



# Cortisol, Memory and Age: The Effects of Chronic Stress

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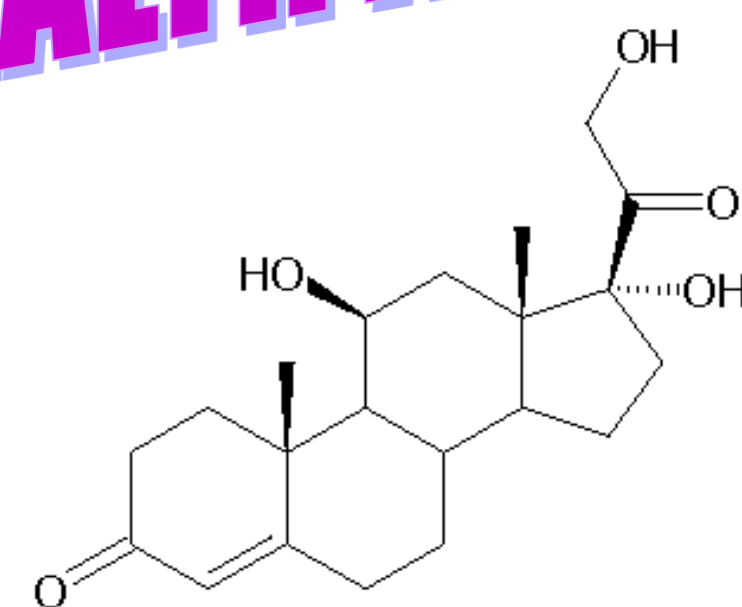
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## What is Cortisol?

Cortisol is a natural, steroid hormone produced by the adrenal gland that helps your body regulate stress. At normal levels and short fluctuations, it is important in helping you remember stressful situations. However, extended high levels of stress are associated with similarly persistent and high levels of cortisol which can prove negative for the body and memory as well. (Joels, 2006)

Cortisol can be found all over the body, from your blood to your saliva and is key to the "fight or flight response". Its effects including increasing blood sugar, suppressing the immune system, reducing bone formation, are useful in emergencies, but harmful if not controlled. (Wolf, 2001)

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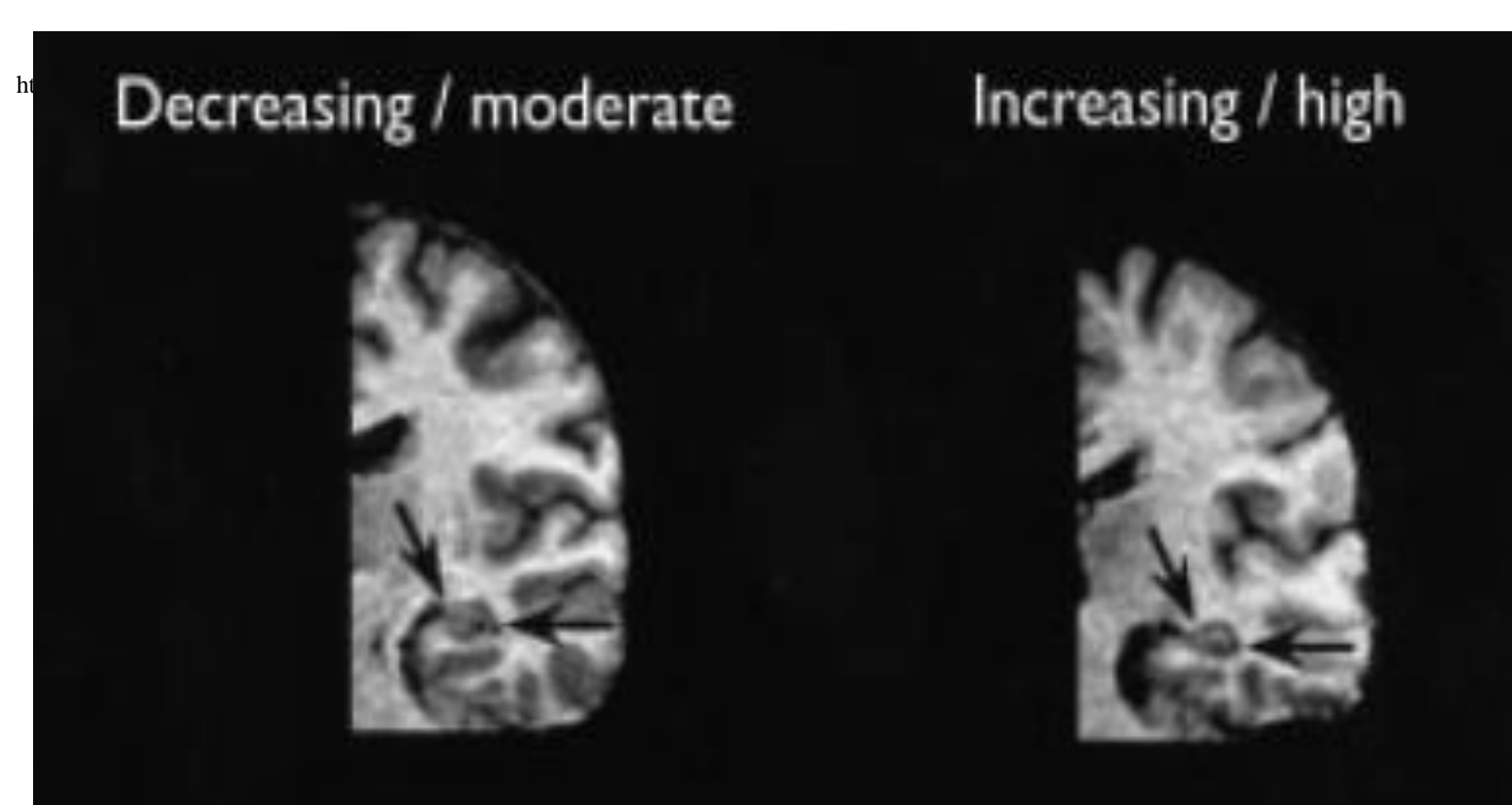
Molecular Structure of Cortisol  
<http://www.icegeb.org/~p450srv/ligand/cortisol.html>

## How can stress/cortisol be both good and bad for memory?

The effects of stress and cortisol on memory appear to be optimized to short, stressful events: dangerous moments like car crashes or your parents scolding you so that you remember how to behave next time. Joels (2006) describes a unifying theory to understand how this works by saying: "stress will only facilitate learning and memory processes: (i) when stress is experienced in the context and around the time of the event that needs to be remembered, and (ii) when the hormones and transmitters released in response to stress exert their actions on the same circuits as those activated by the situation, that is, when convergence in time and space takes place." What this means is that if stress is prolonged, the down-regulation by the HPA axis on the hippocampus and other regions of the brain doesn't stop and memory capability suffers.

## Chronic Cortisol Effects and Age: Does cortisol affect my memory?

Yes. There is literature that suggests that abnormal cortisol levels and patterns can reduce the learning ability of people of all ages and this has been replicated in animal studies as well. Jong (2000) showed piglets raised in barren environments growing up to have static levels of cortisol, similar to those seen in depressed humans. Newcomer (2009) gave oral doses of cortisol to 18-30 year olds and found that those given higher doses showed reversible decreases in verbal declarative memory. Bodnoff (1995) found that older rats given chronic stress levels of the rodent cortisol equivalent showed worsened spatial memory and that this could be reproduced with social stress as well. Lupien (2008) showed trending effects of cortisol in the elderly. Those with increasing or high cortisol levels had reduced volume of the hippocampus (the memory center of the brain) and deficits in memory tasks.



Varying Hippocampus Morphologies in Human Brains  
Associated with Individuals with Either  
Decreasing / Moderate or Increasing / High  
Cortisol Levels  
(Lupien 1998)

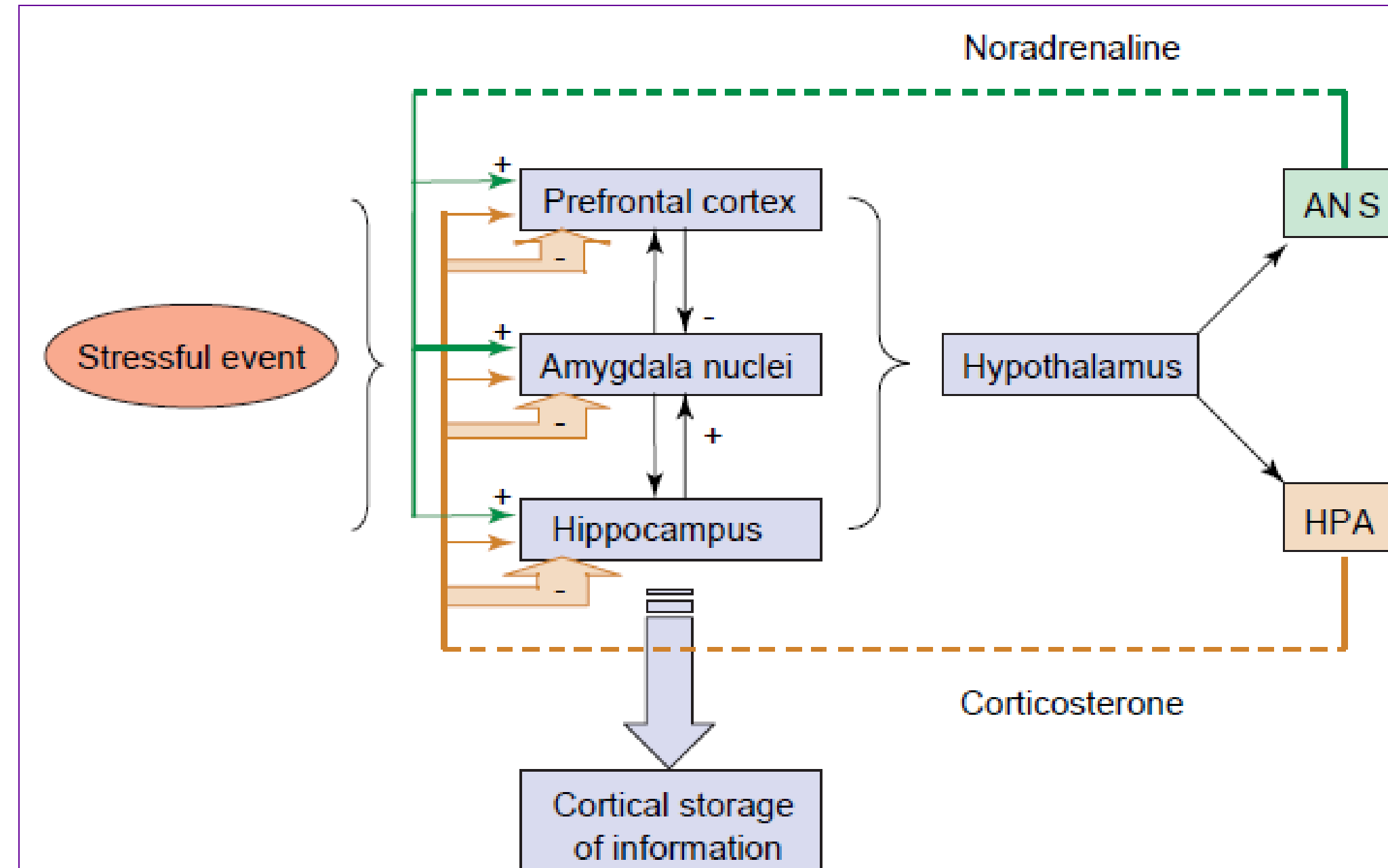


Diagram of stress inducing memory storage increase on a short time scale (green) and reducing it on a long time scale (red) to focus memory on the stressful event (Joels, 2006)

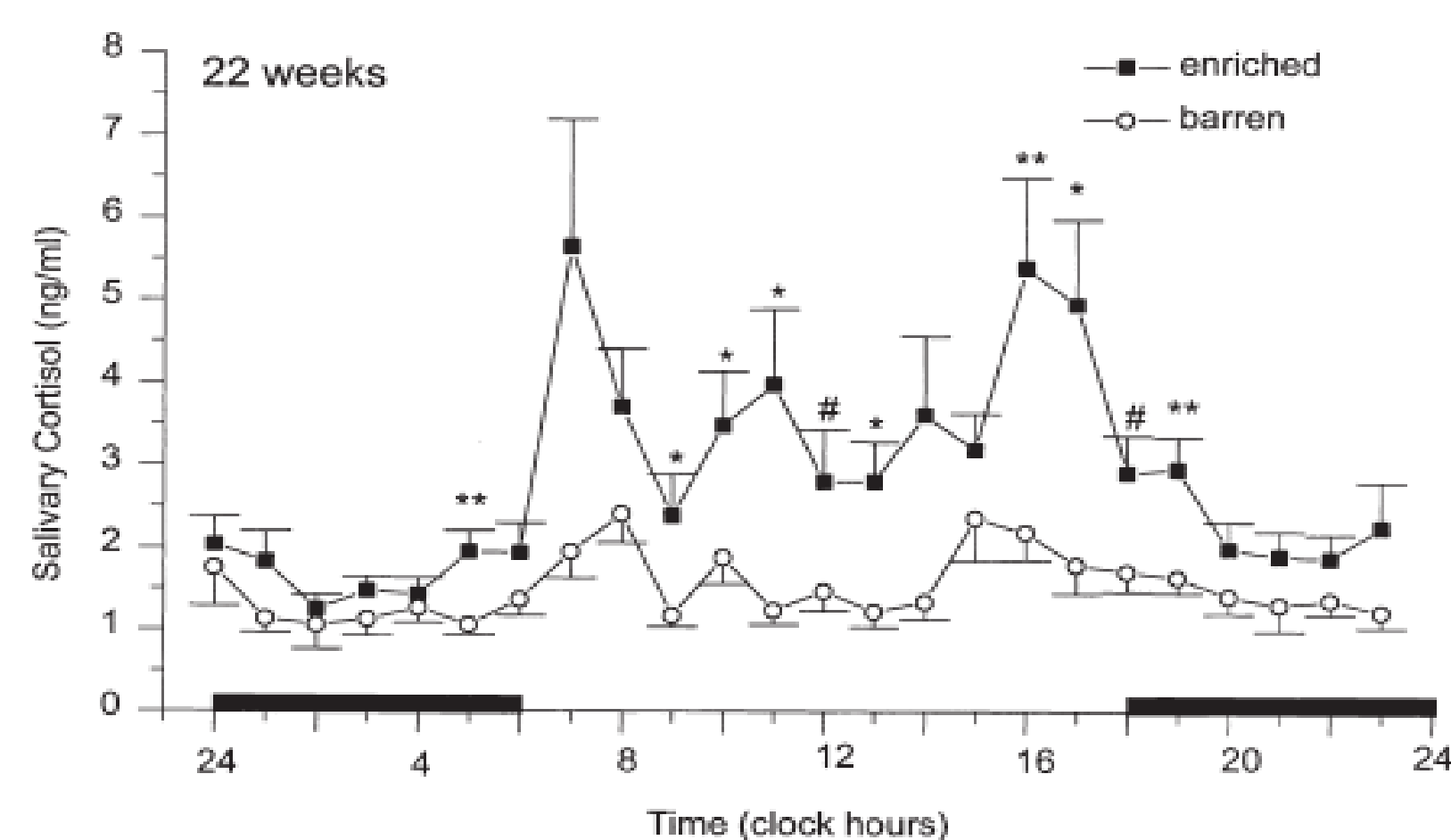


Fig. 2. Baseline salivary cortisol concentrations (mean  $\pm$  SEM) measured over 24 h at 9 weeks of age (upper panel) and at 22 weeks of age (lower panel) for enriched and barren-housed pigs. Black bars indicate the dark period. \* $p < 0.10$  (tendency), \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

Showing how pattern of cortisol levels is just as important as concentration: Piglets in this study raised in comfortable, stimulating environments may have had higher cortisol but had superior spatial memory and were less aggressive. (Jong 2000)

## Things to Remember

- .Cortisol is a natural steroid that helps your body adapt to stress and is correlated to stress.
- .Persistent, high levels of cortisol and stress have fast-acting, negative effects on the body.
- .These effects can alter your learning ability and health at any age.
- .Regardless of whether stress is physical, mental, or social, the effects are the same if of similar magnitude and duration.
- .These effects are reversible.

**If you have further questions,  
please consult your doctor for further advice.**

## Sources Cited:

- Bodnoff, Shari. "Enduring Effects of Chronic Corticosterone Treatment on Spatial Learning, Synaptic Plasticity, and Hippocampal Neuropathology in Young and Mid-Aged Rats." *The Journal of Neuroscience* 15.1 (1995). Print.
- De Jong, Ingrid. "Effects of Environmental Enrichment on Behavioral Responses to Novelty, Learning, and Memory and the Circadian Rhythm in Cortisol in Growing Pigs." *Physiology & Behavior* (2000). Print.
- Joels, Marian. "Learning under Stress: How Does It Work?" *Trends in Cognitive Sciences*.4 (2006). Print.
- Lupien, Sonia. "Cortisol Levels during Human Aging Predict Hippocampal Atrophy and Memory Deficits." *Nature Neuroscience*.1 (1998). Web.
- Ruis, Marko. "The Circadian Rhythm of Salivary Cortisol in Growing Pigs: Effects of Age, Gender, and Stress." *Physiology & Behavior*.3 (1997). Print.
- Wolf, Oliver. "The Relationship between Stress Induced Cortisol Levels and Memory Differs between Men and Women." *Psychoneuroendocrinology* (2001). Print.