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Do children react more strongly to environmental pollutants?

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Swiss Public Health Conference

28 August 2019, Winterthur

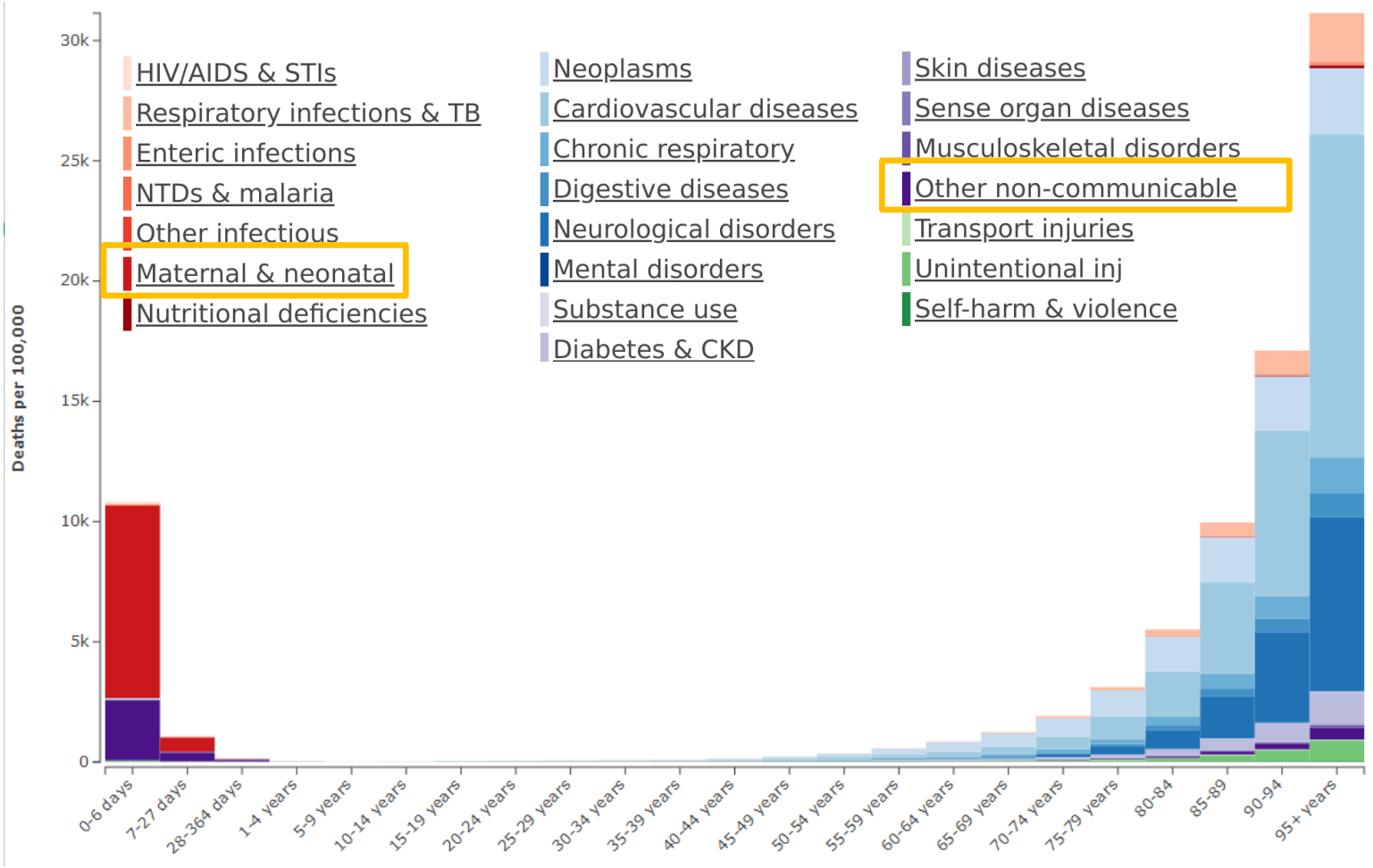
Conclusions: why are children special?

1. Other disease spectrum than adults
2. Developing organism
3. Long post exposure period
4. Different exposure circumstances and paths
5. Different cognitive, physiologic and metabolic processes than adults

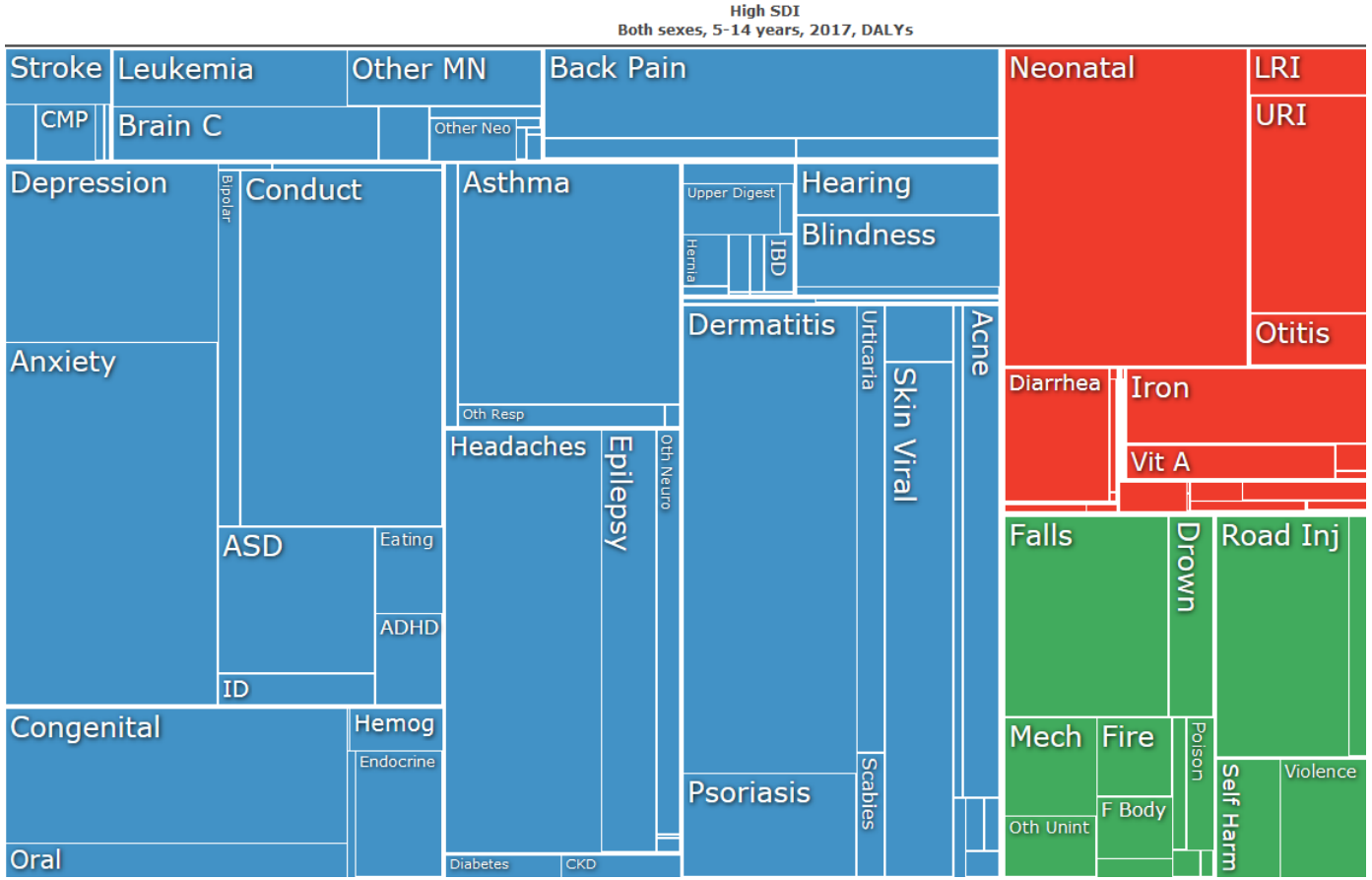
➢ Children are ***not*** small adults!

1) Other disease spectrum: deaths in relation to age in high SDI countries

https://vizhub.healthdata.org/gbd-compare/



Disability adjusted life years in 5-14 years, high SDI: Chronic diseases, infectious diseases, accidents



https://vizhub.healthdata.org/gbd-compare/

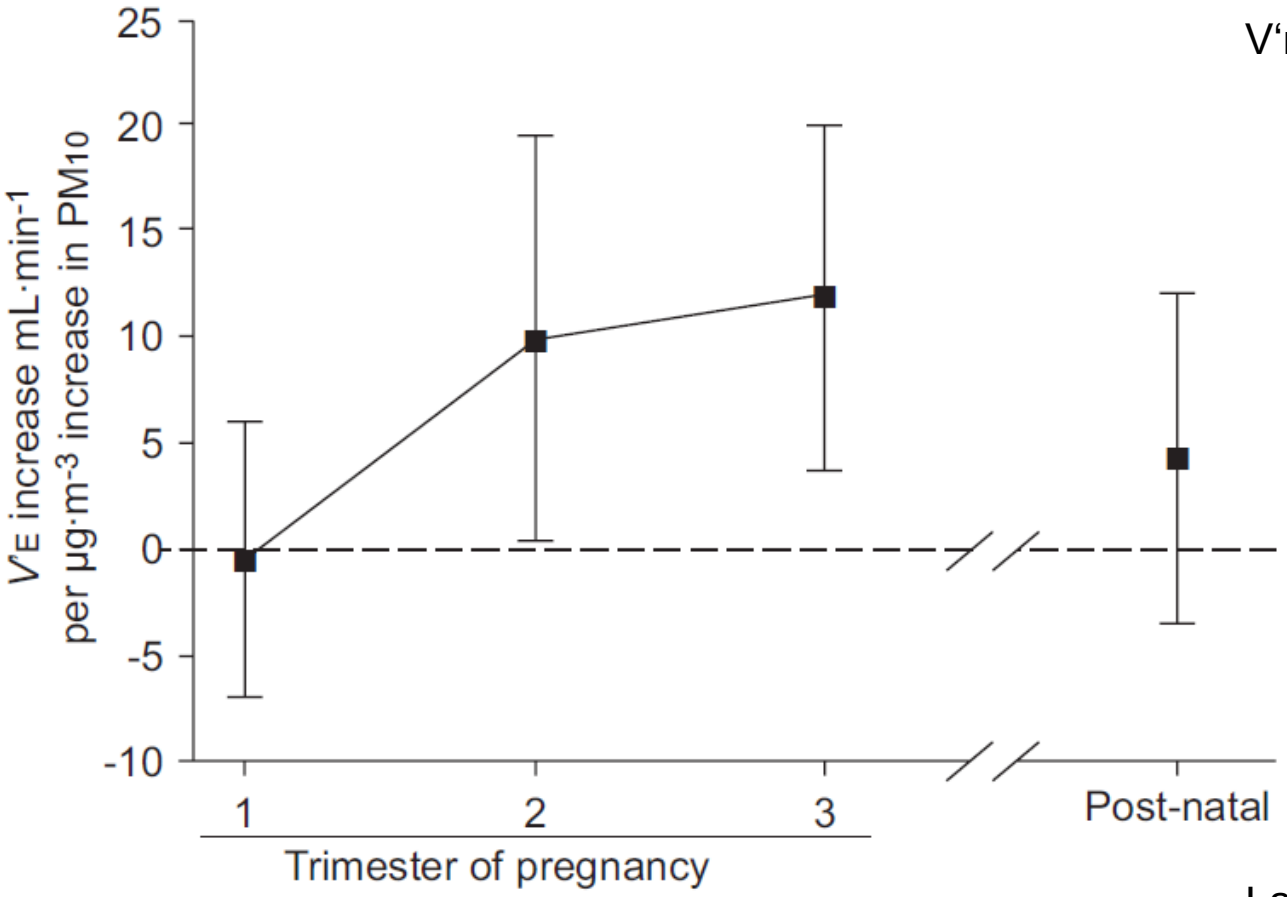
2) Organism is developing: critical time windows

- Thalidomide during pregancy:

from http://www.kent-depesche.com

2) Critical time window: lung function and air pollution

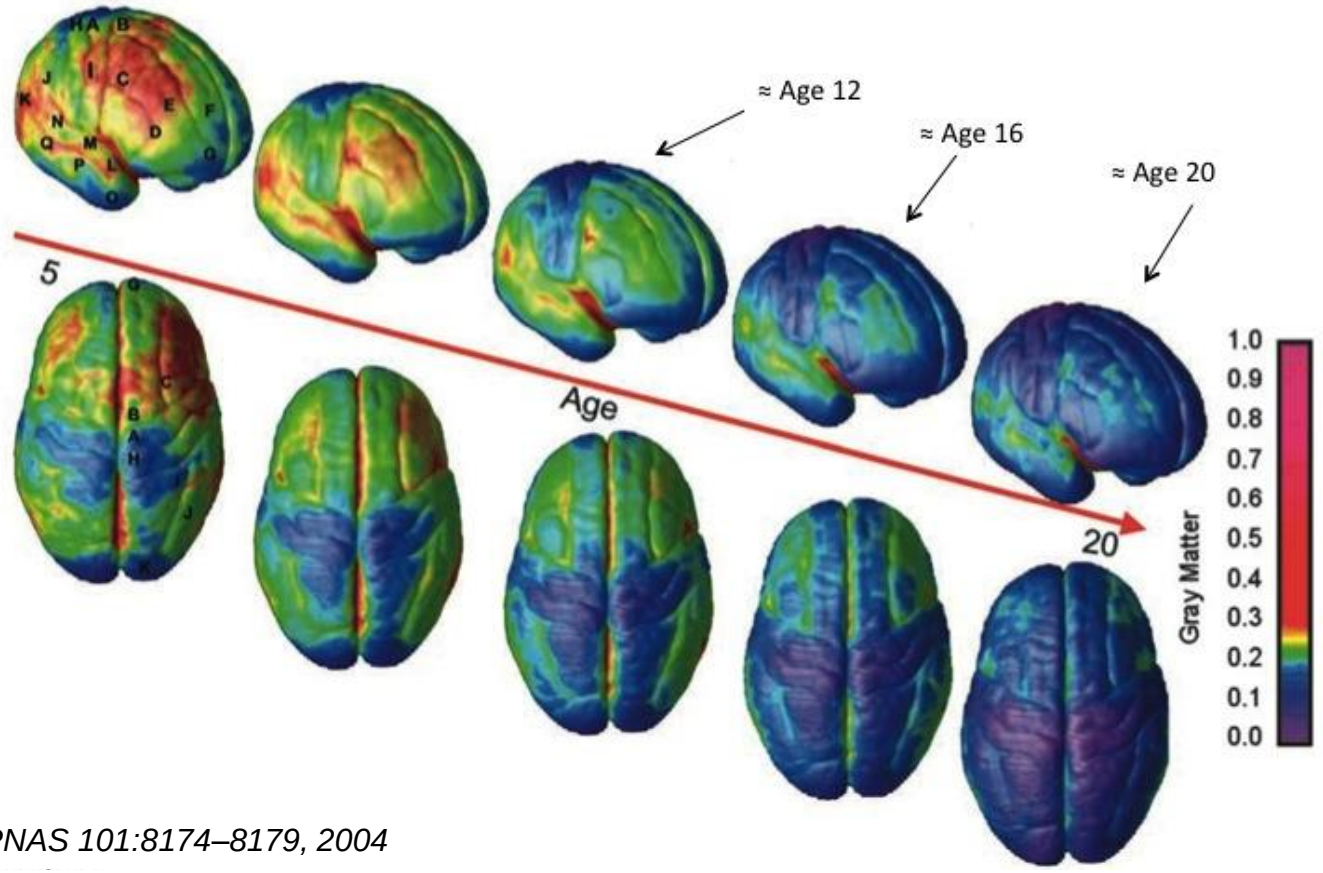
V‘E: Minute ventilation



Latzin et al. ERJ, 2009

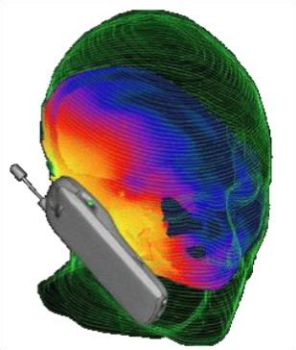
2) Critical time window: developing brain

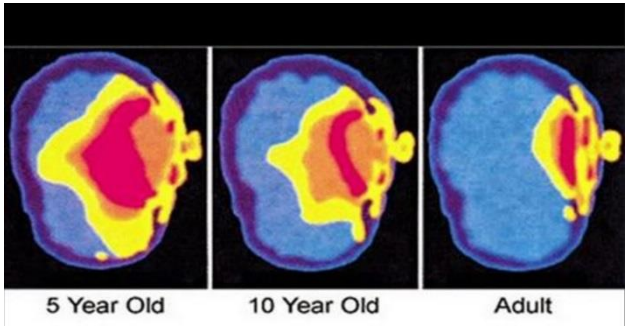
The darker the area, the more developed

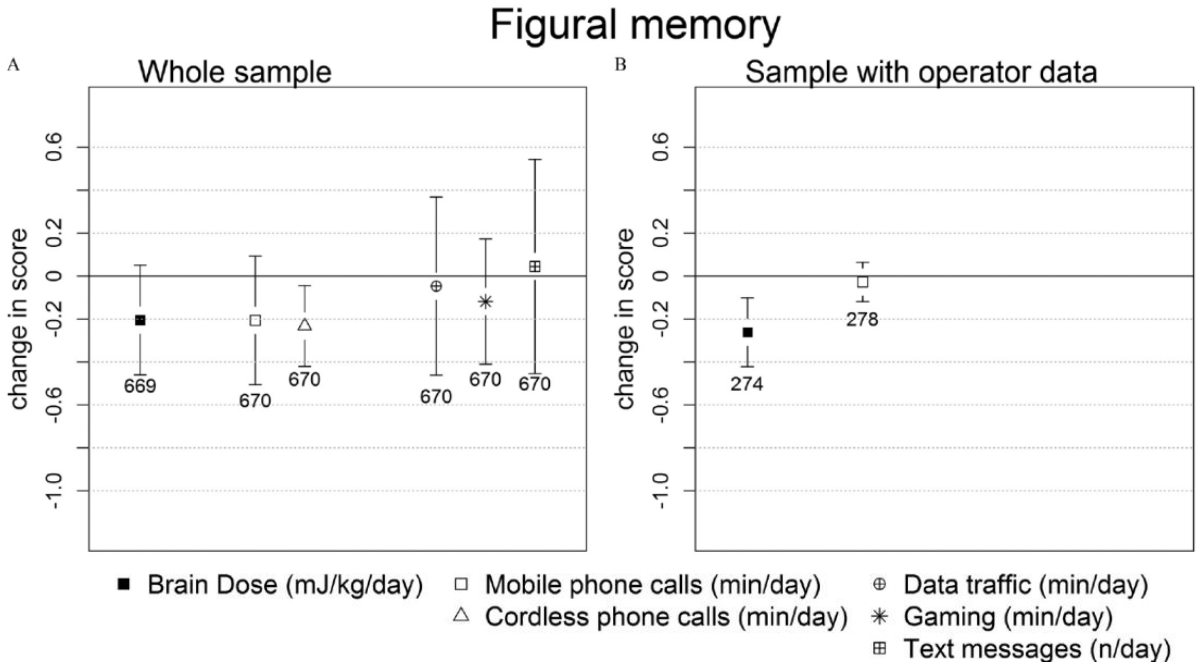


PNAS 101:8174–8179, 2004

Moible phone use and the developing brain





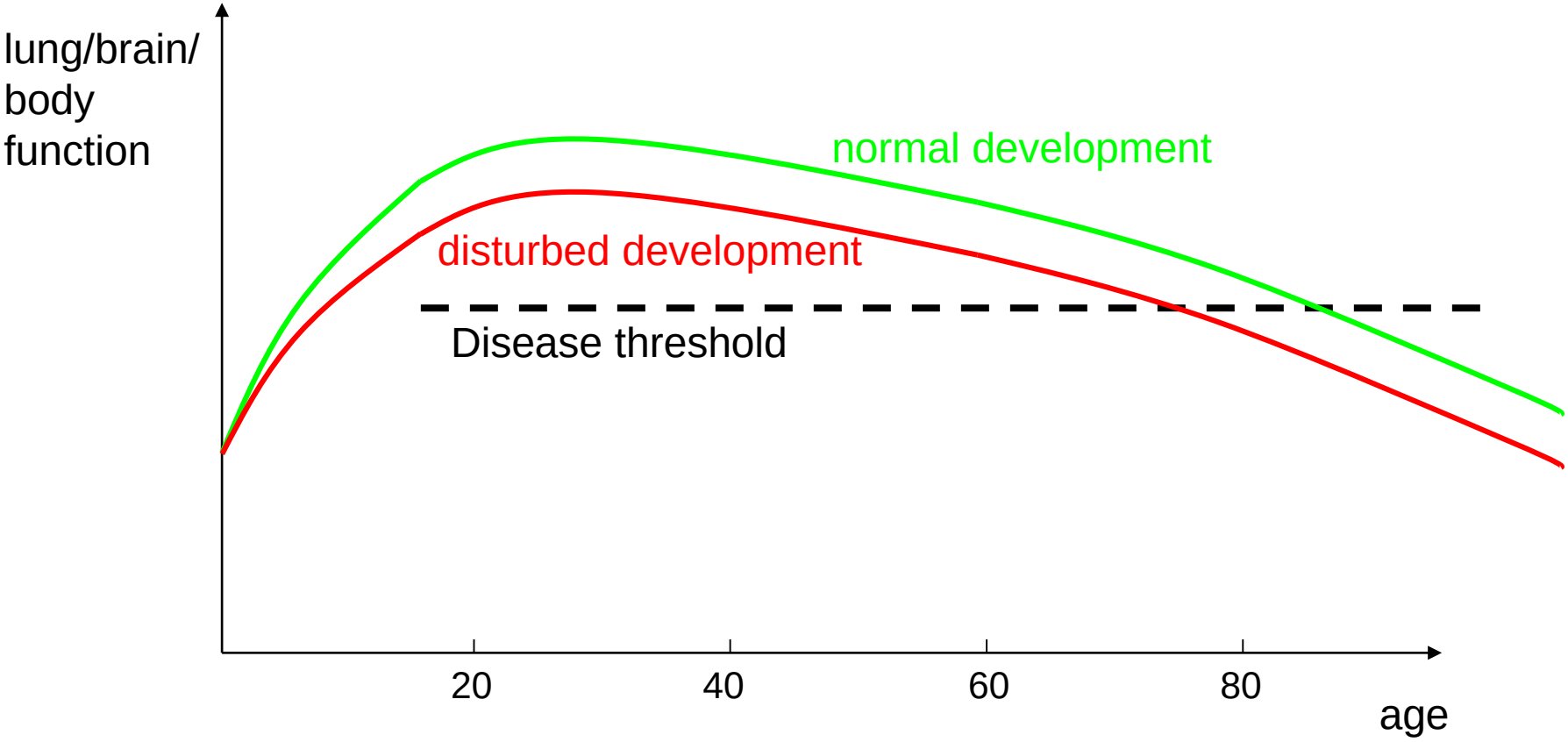


- Association with verbal memory for left side users only
- No association with symptoms, behaviour and concentration capacity
- Needs confirmation

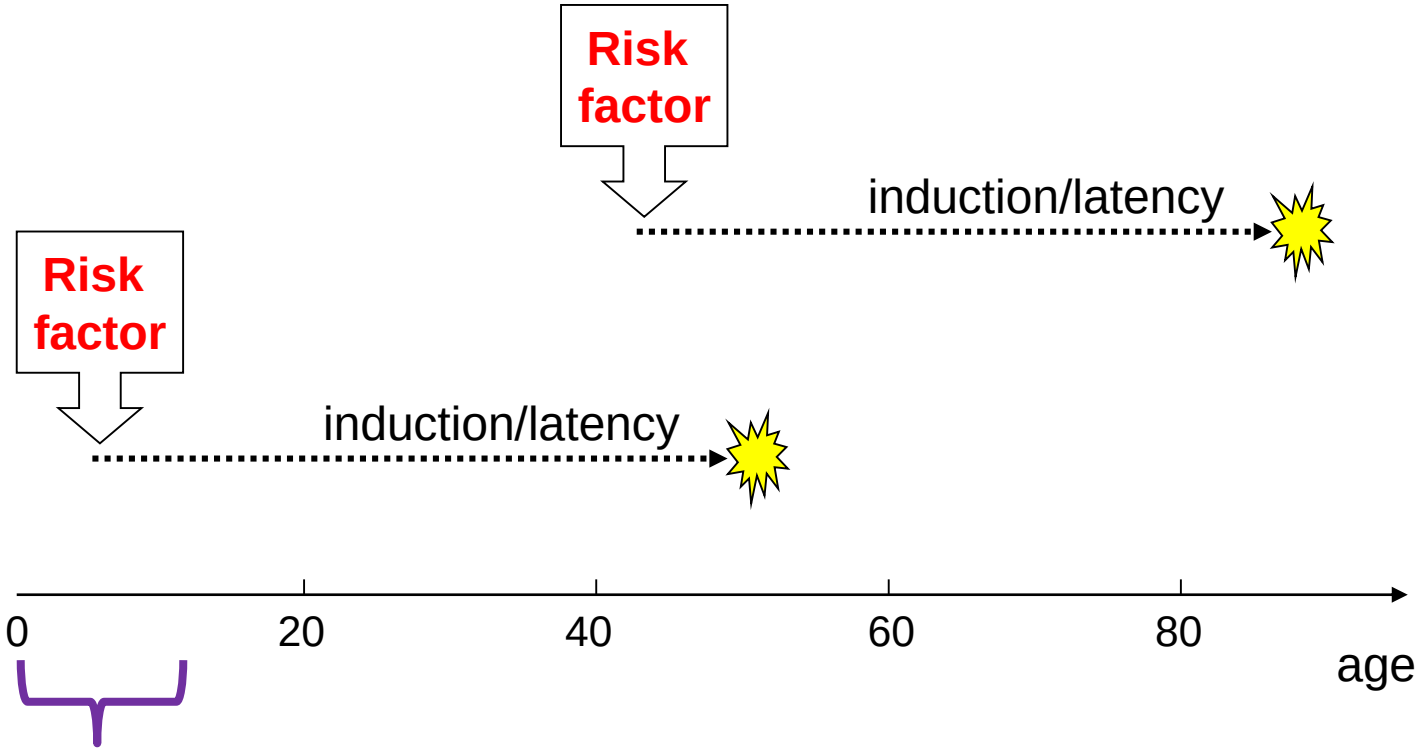
Foerster et al. EHP 2018

For non-radiation effects of e-media use:
- Poster of Chetty-Mhlanga et al
- FMH round table 29.8. 13:15

3) Long post exposure period



3) Long post exposure period: latency for cancer

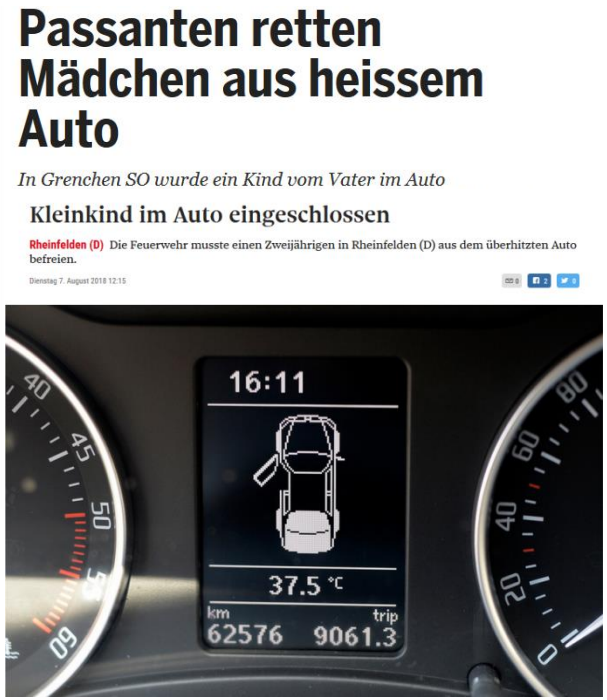


Childhood tumours:
No environmental risk factors established (Zumel-Marne, Neuroepi, 2019)
but high risk of ionizing radiation (Kutanzi et al., ijerph, 2016)

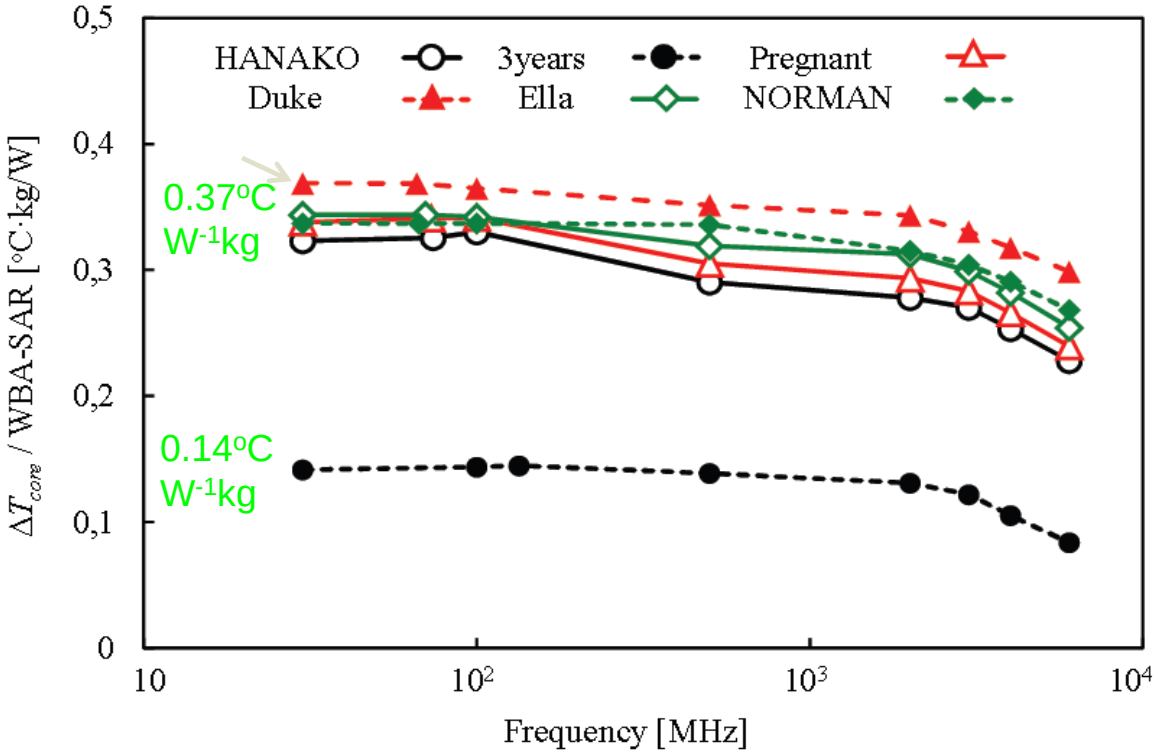
4) Different exposure circumstances

1. Surface to volume ratio is larger
2. Faster metabolism

➢ Child exposed to larger doses relative to the body weight: eating, drinking, inhalation



Temperature increase from EMF



The Minamata 1956 example: in-utero exposure to mercury

- The mother's chemical burden is shared with fetus.

Minamata disease victim, from Wikipedia

- …in every case the mother was healthy and it was not until more than three months after birth that the symptoms were recognized

Effects of mercury exposure

Mental retardation

Ataxia and cerebral palsy

Seizures

Vision and hearing loss

Delayed developmental milestones

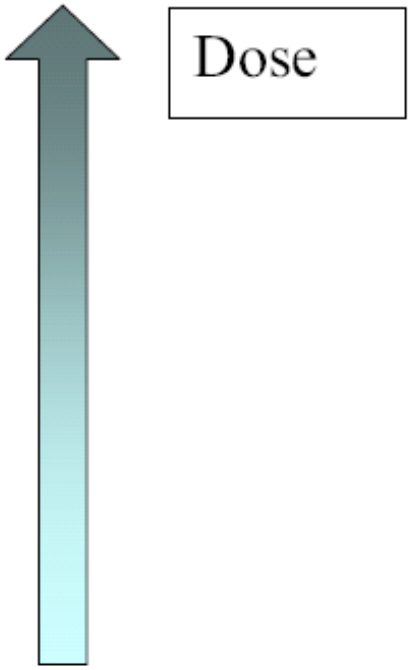
Language disorders

Deficits in fine motor function

Visual spatial disabilities

Memory problems

High blood pressure low cardiac rate variability



from Bose-O'Reilly et al., 2010

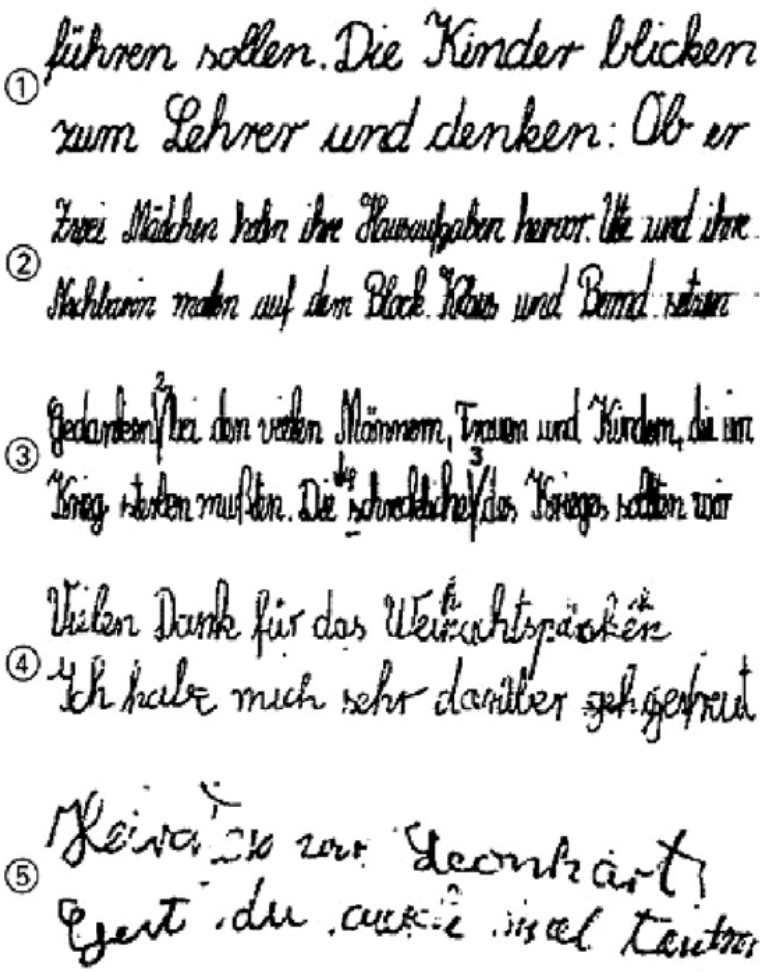
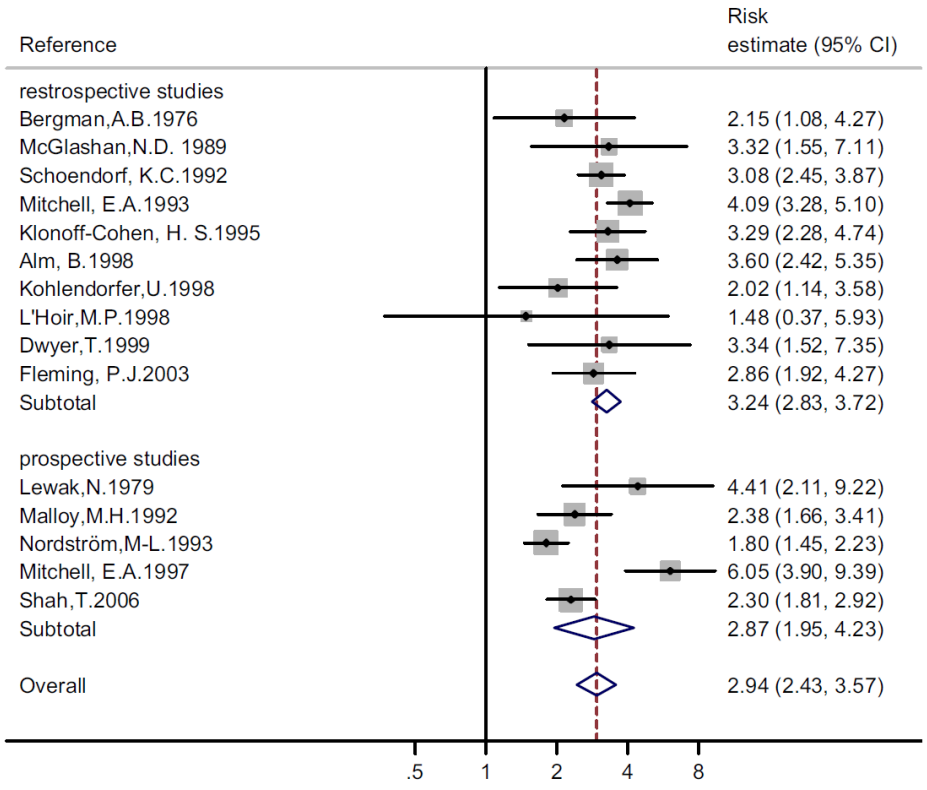


FIG 7. Handwriting example of a 9-year-old girl in monthly intervals after an accidental intake of mercury, showing the increasing tremor in her handwriting (© Stephan Boese-O'Reilly).[161]

Fig. 7 from Bose-O'Reilly et al., 2010

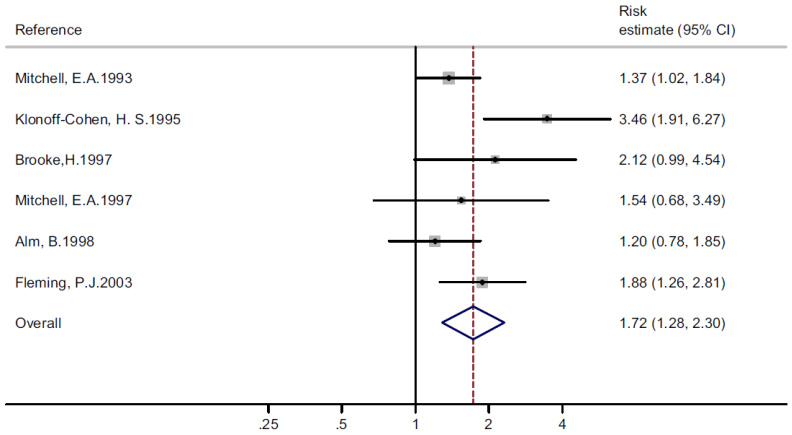
4) Sudden infant deaths and smoking

Maternal smoking during pregnancy

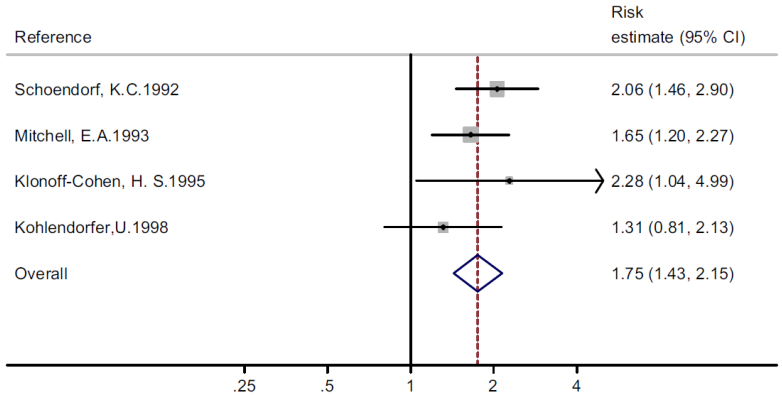


Röösli, PBMB, 2011

Paternal smoking after birth*



Maternal smoking after birth*



* adjusted for maternal smoking during pregnancy

Environmental tobacco exposure (ETS)

- The Report of the Surgeon General (2006) concludes:

1. Sufficient evidence:

   Sudden infant deaths (SIDS)

   Reduced birth weight (maternal ETS exposure)

   Lower respiratory illnesses

   Middle ear disease

   Cough, phlegm, wheeze, and breathlessness among children of school age

   Asthma/wheeze illnesses

   Lung function

2. Suggestive evidence:

   Preterm delivery

   Childhood cancer

4) Different exposure paths: e.g. playing habits, “hands-to-mouth” behaviour)

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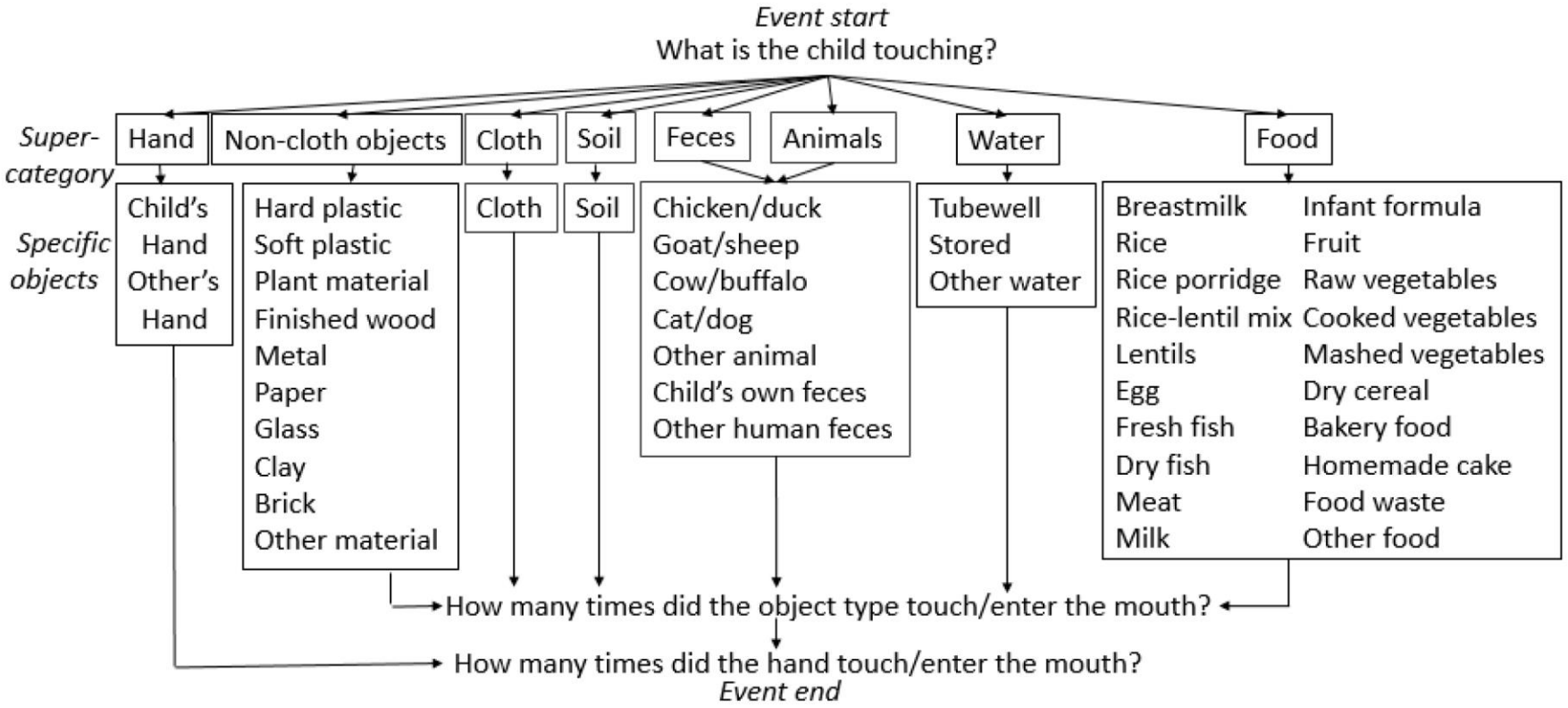


Kwong et al., ijerph 2016

Brominated flame retardants

- Included in plastics, textile applications, electronics, furniture etc.
- High persistency in the environment and bioaccumulative
- May disrupt thyroid hormone functions
- Possible neurobehavioral effects
- Possible endocrine disruption
- Systematic review on exposure studies (Malliari & Kalntzi, Env Int, 2017):
  - Many studies on different indoor environment characteristics, but knowledge gap on the association between children's behaviour and activity patterns and their exposure
  - Only two studied exposure via mouthing toys
  - Infants and toddlers have higher exposures than older children.

Brominated flame retardants

Fig. 1. Worldwide distribution of median BDE-47 indoor house dust concentrations (ng/g).

Malliari & Kalntzi, Env Int, 2017

Brominated flame retardants

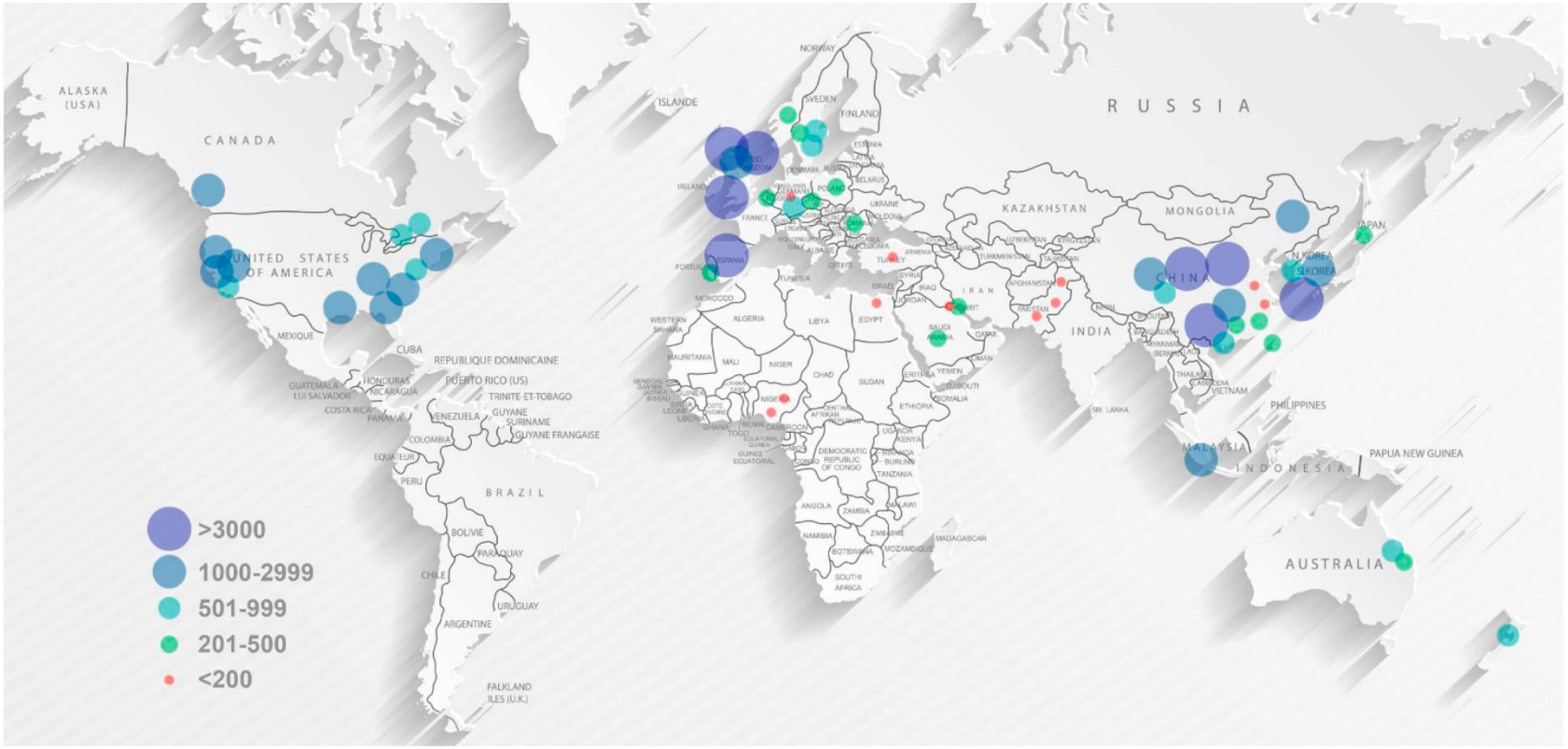


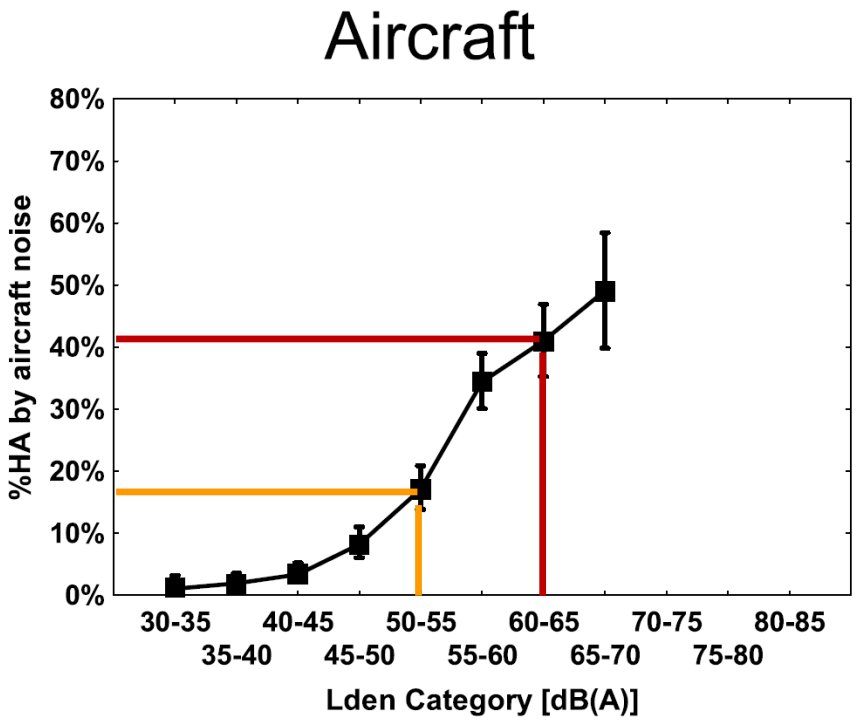
Fig. 2. Worldwide distribution of median BDE-209 indoor house dust concentrations (ng/g).

Malliari & Kalntzi, Env Int, 2017

5) Different cognitive, physiologic and metabolic processes than adults

- Survey on aircraft noise annoyance in 9 to 10 year old children in Europe: 5% at 52 dB and 12% at 62 dB (L_{den}).

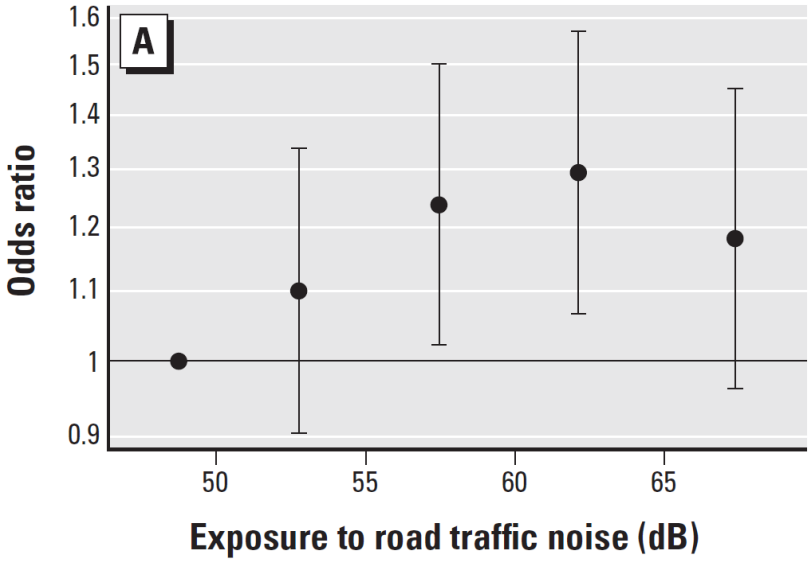
- Proportion of highly annoyed people in a representative survey of Swiss adults (Brink et al, 2019):



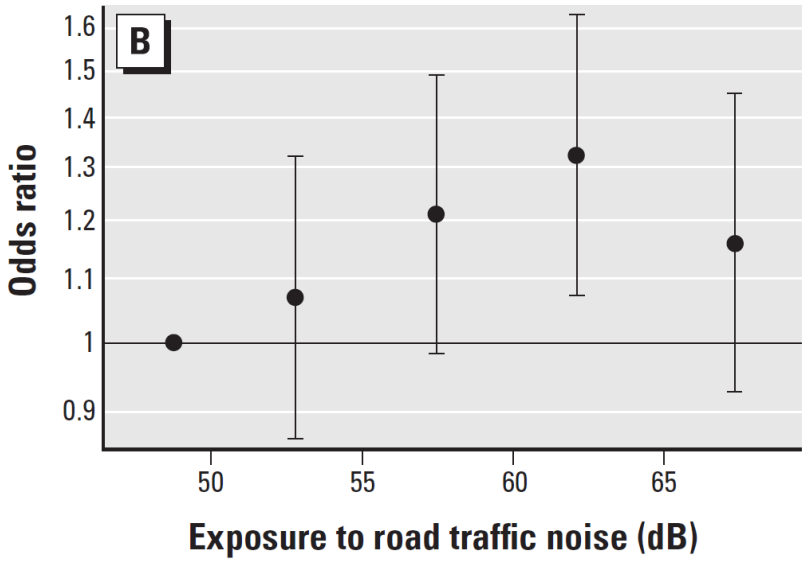
Road traffic noise and behavioural problems in children

An analysis of 46,940 children from the Danish National Birth Cohort Study.

A) Total Difficulty Score



B) Hyperactivity/Inattention



Hjortebjerg, EHP; 2016

Aircraft noise and cognitive functions

Cross-sectional study of 2844 children aged 9–10 years who were attending 89 schools from the Netherlands, Spain and the UK:

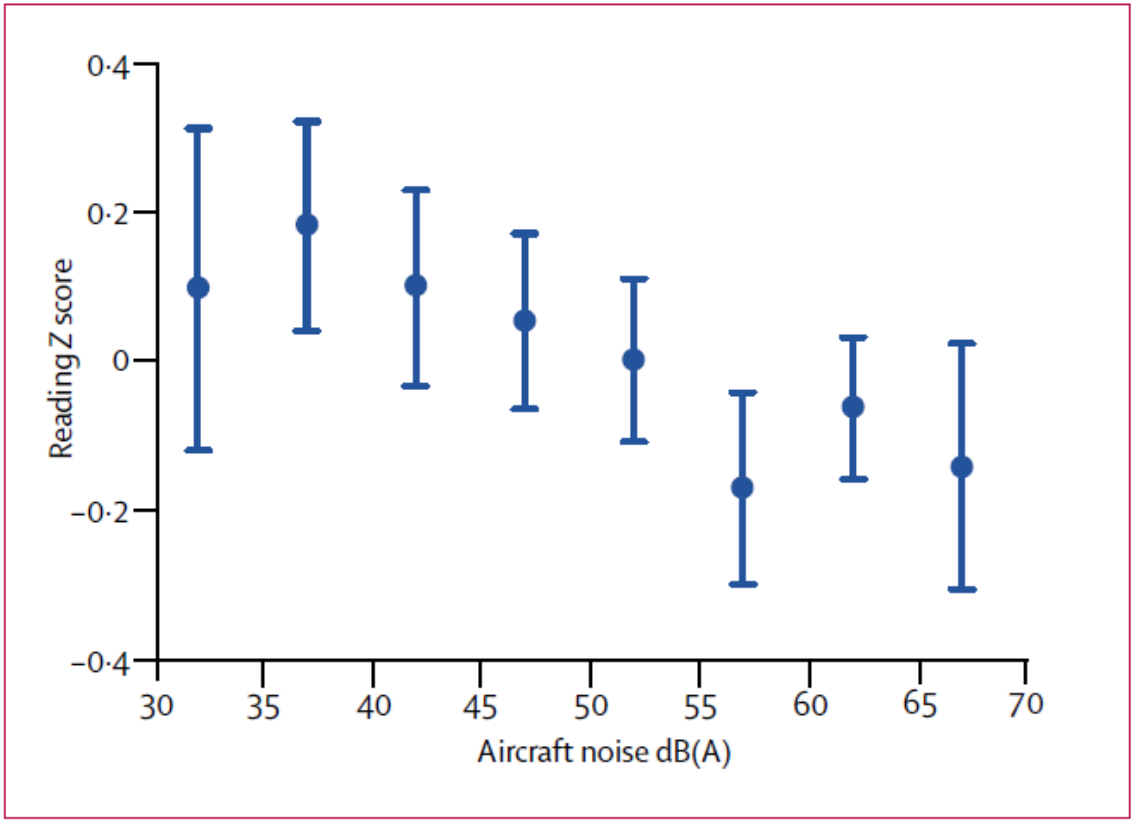
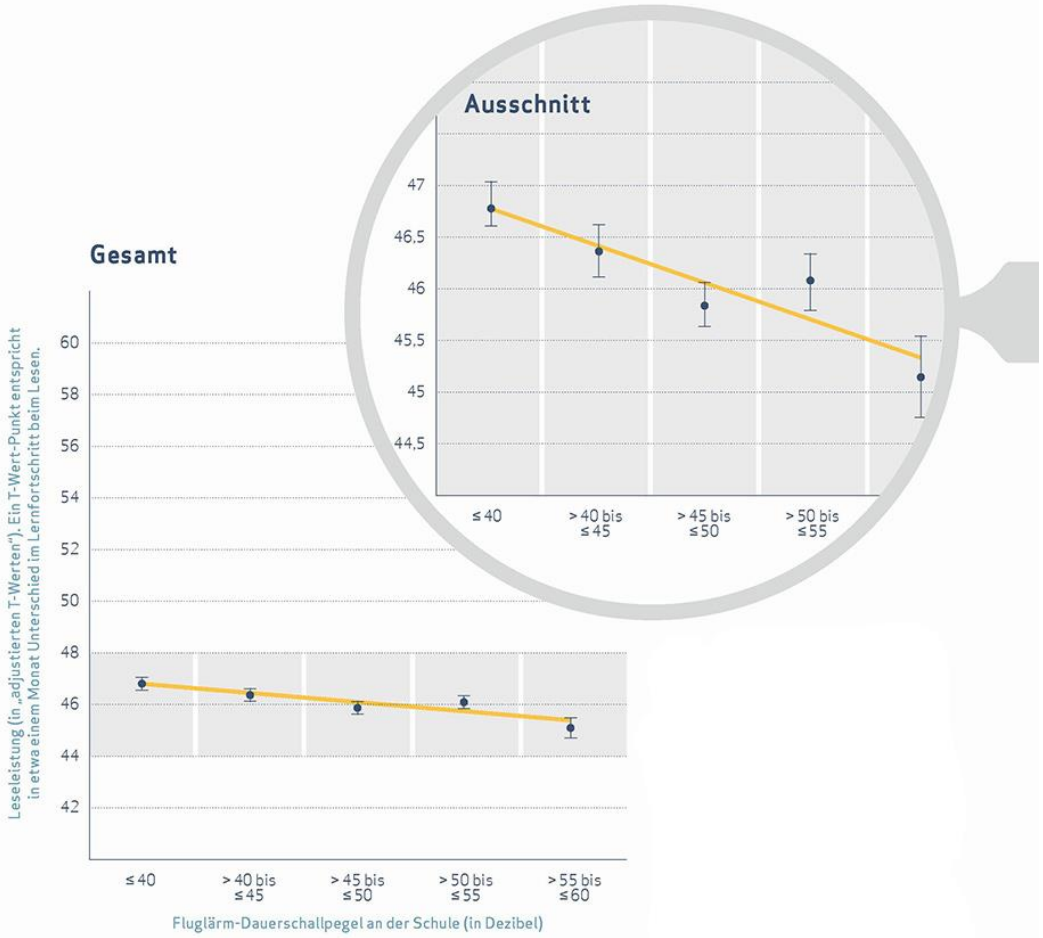


Figure 1: Adjusted mean reading Z score (95% CI) for 5 dB bands of aircraft noise (adjusted for age, sex, and country)

Stansfeld et al., Lancet, 2005

Aircraft noise and reading capacity: NORAH study

Cross-sectional stu
1,243 children from
schools around the
Frankfurt airport



Von http://www.laermstudie.de

Possible mechanisms

- Repeated activation of the hypothalamic-pituitary-adrenal axis (HPA) affects mood of the children
- Chronic stress demotivates the teacher
- Psychological stress: Lack of control results in a passive attitude
- Acoustic discrimination
- Blocking all acoustic stimuli (inattention)
- Interruption of teaching during noise events (slower movement)

Conclusions

1. Other disease spectrum than adults
2. Developing organism
3. Long post exposure period
4. Different exposure circumstances and paths
5. Different cognitive, physiologic and metabolic processes than adults

- Only a few health examples mentioned
- In many circumstances children are more vulnerable but sometimes their resilience and adaptive capacity is higher than adults
- Environmental regulation scarcely consider effects in children