



KINDERSPITAL ZÜRICH 

## Fight or Flight in Hospital

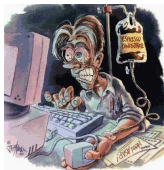




**(Illness related) stress and its effects on learning**

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## Content

- Fight or flight
- Chronic stress
- Effects on health
- Effects on the development of the brain
- Effects on learning
- What can we do against stress?
- Conclusion

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## Fight or flight during stone age



**"Hand-tight" threat:**

- => Stress reaction
- => Fight or flight
- => Healthy adaption which was essential for survival
- => Survival of the fittest

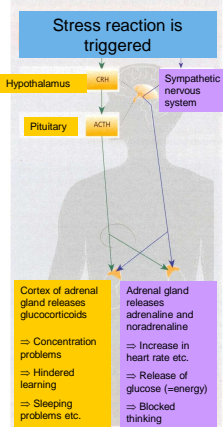
**Sympathetic nervous system (fight and flight)**  
-> active

**Parasympathetic nervous system (rest and digest)**  
-> blocked

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## Acute stress reaction

**Stress reaction is triggered**




**Over -> amygdala (centre for fear)**  
-> **sympathetic nervous system**  
=> **Activation of the adrenal gland:**  
=> Releasing of **adrenaline & noradrenaline**  
=> Increasing heart rate & breath frequency  
=> increased blood pressure  
=> Release of **glucose** into the blood  
=> Activation of learned / conditioned reactions  
=> Inhibition of complex thinking

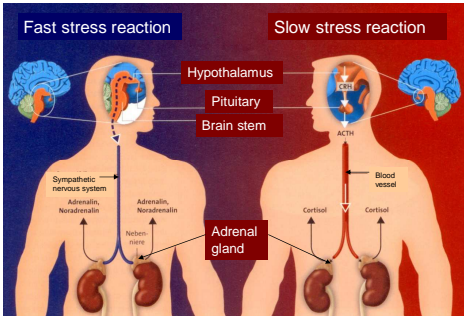
**Hypothalamus – pituitary – cortex of adrenal gland (HPA axis):**  
=> Activation of hypothalamus  
=> Releasing of **CRH** (corticotropin releasing hormone)  
=> Releasing of **ACTH** in the pituitary (adrenocorticotrope hormone)  
=> Releasing of **glucocorticoids (cortisol)** in the adrenal gland

**Cortex of adrenal gland releases glucocorticoids**  
=> Concentration problems  
=> Hindered learning  
=> Sleeping problems etc.

**Adrenal gland releases adrenaline and noradrenaline**  
=> Increase in heart rate etc.  
=> Release of glucose (=energy)  
=> Blocked thinking

Source: Menche, 2003  
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## Fast and Slow Stress Reaction




**Fast stress reaction**      **Slow stress reaction**

**Hypothalamus**  
**Pituitary**  
**Brain stem**

**Sympathetic nervous system**  
Adrenalin, Noradrenalin

**Adrenal gland**  
Cortisol

**Blood vessel**

Source: Gehirn & Geist 1-2 2010  
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## Neocortex and acute stress reaction

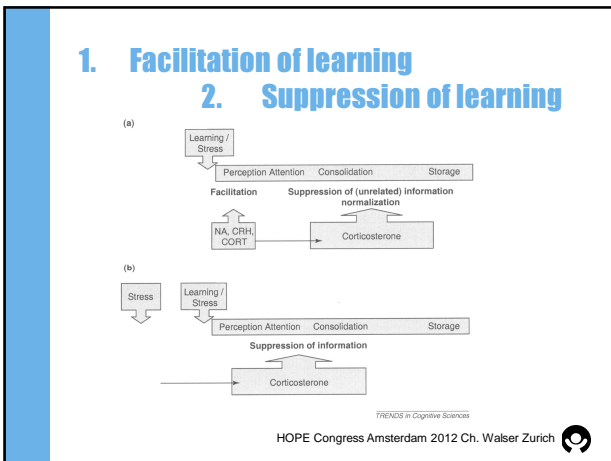
**Neocortex (cerebrum) would think in a too complex and therefore too slow way which could be deadly:**

- => Will be blocked
- => Activation of:
  - automated reactions coming from older parts of the brain (brain stem)
  - conditioned reactions

**Facts which are connected with the traumatising event:**

- => Get burned into the memory (Conditioning)
- => So that we do not e.g. get our fingers burned in the fire twice

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### Stressors from nowadays

= not anymore sabre-toothed tigers but:

- Performance and time pressure
- Noisiness / glare / stimulus satiation
- Neglect / violence
- Sexual abuse etc.

**Especially in hospital:**

- **Conditionings / traumatic experiences** (invasive examinations can be experienced as assaults)
- **Deprivations** (maternal deprivation, motor deprivation etc.)
- **Being in agony or chronic pain etc.**

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### Stress is individual

**Eustress** «positive»  $\leftrightarrow$  **Disstress (Dystress)** «negative» (Hans Selye)

**Allostatic Overload** (Bruce McEwen)

=> positive challenge  
=> peak performance  
=> proudness  
=> satisfaction

=> Constantly too high levels of stress hormones up to  
=> **Cushing syndrome**

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### Effects of acute and chronic stress on health

Reasonable acute stress reaction	Pathological equivalent in chronic stress
Mobilisation of energy	Increased blood sugar => always hungry => appetite for fast food / sweets => overweight, reduced tolerance for glucose, resistance towards insulin => type 2 diabetes, high tension in muscles, muscle weakness, myopathy, depression, burnout, dysfunction of thyroid
Inhibition of fibroblasts	Thin and fragile skin, poor wound healing, fragile vascular walls, osteoporosis, renal stones calculi / renal colic

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Reasonable acute stress reaction	Pathological equivalent in chronic stress
Increased cardiovascular tonus	Hypertension, cardiac arrhythmia, cardiac infarction
Increased cognitive performance	Neuronal cell death, learning difficulties, sleep disturbance, nervousness, aggressiveness, Alzheimer's and Parkinson's disease
Inhibited digestion	Digestion troubles, stomach ulcer
Inhibited growth	Microsomia (dwarfism), delayed puberty

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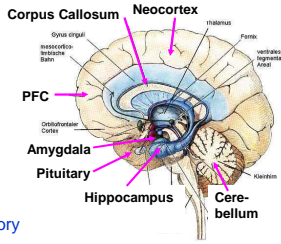
Reasonable acute stress reaction	Pathological equivalent in chronic stress
Inhibited reproduction	Amenorrhea, impotence, suppressed libido, infertility
Suppressed immune system	Increased risk of disease (infectious diseases, cancer,...), immune mediated disease, rheumatism, eczema, allergies, asthma (the last two also in children whose mothers were stressed during pregnancy)

**Chronic stress can lead to epigenetic modifications which can even be passed on to the next generations!**

Sources: According to Sapolsky (1992) in: Spitzer (2002) with additions from Spinaz & Fischli (2001), Blech (2008) and Hopfgarten, A. (2012). Seelische Abwehrkraft. Gehirn & Geist 3, 28ff and Mossop, B. (2012) Angespanntes Gedächtnis. Gehirn & Geist 5, 72ff.

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### Effects on the developing brain



- **Increasing amygdala**  
=> alarm and fear control centre
- **Decreasing hippocampus**  
=> organisation of memory
- **Decreasing prefrontal cortex**  
=> working memory, selective perception, executive functions (CEO of the brain)
- **Impact on the myelinisation of corpus callosum**  
=> reduced (above all: right-left) hemispheric integration
- **Impact on the vermis (cerebellum)**

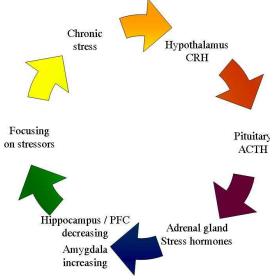
Sources: Lupien, 2005 / McEwen, 2002 & 2007 / Teicher et al 2002  
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### Vicious circle of chronic stress

**Chronic Stress:**

- becomes independent
- increases vulnerability towards stress
- reinforces itself

=> Vicious circle




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### Chronic Stress / Allostatic Overload

=> **Negative Effects on Learning:**


1. Acquisition of knowledge
2. Long-term storage
3. Recall of knowledge



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### Effects on learning

**Neocortex (Cerebrum) under stress hormones**  
=> suppressed or even structurally modified  
=> learning is restrained, especially:  
-> factual knowledge




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### Chronic Stress / Allostatic Overload

=> **Negative Effects on Learning:**


1. Acquisition of knowledge
2. Long-term storage
3. Recall of knowledge



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### Long term storage

- Under a too high level of stress hormones  
=> **disturbed (deep) sleep**  
=> **disturbed consolidation of learned content**
- Proved by different studies:  
-> Born's studies about the declarative memory  
Born & Kraft. (2004) Lernen im Schlaf – kein Traum (Learning while sleeping – not a dream)  
-> **Sleep-Dependent Improvement in Visuomotor Learning: A Causal Role for Slow Waves**  
Landsness, E. et al (Huber R.) in Sleep, Vo. 32, No. 10, 2009
- Different theories why we need sleep:  
-> Born versus Tononi & Cirelli



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### Learning while sleeping

The diagram illustrates the process of learning while sleeping. On the left, 'While being awake', information is processed in the hippocampus (intermediate storage) and then moves to the neocortex. This process is supported by Acetylcholin / Cortisol. On the right, 'While sleeping', the information is consolidated in the neocortex. This process is supported by Acetylcholin / Cortisol, which is shown to be inhibited (marked with an X) during sleep.

Source: Born & Kraft, 2004

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### Synaptic Homeostasis

The diagram illustrates synaptic homeostasis. It shows a cycle between synaptic potentiation (left, yellow background) and synaptic downscaling (right, blue background). Synaptic potentiation leads to an increase in slow waves, which then leads to synaptic downscaling. Synaptic downscaling leads to a decrease in slow waves, which then leads back to synaptic potentiation. The cycle is regulated by energy costs, space costs, and saturation. The diagram also shows the role of Norepinephrine (NA) in learning and the baseline state.

tononi, G. & Cirelli, C. (2006). Sleep function and synaptic homeostasis. *Sleep Medicine Reviews*, 10, 49-62

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### Chronic Stress / Allostatic Overload

=> **Negative Effects on Learning:**

1. Acquisition of knowledge
2. Long-term storage
3. Recall of knowledge

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### Recall of knowledge

**Neocortex (Cerebrum)** under stress hormones  
=> Suppressed  
=> Recall of learned content is hindered

**Blackouts!**

Facts which are connected with the traumatising event:  
=> Get burned into the memory (Conditioning)  
(Such as the situation during the exam!)

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### Exam nerves

**Working memory**  
-> filters information, which are important for the current task  
-> **affected by exam nerves** ("blocked" neocortex)

**Examinees improve success** in exam situation if they write down their fears just before the exam  
-> reduces fear  
=> **facilitates access to the needed knowledge**

Source: Science 331, S. 211-213, 2011

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### What helps against chronic stress?

- Reduction / elimination of chronic stress
- Stress management / tools
- „Safe areas“
- Family / friends
- Reliable and caring surroundings
- Free playing / free activities without aims
- Music / art
- Sports
- Relaxing / meditation / Yoga
- Humour
- Healthy food (e.g. Omega 3)

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## What can we do?

- Hospital school / school lessons
  - = „safe areas“ (needle free zones)
- Be reliable, caring, sympathetic, optimistic, supporting
- Good on-going progressive assessments
  - => **perfect fit of learning matter**
- Exciting offers that promise success, purposeful activities
  - => intrinsic motivation
  - => Flow (after Csikszentmihályi)
  - => Polarisation of attention (after Montessori)
  - => Self efficacy belief (after Bandura)
  - => **“Shower of dopamine”** (self-rewarding system of the brain)

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## Conclusion

### ■ Chronic stress:

- > affects health
- > hinders learning:
  1. acquisition of knowledge
  2. long-term storage
  3. recall of knowledge
- > should be avoided or reduced

### ■ Hospital schools should:

- > be a “safe area”
- > consider reduced learning capacity (because of stress etc.)
- > provide individual, exciting, challenging, perfectly fitting activities

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