Stressing your Brain

Mary ET Boyle, Ph.D. Department of Cognitive Science, UCSD
Stress and the Brain’s Response

- Out of balance
- Threatened

Stress

- Epinephrine (adrenaline)
- Glucocorticoids - cortisol

Response

Disorders

- Anxiety
- Depression

Sense of control will mitigate the effects
Homeostatic balance:
when all of the vital measures of human function – heart rate, blood pressure, blood sugar are in optimal range.

Robert Sapolsky

Stressor:
anything that disrupts homeostasis
- **Physiological changes**
  - Focused attention
  - Fear
  - Flight or fight
- **Inhibitory behaviors**
  - Feeding
  - Sex
  - Sleep

*Must be regulated or else...*

Disorders emerge: arousal, thought & feeling
If the stress becomes chronic, glucocorticoids induce the locus coeruleus to release norepinephrine that communicates with the amygdala leading to the production of more CRH—and to ongoing reactivation of stress pathways.

The amygdala releases corticotropin-releasing hormone, which stimulates the brain stem. In response, the adrenal glands produce the stress hormone epinephrine.

A different pathway simultaneously triggers the adrenals to release glucocorticoids.

The two types of hormones act on the muscle, heart and lungs to prepare the body for “fight or flight”
In an instant, stressful events can seize control of the brain.  

Master switch is the *amygdala*. Where terrifying moments are forged into memories.
Meet Édouard Claparède...

Claparède performed a fairly well-known experiment in which he would test whether or not the trauma of a painful event would be retained if short term memory was lost. His experiment involved a woman who suffered from a form of amnesia. She had all of her old memories as well as her basic reasoning skills, but the recent past was not remembered. *Claparède had greeted her every day, each time she could not remember his face at all.* Then during one session of the experiment, *Claparède hid a pin in his hand and reached to shake the woman's hand, pricking her.* The next day, sure enough, she did not remember him. *But when Claparède went to shake her hand, he found that she hesitated,* recognizing a threat when her memory had been severely damaged.
Classical Conditioning

![Diagram showing classical conditioning process](image)
Typical fear-conditioning experiment
Projections to the Subcortical Forebrain From Anatomically Defined Regions of the Medial Geniculate Body in the Rat

JOSEPH E. LEDOUX, DAVID A. RUGGIERO, AND DONALD J. REIS
Laboratory of Neurobiology, Department of Neurology, Cornell University Medical College, New York, New York 10021
the primary neural pathway for emotional auditory memories runs directly from the thalamus to the amygdala.

bypasses conscious awareness so it can instantly put the body on alert.

LeDoux
A second neural pathway for emotional auditory memories runs from the thalamus to primary auditory cortex then to the amygdala.

Slower but more information rich.
If the first pathway was cut, a rat could not develop a new conditioned response; if a tone was paired with a shock, the animal would not learn to fear the tone.
But if one destroys the second, “smart” route in a conditioned rat, it would be unresponsive to virtually all sound, yet it would still freeze when the tone rings.
The amygdala’s most basic reactions take place independent of awareness.

The simpler pathway makes your **muscles** tense and heart **race** so that you are ready for action.

This cortical pathway is crucial to **emotional actions**. Designed to help you **avoid**, **escape** or **discount** a threat.
Startle someone a few seconds after she has seen a picture of a threatening face (while she is consolidating that memory) and her memory of the face will be strengthened. The memory will also be strengthened if she is startled when she is recalling that threatening face later.
Functional regions in the amygdala play different roles in communicating with other brain areas:
Hippocampus
• A kind of directory for memory storage

Prefrontal Cortex
• Incorporates sensory information into the “thinking” brain

Hypothalamus
• In tense situations recruits the adrenal and pituitary glands to mobilize the body for response.
Once your stress response has been activated, the system keeps you in a state of readiness.
emotional impact boosts incoming data

An epinephrine rush releases a flood of stress hormones and neurotransmitters that activates the amygdala.
Differential effects of active versus passive coping on secretory immunity

Jos A. Bosch, Eco J. C. de Geus, Angele Kelder, Enno C. I. Veerman, Johan Hoogstraten, and Arie V. Nieuw Amerongen

Department of Oral Biology, Academic Centre for Dentistry Amsterdam (ACTA), Amsterdam, The Netherlands; and
Faculty of Psychology, Department of Biological Psychology, Vrije Universiteit, Amsterdam, The Netherlands
Department of Community Dentistry and Dental Health Education, Academic Centre for Dentistry Amsterdam (ACTA),
Amsterdam, The Netherlands
Department of Psychology, Section Methodology, University of Amsterdam, The Netherlands
The Gulf War, stress and a leaky blood–brain barrier

Extreme stress renders the blood–brain barrier permeable to drugs that normally act peripherally (pages 1382–1385).

Pyridostigmine brain penetration under stress enhances neuronal excitability and induces early immediate transcriptional response

Alon Friedman1,2, Daniela Kauf1, Joshua Shemer2,3, Israel Hendler2,3, Hermona Soreq1 & Ilan Tur-Kaspa2,3

1Department of Biological Chemistry, the Life Sciences Institute, the Hebrew University, Jerusalem 91904, Israel
2Medical Corps, Israel Defense Forces, P.O. Box 02419, Israel
3Sheba Medical Center, Sackler School of Medicine, Tel-Aviv University, Tel-Hashomer 52621, Israel

The views expressed are those of the authors and are not to be construed as official policy of the Medical Corps, Israel Defense Forces.

Correspondence should be addressed to A.F.
US troops under threat of chemical warfare don gas masks and chemical suits during the 1991 Gulf War.

Nature Medicine, December 1996
Loud noise can trigger startle response
Long QT Syndrome (LQTS)

- The first documented case of Long QT syndrome was described in Leipzig by Meissner in 1856.
- A deaf girl died after her teacher yelled at her.
- When the parents were told about her death, they told that her older brother who also was deaf died after a terrible fright.

en.wikipedia.org

www.sads.org

Wikipedia
The Secret Of A Tiger’s Roar

ScienceDaily (Dec. 29, 2000) —

A tiger’s intimidating roar has the power to paralyze the animal that hears it and that even includes experienced human trainers. Elizabeth von Muggenthaler, a bioacoustician from the Fauna Communications Research Institute in North Carolina, presented her research at the Acoustical Society of America meeting in Newport Beach, California on December 7.

Bioacoustics is the study of the frequency or pitch, loudness, and duration of animal sounds to learn about an animal’s behavior. At the meeting, von Muggenthaler discussed her work analyzing the frequency of tiger sounds to better understand the part of a tiger’s roar that we can feel, but can’t hear.

Why study something that we can’t hear? “Humans can only hear some of the sounds that tigers use to communicate,” says von Muggenthaler. “Humans can hear frequencies from 20 hertz to 20,000 hertz, but whales, elephants, monkeys, and tigers can produce sounds below 20 hertz.” This low-pitched sound, called “infrasound,” can travel long distances permeating buildings, cutting through dense forests, and even passing through mountains. The lower the frequency, the farther the distance the sound can travel.

Scientists believe that infrasound is the missing link in studying tiger communication. In the first study of its kind, von Muggenthaler and her colleagues recorded every growl, hiss, chuff, and roar of twenty-four tigers at the Carnivore Preservation Trust in Bimbo, North Carolina, and the Riverbanks Zoological Park in Columbia, South Carolina. Bioacousticians found that tigers can create sounds at about 18 hertz and when tigers roar they can create frequencies significantly below this. “When a tiger roars—the sound will rattle and paralyze you,” says von Muggenthaler. “Although untested, we suspect that this is caused by the low frequencies and loudness of the sound.”

When the researchers played back a tape of recorded tiger sounds including audible and infrasounds, the tigers appeared to react to these sounds. Sometimes they would roar and leap towards the speakers and sometimes sneak away. The next step for von Muggenthaler is to take the recorded infrasounds to scientists who can determine whether or not tigers can hear the infrasounds. Von Muggenthaler hopes to learn more about tigers, protect them from extinction, and understand the unheard, paralyzing power in their roar.
Noise Stress Impairs Prefrontal Cortical Cognitive Function in Monkeys

Evidence for a Hyperdopaminergic Mechanism

Amy F. T. Amsten, PhD; Patricia S. Goldman-Rakic, PhD
The effects of noise stress on performance of the
delayed-response task following no delay (0-second delay
conditions) vs delay conditions.
Results represent mean±SEM percent correct for n=5 monkeys,
where 50% correct is chance level of responding.
Asterisk indicates significantly different from control.
March 6, 1990

Research On Noise Disappears In the Din

By MALCOLM W. BROWNE

AMERICA is noisier than ever, audiologists say, and the costs may include lost hearing, impaired health, reduced learning ability and antisocial behavior.

Noise causes stress, just as crowding and the threat of crime do, said Dr. Alice H. Suter, an audiologist at the National Institute for Occupational Safety and Health. "But unlike some of the other problems," she went on, "noise seems to be accepted by our society these days as a necessary evil."
Community noise exposure and stress in children

Gary W. Evans*1
Design and Environmental Analysis, Human Developments, Cornell University, Ithaca, New York 14853-4401

Peter Lercher*
Institute of Social Medicine, University of Innsbruck, Rosenburgerstrasse 16, A-6020 Innsbruck, Austria

Markus Mais
Institute for Research into Man-Environment-Relations, Department of Psychology, University of Oldenburg, D-26111 Oldenburg, Germany

Hartmut Ising
Federal Environmental Agency, Institute for Water, Soil, and Air Hygiene, Germany

Walter W. Koller
Institute of Hygiene and Social Medicine, Section Social Medicine and School of Public Health, University of Innsbruck, Rosenburgerstrasse 16, A-6020 Innsbruck, Austria

(Received 19 June 2000, accepted for publication 23 November 2000)

High noise condition:
Over 60 dB
Loud conversation

Low noise condition:
50 dB
Clothes dryer

<table>
<thead>
<tr>
<th>TABLE II. Psychophysiological results.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low noise sample</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
</tr>
<tr>
<td>Heart rate</td>
</tr>
<tr>
<td>Heart rate reactivity</td>
</tr>
<tr>
<td>Epinephrine</td>
</tr>
<tr>
<td>Norepinephrine</td>
</tr>
<tr>
<td>20A-dihydrocortisol</td>
</tr>
<tr>
<td>Cortisol</td>
</tr>
</tbody>
</table>

*bpsm=beats per minute.
*\( h=\)hours.
*Statistically significant difference (see the text for details).
New studies suggest that the stress of being poor has a staggeringly harmful influence on health.

By Robert Sapolsky
Childhood poverty, chronic stress, and adult working memory

Gary W. Evans and Michelle A. Schamberg

Departments of Design and Environmental Analysis and Human Development, Cornell University, Ithaca, NY 14853-4401

Edited by Bruce S. McEwen, The Rockefeller University, New York, NY, and approved February 24, 2009 (received for review November 22, 2008)

Here, we test 2 hypotheses. One is that childhood poverty will interfere with working memory in young adults. Working memory is the temporary storage mechanism that enables us to hold a small amount of information active over a short interval and to manipulate it. Working memory is essential to language comprehension, reading, and problem solving, and it is a critical prerequisite for long-term storage of information. The second hypothesis we test is that the prospective relationship between childhood poverty and adult working memory will be mediated by chronic stress exposure, (i.e., poverty → chronic stress → working memory).
<table>
<thead>
<tr>
<th></th>
<th>Low noise sample</th>
<th>High noise sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diastolic blood pressure</strong></td>
<td>73.00 mmHg</td>
<td>72.75 mmHg</td>
</tr>
<tr>
<td><strong>Systolic blood pressure</strong></td>
<td>115.32 mmHg</td>
<td>117.29 mmHg</td>
</tr>
<tr>
<td><strong>Heart rate</strong></td>
<td>89.99 bpm&lt;sup&gt;a&lt;/sup&gt;</td>
<td>90.43 bpm</td>
</tr>
<tr>
<td><strong>Heart rate reactivity</strong></td>
<td>3.87 bpm</td>
<td>5.81 bpm&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Epinephrine</strong></td>
<td>697.96 ng/8 h&lt;sup&gt;b&lt;/sup&gt;</td>
<td>690.48 ng/8 h</td>
</tr>
<tr>
<td><strong>Norepinephrine</strong></td>
<td>8920.38 ng/8 h</td>
<td>9900.86 ng/8 h</td>
</tr>
<tr>
<td><strong>20A-dihydrocortisol</strong></td>
<td>7.75 ug/8 h</td>
<td>9.80 ug/8 h&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Cortisol</strong></td>
<td>3.86 ug/8 h</td>
<td>4.87 ug/8 h&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>bpm = beats per minute.
<sup>b</sup>h = hours.
<sup>f</sup>Statistically significant difference (see the text for details).
sustained stress can damage the hippocampus

There are glucocorticoid receptors in the hippocampus. These receptors, when activated, inhibit the production of CRH in the hypothalamus and thus dampen the stress response.

Mark Smith of the Du Pont Merck Research Labs and researchers at the National Institute of Mental Health