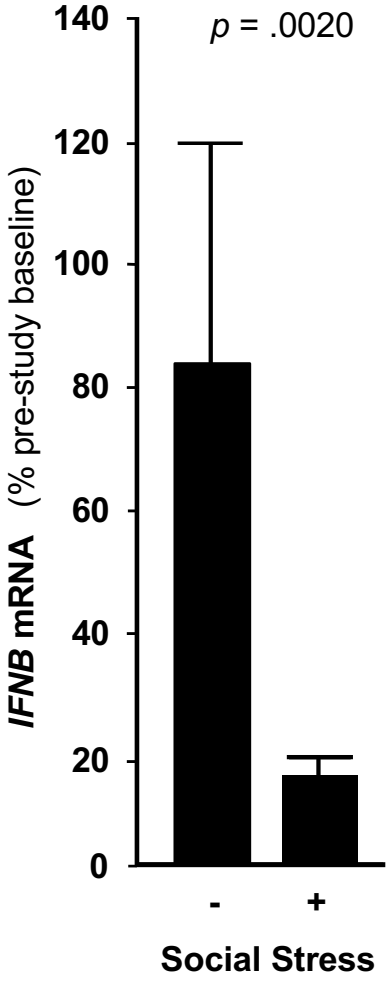
Stable social conditions



Unstable

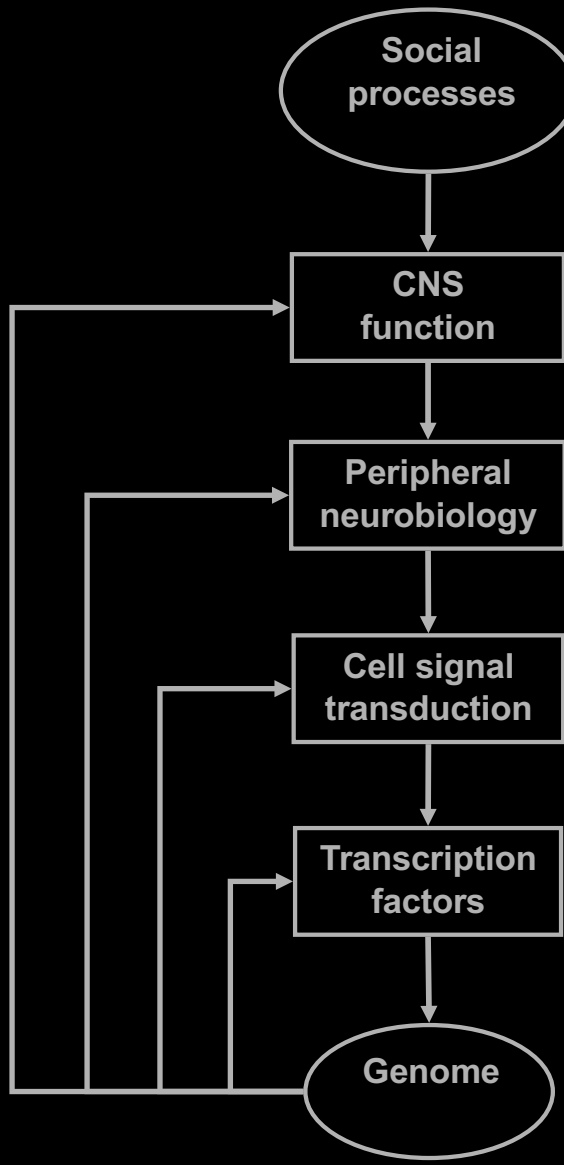


IFNB mRNA



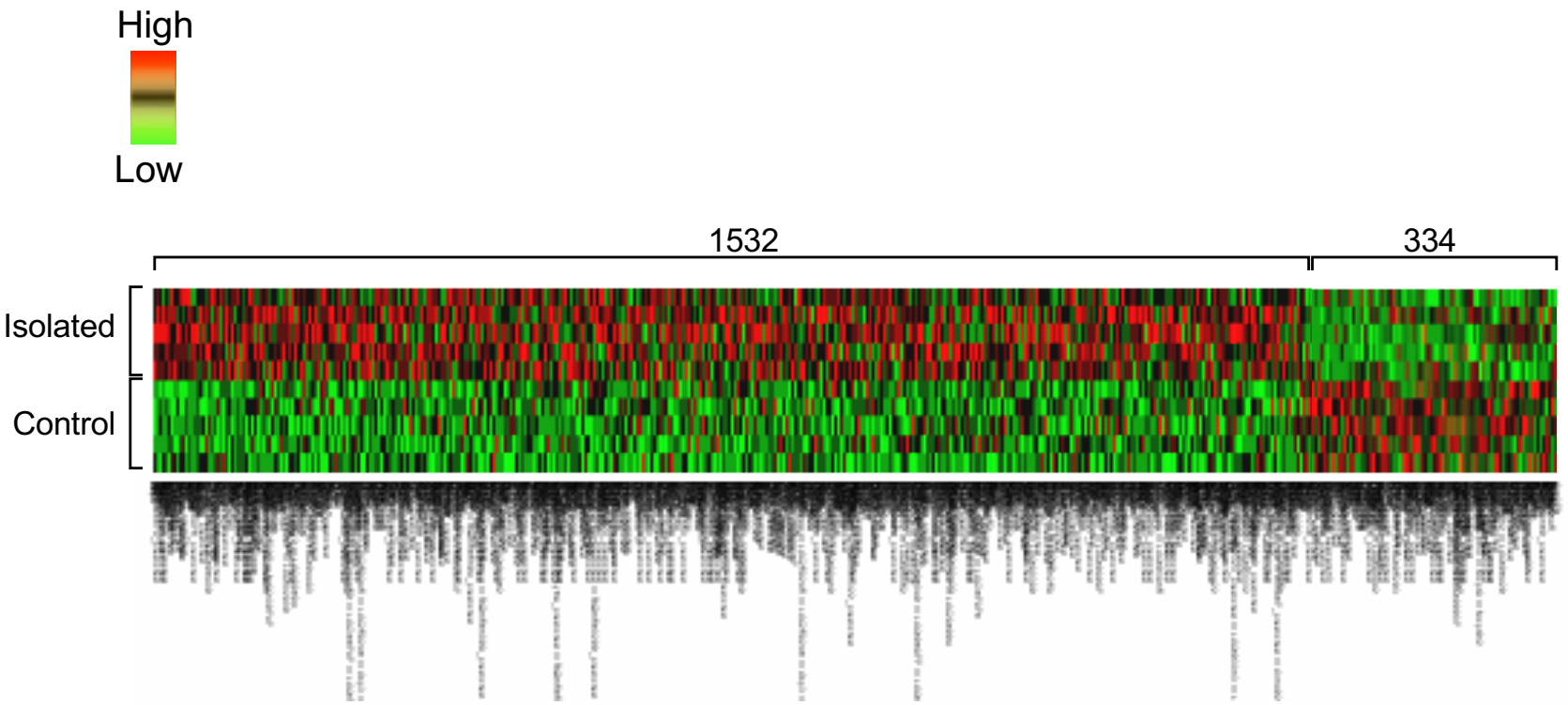
Sloan et al., Journal of Neuroscience, 2007
Capitanio & Cole, Philos Trans R Soc Lond B Biol Sci., 2015
Cole et al., PNAS, 2015

Social signal transduction

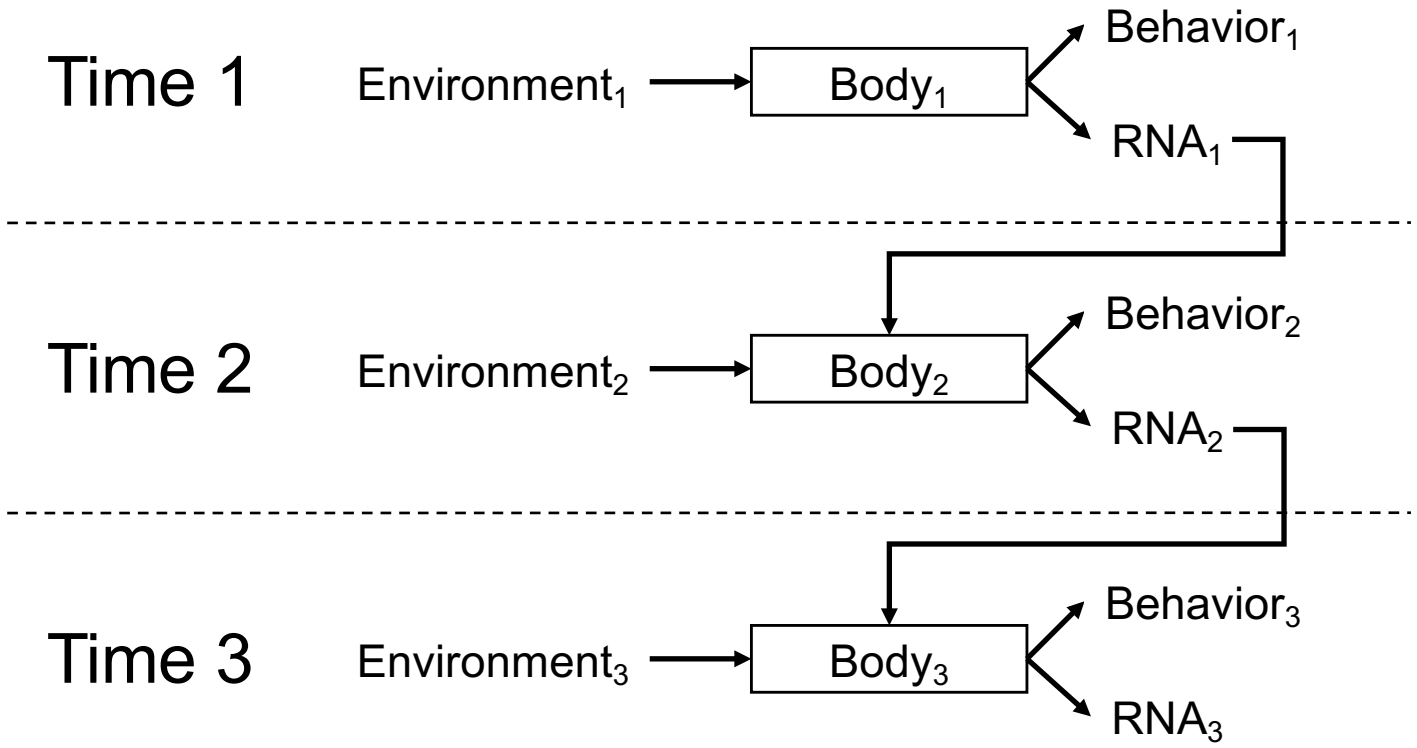


Recursive persistence

Social isolation



Recursive developmental remodeling



RNA = intra-organismic adaptation

Cole, Current Directions in Psychological Science, 2009
Cole, American Journal of Public Health, 2013
Gray et al., Molecular Psychiatry, 2014

Low early-life social class leaves a biological residue manifested by decreased glucocorticoid and increased proinflammatory signaling

Gregory E. Miller[a,1], Edith Chen[a], Alexandra K. Fok[b,c], Hope Walker[a], Alvin Lim[a], Erin F. Nicholls[a], Steve Cole[d,e,f], and Michael S. Kobor[b,c]

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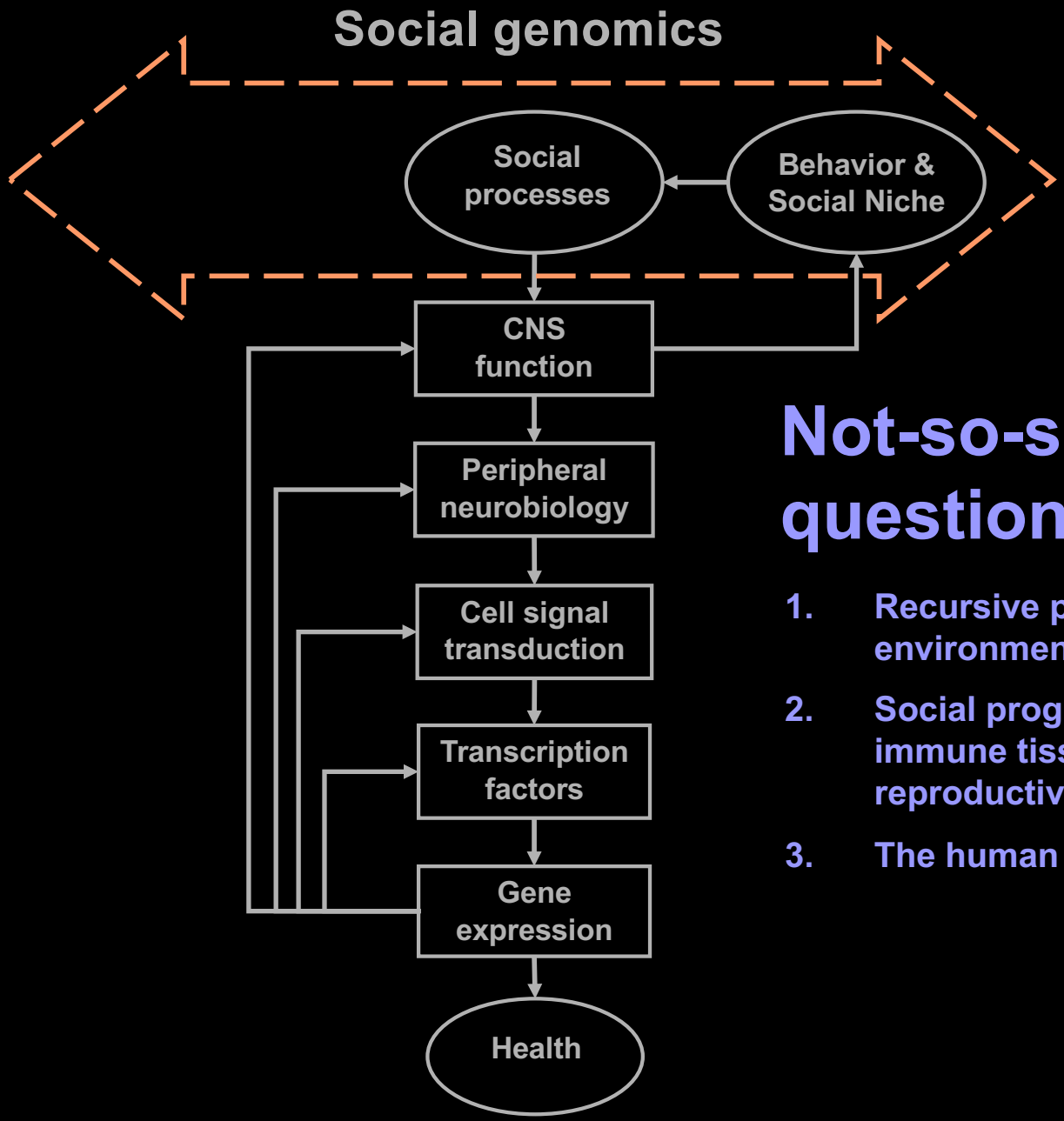
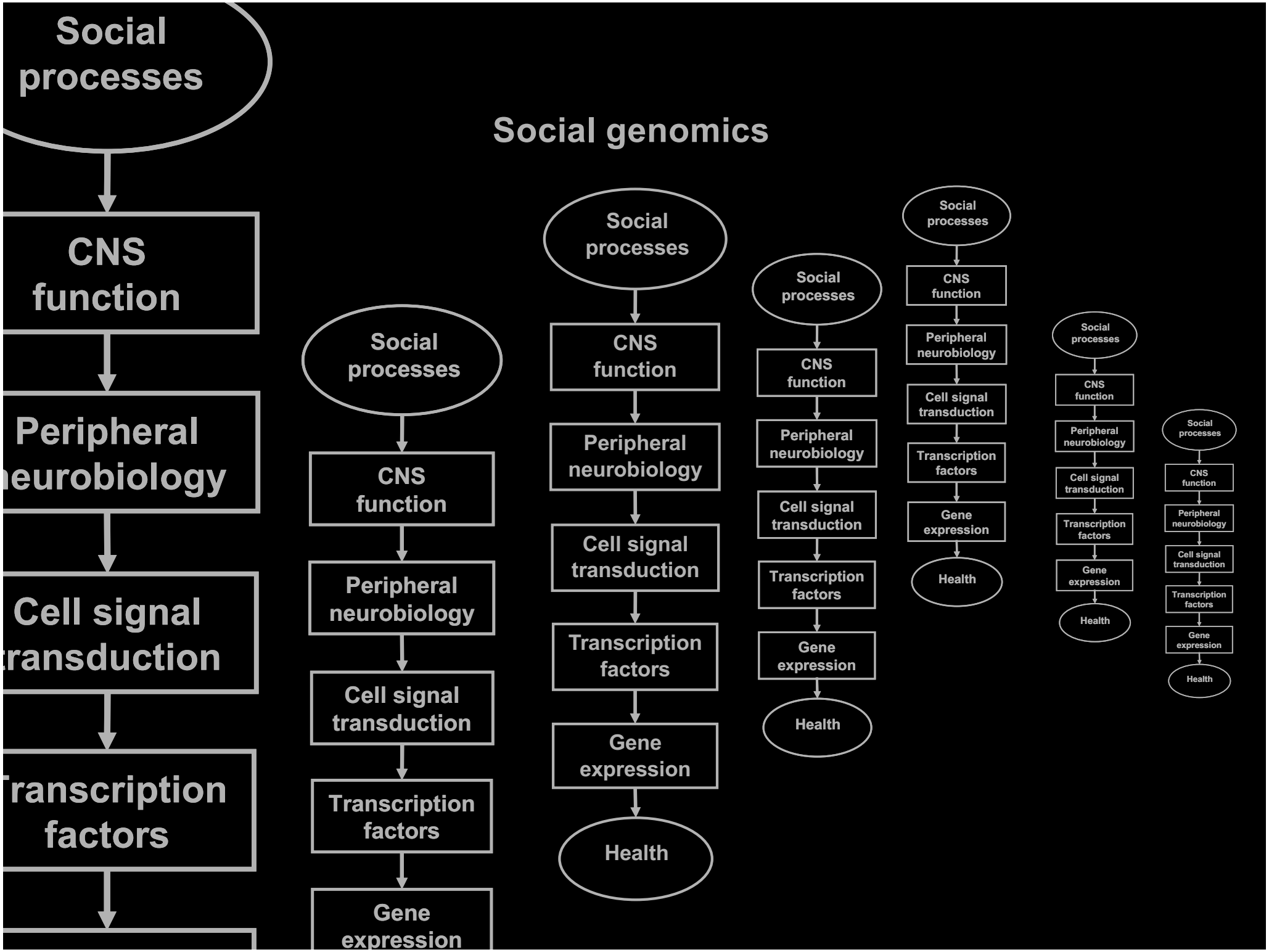


Not-so-simple questions

1. Recursive persistence and environmental embedding
2. Social programming of non-immune tissues (e.g., neural, reproductive)
3. The human metagenome


Social genomics
Social processes
CNS function
Peripheral neurobiology
Cell signal transduction
Transcription factors
Gene expression
Health

Your experiences today
will influence the molecular composition of your body
for the next 2-3 months

… or perhaps the rest of your life.

Plan your day accordingly.

Collaborators

John Cacioppo, Louise Hawkley, Bob Rose
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John Capitanio, Erica Sloan
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Margaret Kemeny, Jerry Zack
Teresa Seeman, Andrew Fuligni
Barbara Fredrickson, Karen Grewen

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NIA AG107265, AG033590, AG034679
NIMH MH00820, MH15750
NCRR RR020645
UC Universitywide AIDS Research Program
UCLA AIDS Institute
MacArthur Foundation
James Pendleton Charitable Trust
Santa Fe Institute for Complex Systems
Norman Cousins Center