ÄÄNIERGONOMIA OSANA LAAJAA ERGONOMIAN KENTTÄÄ

ERGONOMIAN UUDET TUULET TYÖELÄMÄSSÄ

Vuorovaikutuksessa puhe ja ääni, kuulo, akustiikka sekä perinteinen ergonomia

pe 1.2.2019 Tampere, Kalevantie 4, Päätalon sali A3

Eeva Sala, MD, PhD
Docent in phoniatrics
University of Turku
eevasala@gmail.com

ÄÄNIERGONOMIA OSANA LAAJAA ERGONOMIAN KENTTÄÄ

Aiheita

- Suomen Ääniergonomiaseura
- IEA – International Ergonomics Association
- Ergonomian aloja
- Ääniergonomian ydinalueet
- Tulevaisuuden visioita

SUOMEN ÄÄNIERGONOMIASEURA ry

http://www.aaniergonomiaseura.com/

- **Puheenjohtaja Elina Kankare**
- **Hallituksen jäsenet: Sofia Holmqvist-Jämsén, Tarja Karttunen, Jonna Kuuskoski, Catharina Nordström, Leena Rantala, Eeva Sala ja Hanna Vertanen-Greis**
- **12.10.2011: Me allekirjoittaneet perustamme Suomen Ääniergonomiaseura ry, Finlands Röstergonomisällskap rf nimisen yhdistyksen.**
- **Perustajajäsenet: Eeva Sala, Suvi Hakala, Sofia Holmqvist, Tarja Karttunen, Ritva Ketola, Anneli Laine, Marika Muttilainen, Leena M. Rantala, Kaarina Ruusuvirta, Katja Saarela, Jaana Sellman, Susanna Simberg ja Marketta Sihvo**
- **Seuralla on nettisivut**

IEA – International Ergonomics Association

IEA is the federation of ergonomics societies around the world

- IEA on kansallisten ergonomiaseurojen keskusjärjestö

- Viimeinen Kongressi oli Firenzessä 2018,
- seuraava on **Vancouverissa 13-18.6.2021**
- Kongressi proceedingsit käsittävät 10 kirjaa, mikä kuvastaa kongressin suurta laajuutta
- Proceedingskirjassa numero 10 on mm. vocal ergonomics, ja auditory ergonomics ym
- https://www.iea.cc/
- http://www.iea.cc/whats/index.html
- https://www.springer.com/us/book/9783319960647

Lähes kaikkia asioita voi tarkastella ergonomian näkökulmasta.

ERGONOMIAN ALUEITA

- kongressin aihealueet

I. Healthcare Ergonomics

II. Safety and Health and Slips, Trips and Falls

III. Musculoskeletal Disorders

IV. Organizational Design and Management (ODAM), Professional Affairs, Forensic

V. Human Simulation and Virtual Environments, Work with Computing Systems (WWCS), Process control

VI. Transport Ergonomics and Human Factors (TEHF), Aerospace Human Factors and Ergonomics

VII. Ergonomics in Design, Design for All, Activity Theories for Work Analysis and Design, Affective Design

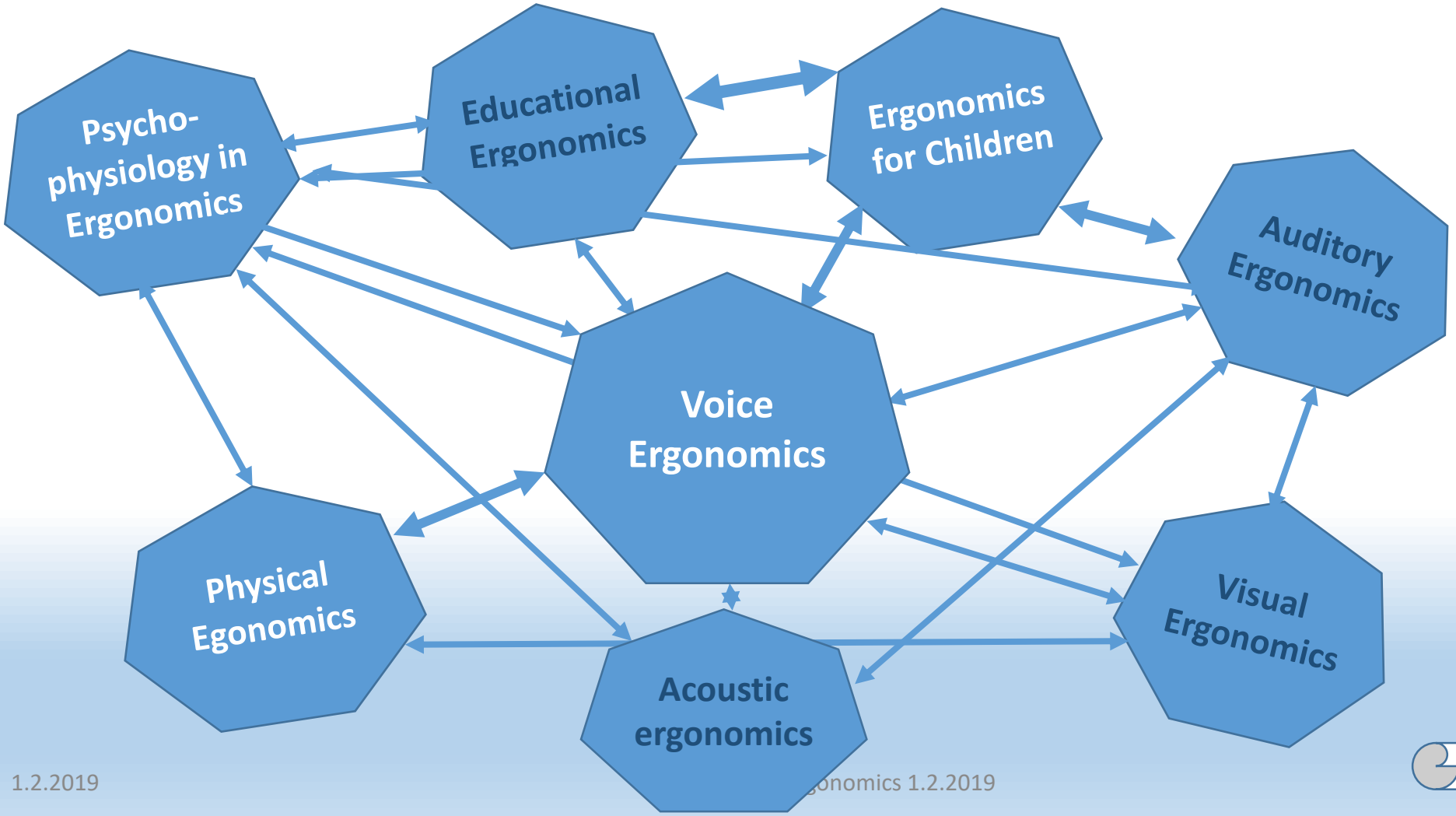
VIII. Ergonomics and Human Factors in Manufacturing, Agriculture, Building and Construction, Sustainable Development and Mining

IX. Aging, Gender and Work, Anthropometry, **Ergonomics for Children** and **Educational Environments**

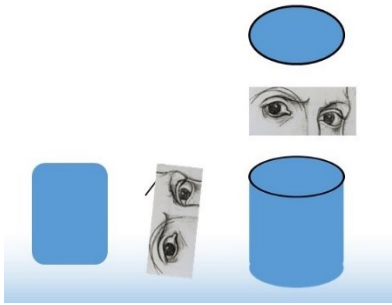
X. Auditory and Vocal Ergonomics, **Visual Ergonomics**, **Psychophysiology in Ergonomics**, Ergonomics in Advanced Imaging

ERGONOMIAN OSA-ALUEET OVAT VUOROVAIKUTUKSESSA

- osa-alueet tukevat ääniergonomiaa



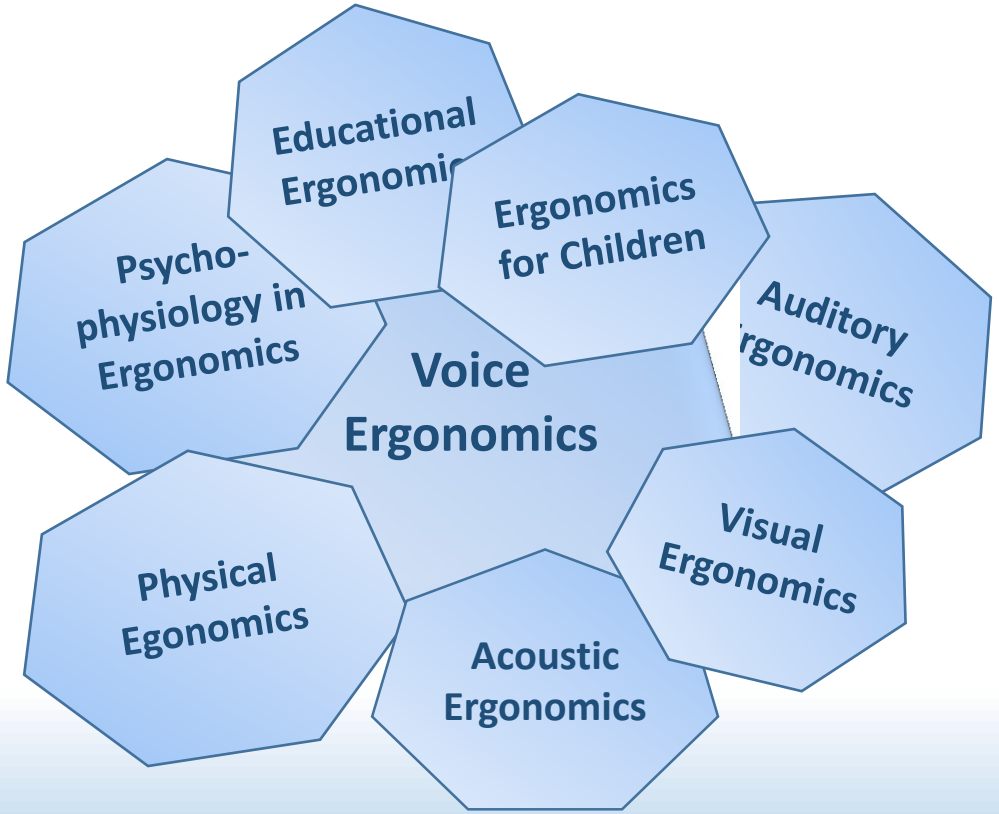
Sama ilmiö, eri näkökulma



*Kun Suomessa puhutaan **ergonomiasta**, tarkoitetaan yleensä **tuki- ja liikuntaelin ergonomiaa**, koska muita ergonomian aloja tunnetaan huonosti.*

ERGONOMIAN OSA-ALUEET OVAT VUOROVAIKUTUKSESSA

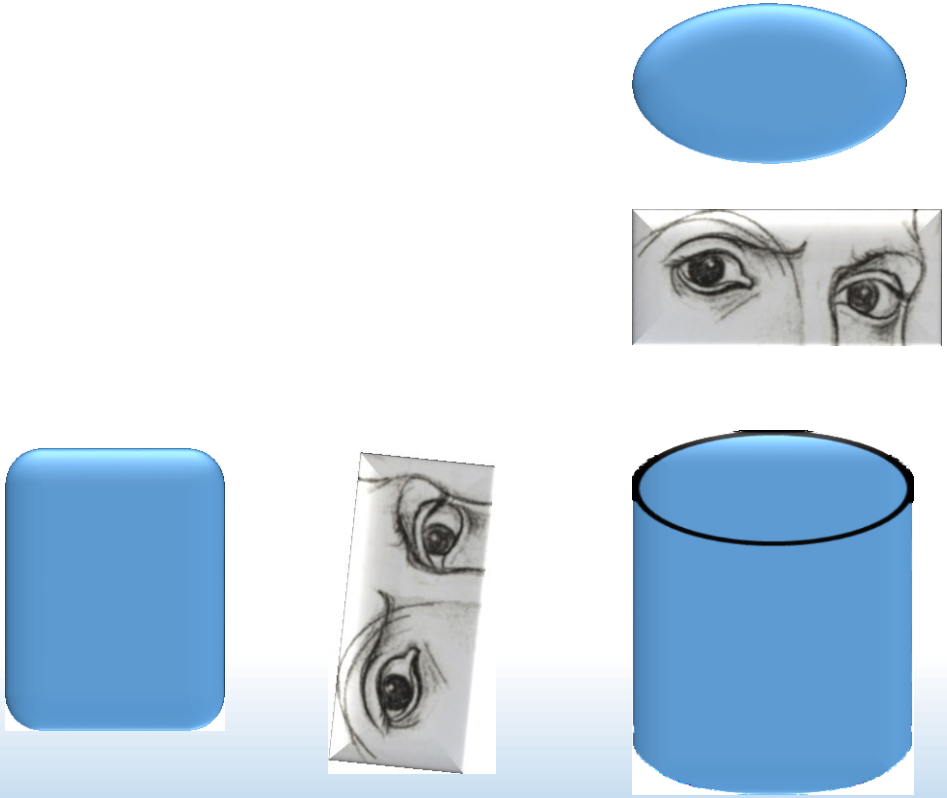
- yhteistyön terve on välttämätön



Osa-alueet ovat päällekkäisiä

YHTEISTYÖN VOIMA PIILEE NÄKÖKULMISSA

- “kaksi näkee enemmän kuin yksi”



<u>HYVÄ TIEDOSTAA</u>

Oman osaamisalueen rajat

Taloudellisen hyödyn tavoittelu

VOICE ERGONOMICS – ÄÄNIERGONOMIA

- perustuu – tarkoittaa – sillä on tavoite

Perustuu

- **Voice ergonomics is the theoretical and fundamental understanding** of human voice production, speaking and speech hearing in speech communication environments, and application of that understanding to the design of these interactions in the context of real settings.

Tieto ja ymmärrys

Tarkoittaa

- **Voice ergonomics means to observe work environment** from the speech communication point of view that means speaking, voice production, speech hearing and speech recognition, and to reduce noise in order to prevent its detrimental cognitive effects on attention and memory.

Havainnointi ja tunnistaminen

Tavoite

- **The goal of voice ergonomics** is to get work environment as good as possible for **voice use and speech communication, and cognitive functions attention and memory**.

Kuormituksen vähentäminen

VOCAL ERGONOMICS vai VOICE ERGONOMICS

- Voice ergonomics

Ääniergonomia/Voice ergonomics
Fokus on
äänessä,
äänen tuottamisessa
äänen kuulemisessa, ja
ympäristössä (akustiikassa).

IEA käyttää ilmaisua **Vocal ergonomics**
Fokus on laulamisessa.

Vocal Ergonomics – fokus on laulamisessa

Voice Ergonomics – fokus on ihmisäänessä
- äänentuotossa
- äänen kuulemisessa
- ääniympäristössä

Ääniergonomian ydinalueet

- **kuormittavat ääntä**

1. Melu ja akustiikka
2. Sisäilma
3. Työskentelyasennot
4. Toimintakulttuuri
5. Stressi
6. Apuvälineiden tarve
7. Lasten ääniergonomia

A LOADING or A RISK FACTOR?

● what is the difference?

Kuormittava tekijä - A loading factor

a factor that puts **demands on the vocal organ, or speech production, or speech hearing**

Noise and poor acoustics, speaking a lot, speaking with a high voice level, poor indoor climate, poor postures and working practices, and excess stress.

There is always loading – but is there also over loading?

Over loading –> tissue damage/disease

Esim. MELU

Terveysriski - A risk factor

a factor that may increase the risk for a voice disorder

exposure to an environmental hazard that leads the individual to have **a greater likelihood of developing a disease**.

A loading and a risk factor may be **the same factor**

Risk factor

Esim. Äänihuulikyhmyt

RISKITEKIJÄ AIHEUTTAA SAIRAUDEN

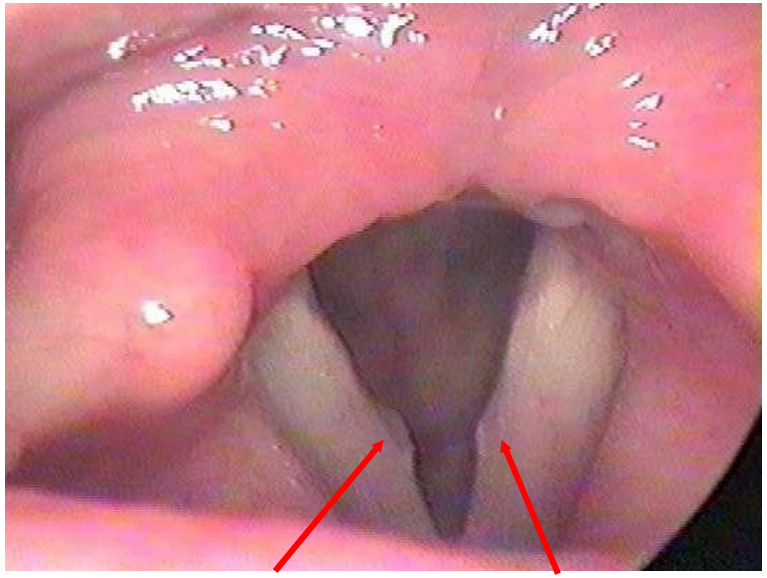
- **mekaaninen rasitus, toistuva liike**

Terveysriski - A risk factor

a factor that may increase the risk for a voice disorder
exposure to an environmental hazard that leads the individual to have **a greater likelihood of developing a disease**.

A loading and a risk factor may be **the same factor**

Risk factor -> Äänihuulikyhmyt



Äänihuulikyhmyt

Katso: Sonninen A, et al. Folia Phoniatr et Logopaed 2003;55:189-198.

Ammattitaudin kriteerit täyttyy
- Altistusmekanismi todistettu
- Altistuksen määrä riittää
- Altistus olemassa

LOADING FACTORS OF VOICE DISORDERS

personal loading factors

Personal loading factors include

- the **health** of the vocal organ,
- voice use **skills** and **practices**,
- **personality**,
- **lifestyle** and **diet**,
- **leisure time** activities, and
- voice demands at **work**.

Personal loading

- Voice Hygiene

Ammattiäänenkäyttäjä
Valioäänenkäyttäjä
Aktiiviäänenkäyttäjä

KOHDERYHMÄT

Äänityöläinen

Typical occupational voice users are

- teachers,
- military trainers,
- sport coaches,
- clergy/priests,
- physical-education instructors, and
- Politicians

Typical professional voice users are

- classical singers,
- singers,
- actors, and
- cantors.

Sana professional viittaa korkeampaan ammatilliseen tasoon

Typical active voice users are

- telemarketers,
- customer call-center workers,
- office workers,
- product demonstrators,
- lawyers,
- nurses,
- physicians,
- speech therapists,
- physio therapists, and
- TV and radio broadcasters.

Ryhmät poikkeavat toisistaan

- **Vaatimukset**
- **Viestintätilanne**
- **Äänikoulutus**

Sana professional viittaa korkeampaan ammatilliseen tasoon kuin occupational.

SPEAKING IN NOISE

characteristics of speech

Changes acoustic–phonetic characteristics of speech

- an increase of sound pressure level (SPL)
- fundamental frequency (F0) and
- energy at 1–3 kHz
- decrease in speaking rate
  - increase in vowel and pause durations
- an increase in harmonics-to-noise ratio
- and decreased jitter and shimmer
  - there is some differences depending on the speaker age group

Smiljanica and Gilbertb 2017

- **With voice problems: Higher speech level, higher F0, longer duration.**
  Lyberg-Åhlander et al. 2014
- **With vocal noduls: Higher speech level, higher F0, longer duration.**
  Szabo Portela et al. 2017

- **Pragmatics** of conversation and communication in noisy settings resembles that of people with a hearing loss (McKellin et al. 2007).
- Expressions become shorter (Van Summers et al. 1988).
- To code positive **emotional information** to the speech - the codes are **incorrect** or **unintentional** like interpreting a voice for example as angry. Some reference for that has been found in preliminary studies by Brännström et al. (2015).
- *Muuttaako pysyvästi opitun kielen luonnetta?*

Äänihäiriöisillä on paljon elimellisiä muutoksia = Tissue damage

LARYNGEAL FINDINGS in a CLINICAL SAMPLE

● in vocally loading professions

Nodules are predominant in teachers

Pereira et al. 2015

	Dysphonic teachers	Dysphonic nonteachers
Normal	33.3%	26.7%
Nodules	34.4%	11.1%
LPR	14.4%	20.0%
Etc.		

Need more studies on

- the association of vocal fold pathologies and environmental factors
- to get more powerful evidence as occupational basis of voice disorders
- to fulfill legal/strict criteria of occupational voice disorder – tissue damage
  - Exposure -> tissue damage
- the effects on toxic substances in the air to the vocal fold mucous membranes – toxic laryngitis

Other clinical studies:

- Ebersole et al. J Voice 2017
- Lu et al. J Voice 2017

OPEN LEARNING ENVIRONMENTS

• speech hearing and processing

- **Noise levels** in open learning spaces are about the same as in enclosed learning spaces[1]
- **Noise is mostly speech noise**
  - **Irrelevant meaningful speech** is more detrimental than non-speech noise[2]
  - and **intermittent speech** is more detrimental than continuous speech[2]
- Irrelevant meaningful speech **impacting on information processing**

Problems are

- **Intrusive noise from near groups**
  - **Speech noise: Irrelevant meaningful speech**
- **Visual distraction**
  - Students see what they do in other groups
  - *It is said that they get used to it, but there no scientific evidence*
- **Lack of privacy**
  - All the time somebody is following what you are doing

- [1]Shield et al. *Noise and Health*, 2010;12:225-234
- [2]Szalma and Hancock. *Psychological Bulletin,* 2011;*137*(4), 682-707.

INDOOR CLIMATE - SISÄILMASTO

- laryngeal effects

- **Indoor air** is air in the building or a room.
- **Indoor climate** includes air and temperature in the building or a room.
- **Indoor environment** includes air in the building or a room and temperature, acoustic conditions, lighting, electricity and magnetic field.

INDOOR CLIMATE - SISÄILMASTO

• laryngeal effects

- **Good indoor air** quality is important for a well-functioning voice.
- Air that is too **dry** or **moist** may be damaging for vocal health.
  - **Reasonable moist air** preserves vocal fold mucous membrane pliable to make delicate waves.
- **Pollutants** in the air may have health effects because of their **toxicity** or **hypersensitivity**.
- Draft may cause **muscle tension** and thus affect voice production.

Poor indoor air quality increased risk for the occurrence of laryngitis

Rantala et al. 2012; Rantala et al. 2015

- **Mold emits toxic substances**
- **Toxic laryngitis**

Allergic reactions cause laryngitis

Sala et al. 1996; Simberg et al. 2009

Coughing/throat clearing involves mechanical forces

Kallvik et al. 2017; Hess et al. 1998

Increased use of asthma medication

Gallivan et al. 2007; Ihre et al. 2004

LARYNGEAL FINDINGS - LÖYDÖKSET

- in vocally loading professions

MIKSI TUTKIMUKSIA EI OLE ENEMPÄÄ?

- Tutkimukset ovat pääasiassa kyselytutkimuksia
- Kurkunpään tilan arviointi vaatii osaamista
- Eettiset säännöt rajoittavat minkälaisia tutkimuksia voi tehdä

Laryngeal examinations in day care

Sala et al. 2001

Finding	Teachers N=262	Nurses N=107
Organic findings	29%	7%
Laryngitis	17%	6%
Noduls	6%	1%
Etc.		

School teachers self reported

Rantala et al. 2012

Finding	N=39
Recurrent rhinitis	51%
Laryngitis	38%
Sinusitis	28%
Etc.	

Need to have more studies

- Association of vocal fold pathologies and environmental risk factors
- To get more **powerful evidence of occupational basis** of voice disorders
- To **fulfill strict/legal criteria** of occupational voice disorder – tissue damage
  - Exposure -> tissue damage
  - the effects of toxic substances in the air on vocal fold mucous membranes – toxic laryngitis
- *Difficulty in interpreting the findings, especially laryngitis*
  - *"Irritation" is a symptom not a finding!*

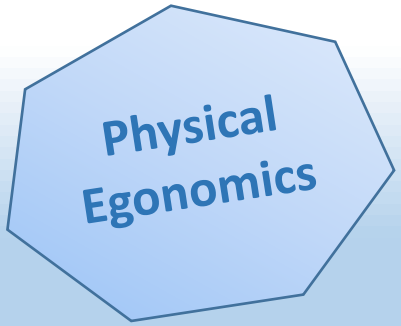
WORKING POSTURES – TYÖSKENTELYASENNOT

● in vocally loading professions

- **Good postural alignment** is important in optimizing voice function.
- **Poor postures** make voice production difficult and increase vocal loading.

  Rantala L, Sala E & Kankare E. Logop Phon Vocol. 2018;70:24-36.

- **Furniture** and **equipment** determine largely postures the speaker uses.
- The use of **certain devices** may trigger poor speaking postures.



Working postures that may include a risk factor for an occupational voice disorder are:

Head

- turned,
- thrust forward/ backward/ upward,
- tilted toward shoulder, or
- poor posture, e.g. when using bifocals or varifocal glasses.

Shoulders

- bent down/ hunched, or
- raised.

Body

- turned to side while speaking.

Arms

- held up/picking up heavy things.

WORKING POSTURES – TYÖSKENTELYASENNOT

- teachers

Preferable good postures	Avoidable poor postures
When talking to an audience using a document camera, keep the body facing the audience.	When talking to an audience using a document camera, avoid bent and twisted postures.

WORKING PRACTICES - TOIMINTAKÄYTÄNNÖT

● in open learning environments

Before

- Enclosed classrooms
- Teacher directed teaching

Kattilakoski, Raija. A school's operating culture in open learning spaces – An ethnographic study on moving to a new school building.

Jyväskylä: University of Jyväskylä, **2018**, 201 p.

(Jyväskylä Studies in Education, Psychology and Social Research ISSN 0075-4625; 616)

ISBN 978-951-39-7439-8 (print)

ISBN 978-951-39-7440-4 (PDF)

Today

- Open learning environments

We do not know

- **Job description** of teachers?
  - Several student groups and several teachers in the same space
- What are the **voice ergonomic loading factors** in open learning environments?
- How are **speaking practices**?
  - Speaking to individuals, small groups, whole group
  - ✓ We need to monitor speech, hearing and noise during work
- How are **speaking postures**?
- **Stress?**

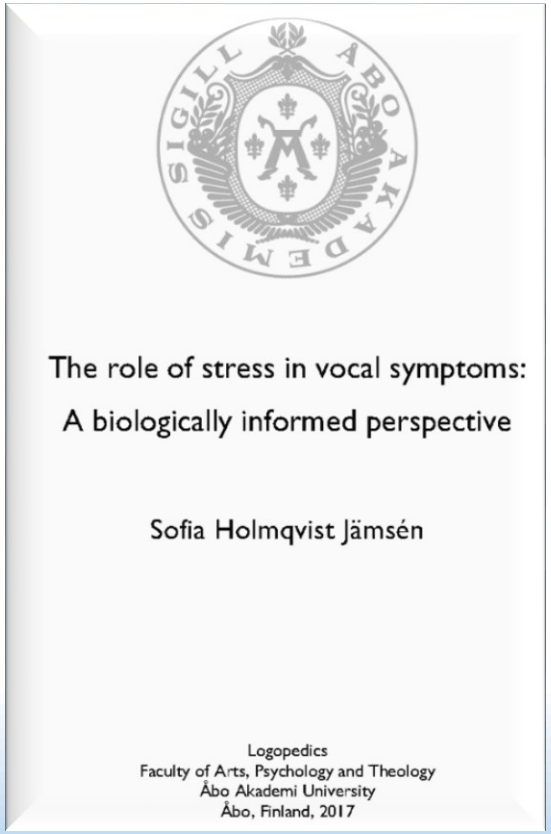
STRESS - STRESSI

The term *stress* has a variety meanings and several definitions

- **A contributing factor for a voice disorder**
- **A contributing factor in a specific voice disorder**
  - **MTD (muscle tension dysphonia)**

Mekanismit:

- ✓ **Increased muscle tension**
- ✓ **A reduction of secretion or a more viscous secretion**



AIDS - APUVÄLINEET

- Äänenvahvistimista monta hyötyä
- Valikoiva käyttö on suositeltavaa
- Voi hyvin yhdistää opetusteknologiaan

Benefits on teachers' voice

- Easier to speak
- Decreased need to repeat instructions
- Voice lasts a longer time
- Less voice tiring
- Less voice symptoms
- Better voice quality
- Voice symptoms decrease in subjects with a voice disorder
- Recovery from a voice disorder easier

Benefits on students

Better

- Speech perception
- Concentration
- Attention
- Reading skills
- Language skills
- Mathematical skills
- Learning results

Sala E. Sound Amplifiers Supporting Speech Communication s. 106-115 in Eeva Sala and Leena Rantala eds. Voice Ergonomics: Occupational and Professional Voice Care. Cambridge Scholars Publishing 2019

VOICE ERGONOMICS FOR CHILDREN – LASTEN ÄÄNIERGONOMIA

- The focus is on voice, hearing and speech perception

- Samat osa-alueet kuin aikuisilla

Voice ergonomics for children is quite a new area

Anatomically children are not just scaled down versions of adults

Physiology of children's voice production seems to be at least as loading as that of adult

RISK FACTORS ARE:

- **Noise**
- **Indoor air problem due to moisture damage**
- **Allergies, asthma, frequent respiratory tract infections and cough**
- "Significant correlation between the degree of indoor air problem due to moisture damage and the frequency of hoarseness." (Kallvik et al. 2016).
- "The mechanical trauma to the vocal fold mucous membrane caused by frequent coughing can lead to a hoarse voice." (Kallvik et al. 2017; 2018)

Prevalence of voice disorders is high (10-15 %)

- **Dysphonic children are aware of their voice problem.**
- **Children with a dysfunctional voice are judged more negatively by teachers compared to non-hoarse children**

Prevention of adverse effects of noise:

- Start to raise awareness in the **general public and teachers** in preschools and schools about this problem.
- **In teacher's education**: **awareness of the problem** and, consequently, have an impact on activities and pedagogy in preschools and schools.
- **Planners' awareness and …**

VOICE ERGONOMICS FOR CHILDREN – LASTEN ÄÄNIERGONOMIA

- The focus is on children's voices, speech perception, cognition

Tulisi olla osa kielihäiriöisten kuntoutusta

NOISE

- **Children are exposed to higher noise levels than adults.**
- **Children are more impaired than adults by unfavorable listening conditions such as reverberation and noise.**
- **Children perceive and are annoyed by noise.**

Voice ergonomics is tangent to attention, memory, and learning.

Adverse noise effect include also: attention, language learning, reading comprehension, mathematical performance, memory, and increased stress.

THERE ARE SEVERAL VULNERABLE GROUPS:

- Young children (<15 years old)
- Teaching language is a nonnative language
- Bilingual
- Central auditory processing deficits
- Learning disabilities | difficulties
- Phonological problems
- Articulation disorders
- Dyslexia or other reading disabilities
- Language disorders
- Developmental delays
- Attention deficits
- Low working memory capacity
- Children with fluctuating conductive hearing loss
- Children with otitis media
- Mild/moderate sensorineural hearing loss
- Unilateral hearing loss

Modified according to Crandell et al. (2005)

Ryhmässä yksi tai useampia lapsia, jopa yli puolet

MILTÄ TULEVAISUUS NÄYTTÄÄ?

● Yksityisiä pohdintoja

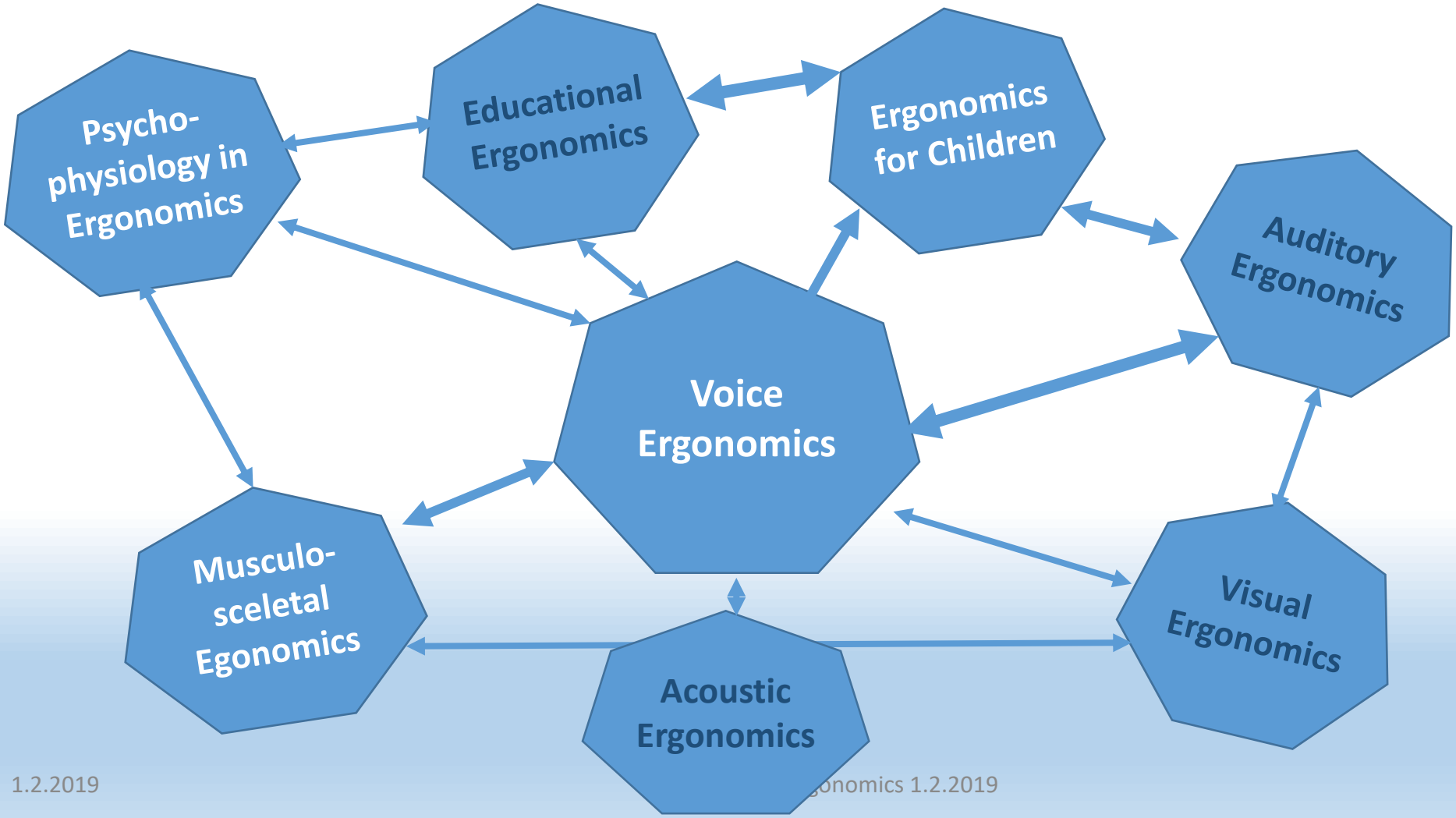
- Maailma muuttuu kiihtyvällä vauhdilla
- Viestintätavat muuttuvat
- Puheviestintä ei katoa, voi jopa lisääntyä
  - Esim. koneiden ja laitteiden ohjaaminen puheella, robottien p
- Viestintäympäristöt muuttuvat
- Tiedon käyttö vähenee, tunteiden lisääntyy
- Tekoälyn sovellusmahdollisuudet rajattomia
- Taloudellinen voitto/asiantuntemus kamppailee

Esim. voi seurata miten hyvät oppimisolosuhteet toteutuvat Ohjausmahdollisuus

- Ergonomian on hyvä olla kehityksen etulinjassa mukana
- Miten se tehdään?

ERGONOMIAN OSA-ALUEET OVAT VUOROVAIKUTUKSESSA

- Osa-alueiden rajat ovat liukuvia



Ilmestyy keväällä 2019

Cambridge Scholars Publishing

Health Sciences

Life Sciences

Physical Sciences

Social Sciences

VOICE ERGONOMICS

Occupational and Professional Voice Care

Editors: Eeva Sala and Leena M. Rantala

Contributors: Sofia Holmqvist-Jämsén
Anita McAllister
Leena M. Rantala
Eeva Sala
Susanna Simberg

The book is a professional resource for the use of voice specialists and experts, occupational and professional voice users which includes the theoretical background of voice ergonomics and its practical applications. This book is also suitable as a textbook for graduate Prospective Speech-Language Pathology (SLP) graduates.

Voice problems are an increasing public health and economic challenge. The economy has become dependent on communication-based employment and this trend will increase during the next century.

Voice ergonomic intervention is one tool among others to prevent, treat and relieve voice disorders. There are nowadays plenty of scientific studies and publications on voice ergonomic risk factors.

The book focuses on the effects of noise, indoor climate, working postures, working practices, stress and the need for amplifiers, but also on voice ergonomics in children.

The book gives valuable guidelines to avoid adverse effects of those loading and risk factors.

Knowledge about voice ergonomics on a practical and popular level is sparse, and before this book very little of good voice advice has been available to apply in practice. There is no entire book in English published on this topic so far.

Eeva Sala, MD, PhD, finished a medical doctor degree and received a specialist in ear, nose and throat diseases and a specialist in laryngology (phoniatrics) and obtained her PhD in the field of audiology from Turku University. She is Associate professor (Docent) in Turku University Medical faculty. She is the author of dozens of publications in peer-reviewed articles in the field of voice disorders. She is also an author of several book chapters and books in the field of voice and acoustics. She has been an active international speaker in the voice field. She has had a long career in clinical work and also in occupational medicine.

Leena M. Rantala, PhD, is a senior lecturer at the University of Tampere, Department of Logopedics, Faculty of Social Sciences, and Associate professor in Logopedics, University of Oulu. She graduated as Master of Arts in Logopedics, Doctor of Philosophy, Logopedics, and Docent (Associate professor) at the University of Oulu, Finland. She has done research on voice and she is the author of dozens of publications in peer-reviewed articles in the field of voice disorders. She has been an active international speaker in the voice field. She has taught a large number of courses on voice and voice disorders, voice therapy, occupational voice and voice ergonomics. Additionally, she has supervised several BA and MA theses on voice and at the moment she is supervising two PhD theses on voice ergonomics. She has educated teachers and other groups of persons working in voice demanding occupations.

https://www.cambridgescholars.com/

Eeva Sala, MD, PhD
Docent in phoniatrics
University of Turku
eevasala@gmail.com