Sensory integration and processing in preterm-born children

Ulla Niutanen MSc, OTR

Doctoral Researcher in Clinical Research
Faculty of Medicine, University of Helsinki

New Children's Hospital, Pediatric Research Center,
University of Helsinki and Helsinki University Hospital, Finland

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

What is the evidence of sensory integration and processing impairments in preterm children?

balance
body awareness
motor skills
eye-hand skills
executive functions
sensory reactivity
self-regulation
attention
play skills

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Presentation outline

1. Prematurity
2. Review of research
3. Results
4. Conclusions

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

1. Prematurity

<37 weeks of gestation or

Globally:
Preterm births / year
- 15 million
- 5%–18% of births / country

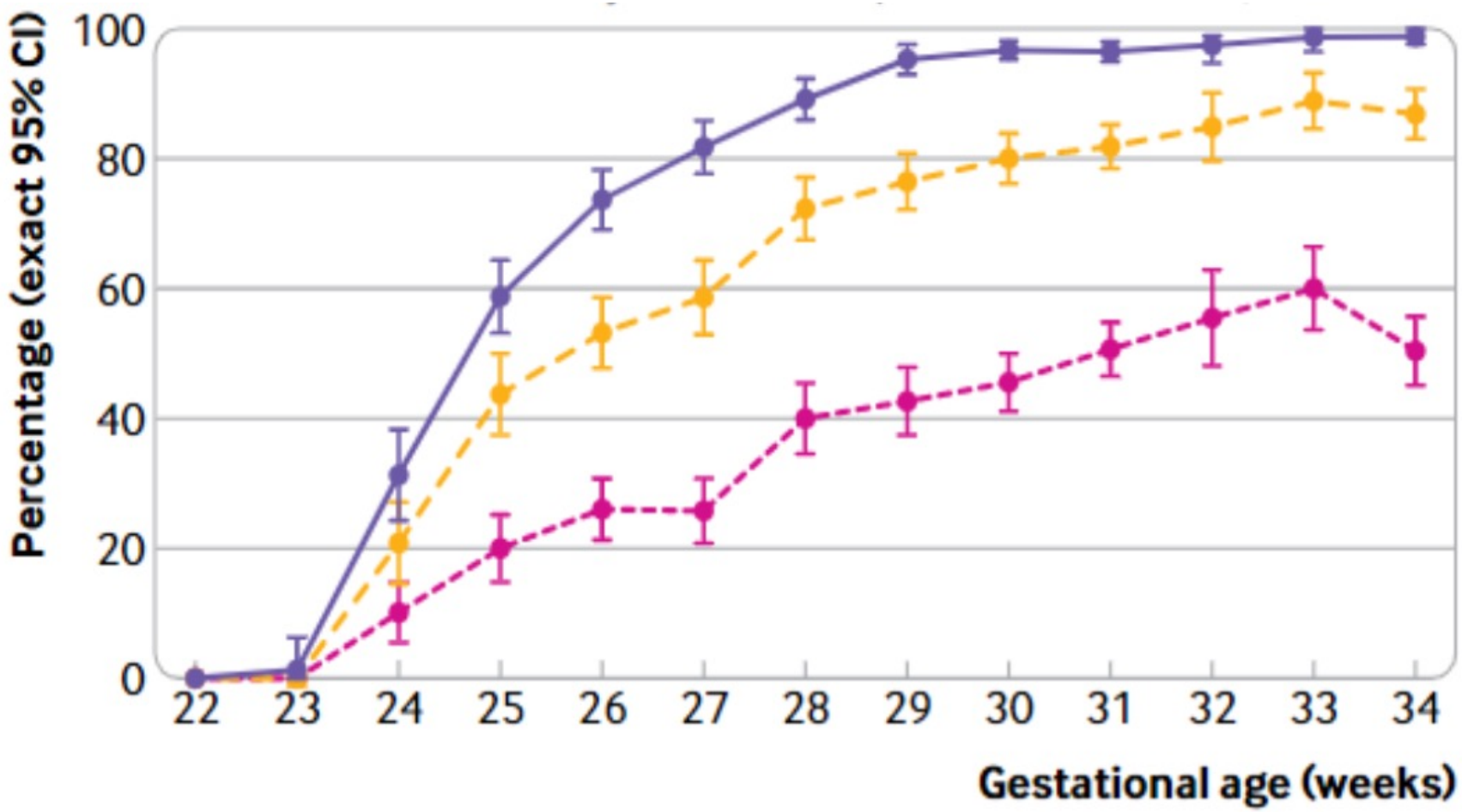
Preterm-born deaths / year
- 1 million

Photo: Hush Naidoo on Unsplash

(Blencowe et al 2012, Chawanpaiboon et al 2019, Walani 2020, WHO 20229

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Gestational age matters



Survival

Survival without moderate or severe disabilities

Survival without any disabilities

EPIPAGE-2 study
(N=4440)
age 5½ years

Pierrat et al 2021, Fig 2.

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

2. Review of research

Systematic search 8 November 2018, update 10 January 2022

34 peer-reviewed articles

Systematic reviews (n=3)

Case-control designs (n=22)

- 2 Randomized Controlled Tria
- 11 Cohorts
- 7 Cross-sectional
- 2 Intervention studies

Single designs (n=9)

- 8 Cohorts
- 1 Cross-sectional

REVIEW ARTICLE

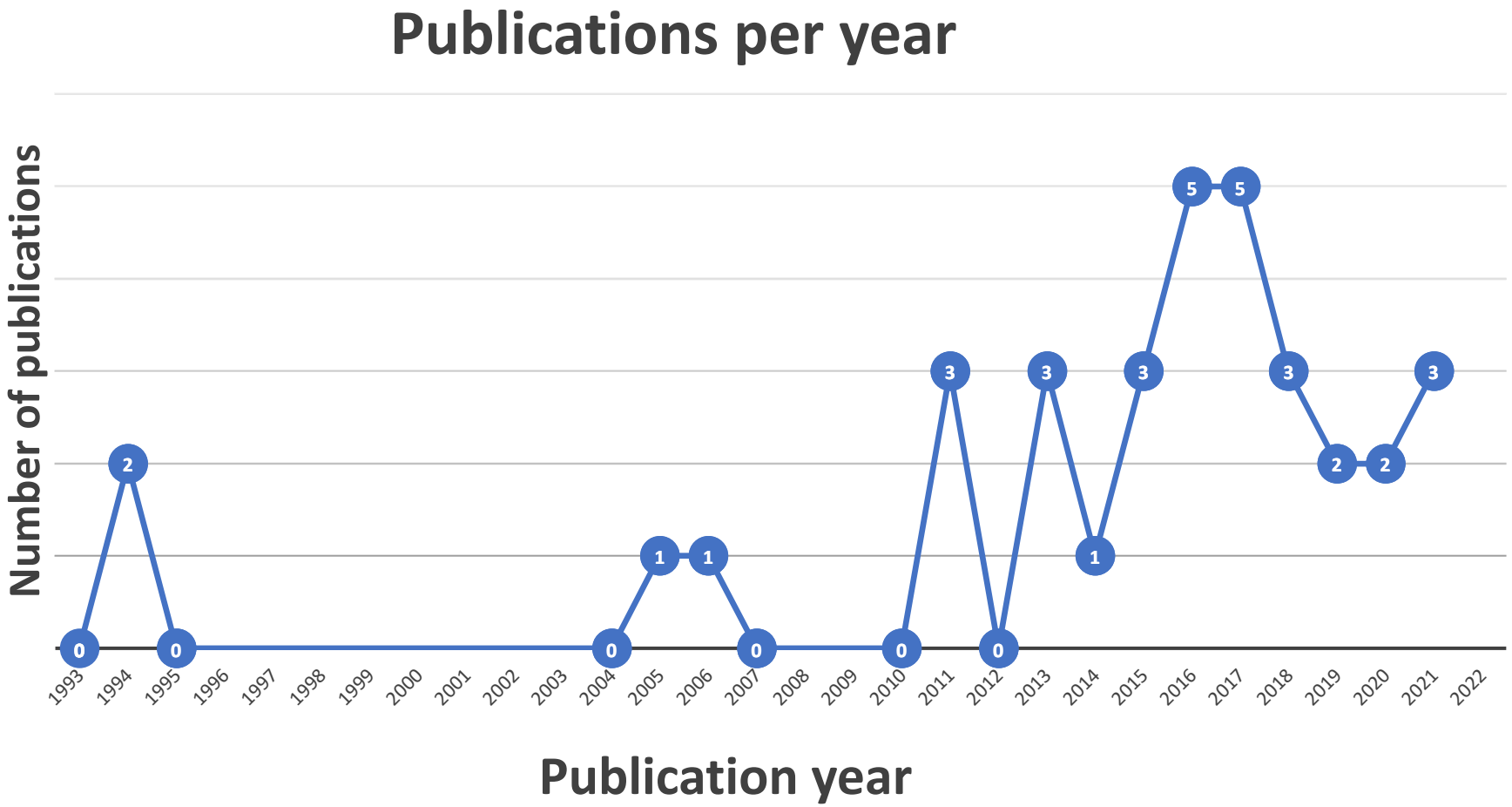
Systematic review of sensory processing in preterm children reveals abnormal sensory modulation, somatosensory processing and sensory-based motor processing

Ulla Niutanen, Toini Harra, Aulikki Lano, Marjo Metsäranta

First published: 27 July 2019 | https://doi.org/10.1111/apa.14953 | Citations: 6

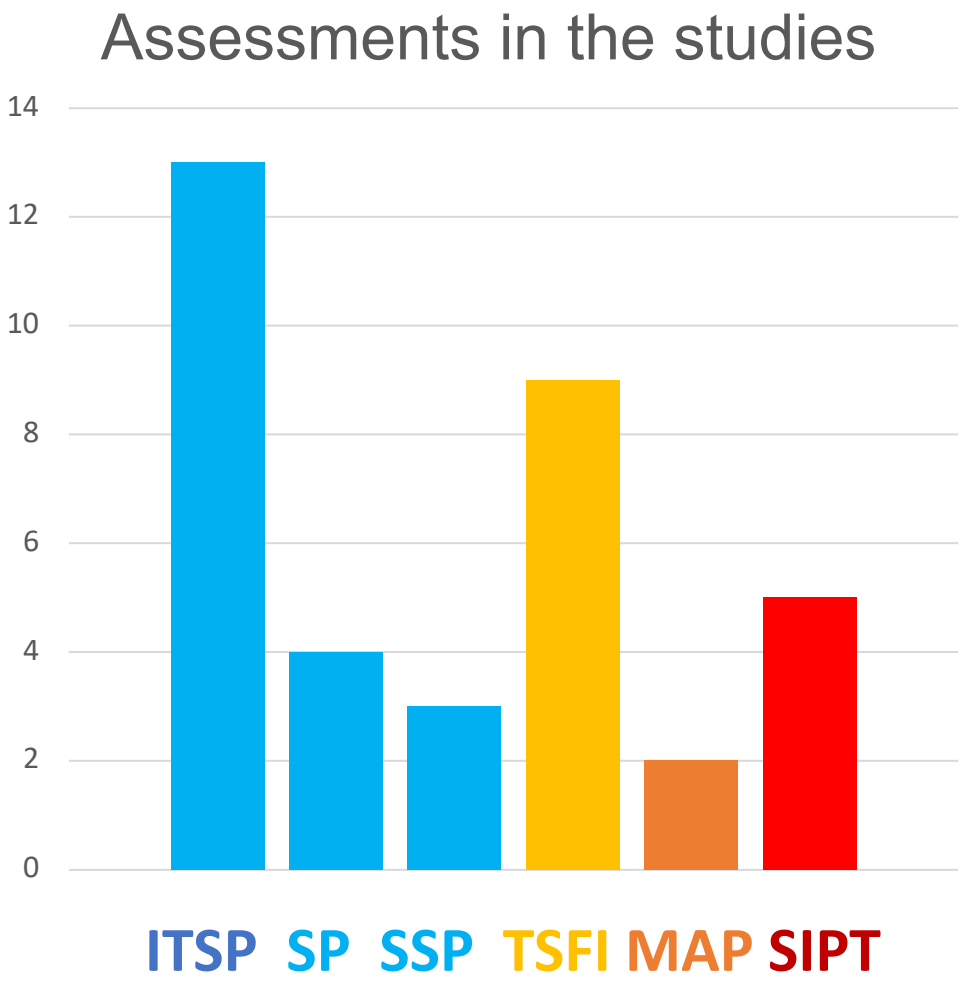
UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Publication years



UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

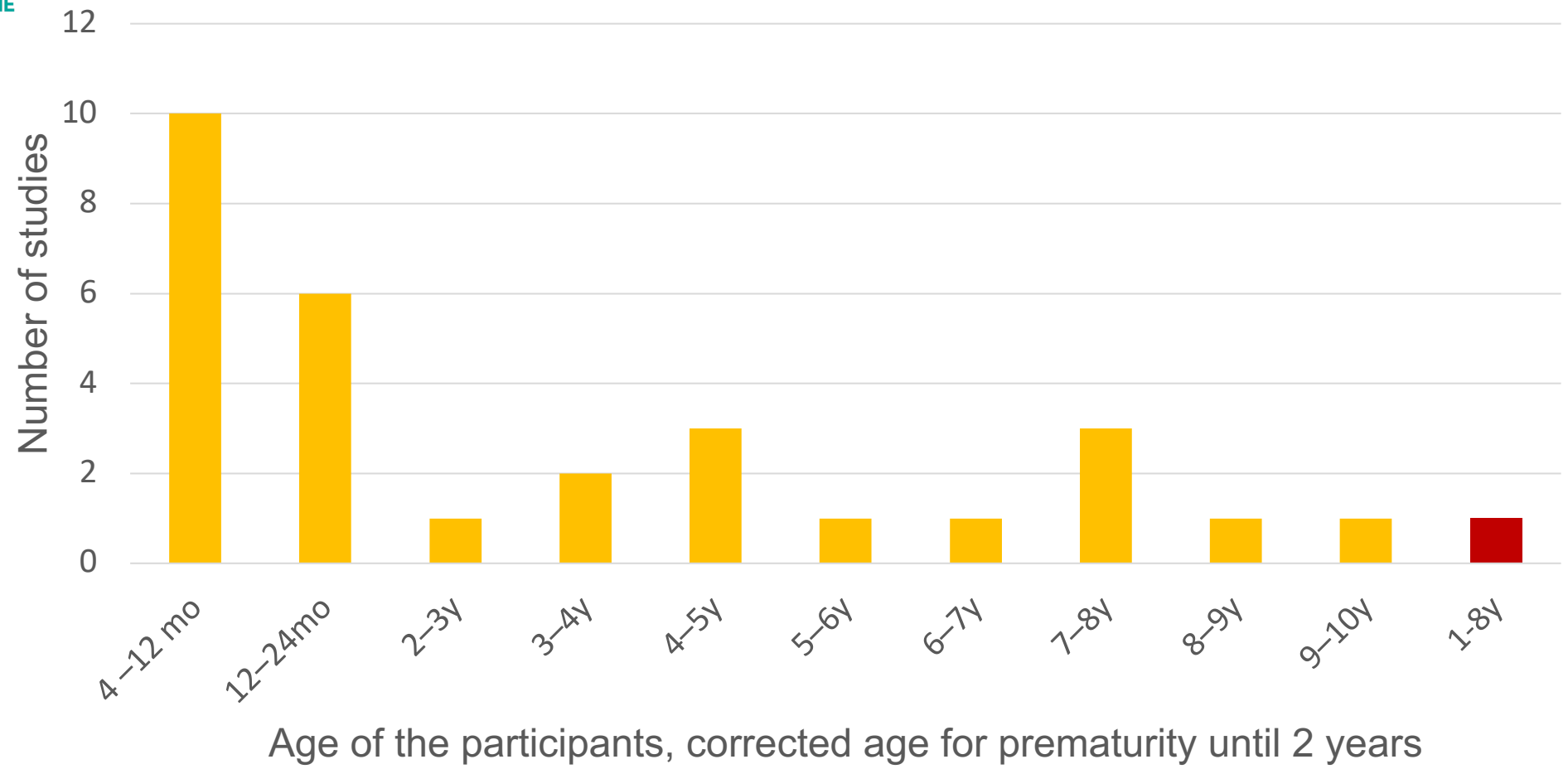
Assessments of sensory integration and processing



- Questionnaires
- Performance assessments

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Age of the participants in the original studies



UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

3. Results

Systematic reviews:

3 studies

1. **Mitchell et al 2015: Signs of sensory processing** in multi-professional assessments of 0–3 year old preterm…
- 45 studies, 295 signs, 44% suggesting difficulties, mostly **over-responsivity**

2. **Bröring et al 2017: Sensory modulation** in preterm…
- 18 studies, incl. 3 population (registry) studies implied, most affected was **low registration**

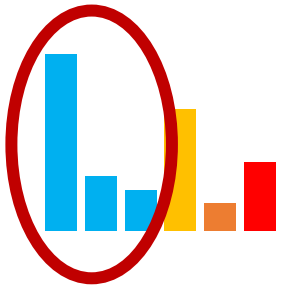
3. **Machado et al 2017: Sensory processing** in preterm…
- 8 studies concluded, preterm birth **is a risk** factor for sensory processing disorder

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Questionnaires

Sensory profiles, SP

ITSP, Toddler SP, age 7–35 months, 48 items, (13 studies)
SP, age 3–10y 11mo, 125 items, (4 studies)
SSP, Short SP, age 3–10y 11mo, 38 items, (3 studies)



20 studies

>1SD* **sensory sections** for preterm vs. term-born children

7%–65%	auditory	0%-12%
16%–46%	visual	
9%–45%	tactile	
18%–61%	vestibular	
18%–36%	oral section	

>1SD* **behavioral response** quadrants for preterm-born children

23%–71% low registration	14%–33% sensation seeking
7%–62% sensory sensitivity	18%–54% sensation avoiding

* SD, standard deviation

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Performance assessments

Test of Sensory Functions in Infants (TSFI)

Infants 4–18 months; 24 Items, 5 domains

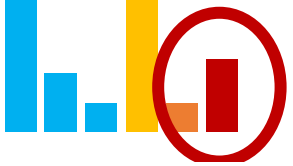
9 studies

Total scores	**preterm**	**term-born infants**
≥ 1SD at-risk	37% – 82%	0% – 22%
≥ 2SD deficient	37% – 73%	0%
Domains ≥ 1SD		
Reactivity to deep tactile pressure	17% – 93%,	0%
Adaptive motor function	18% – 79%	4%
Visual-tactile integration	18% – 33%	0%
Ocular-motor control	12% – 50%	N/A
Reactivity to vestibular stimulation	21% – 80%	0%

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Sensory Integration and Praxis Test, SIPT

17 independent tests (319 items), ages 4y – 8y 11mo



5 studies

Somatosensory processing, preterm-born vs. **term-born** children

Mild to severe dysfunction

-1SD to -3SD	9% – 71%	0% – 30%

Sensory-motor processing, preterm-born vs. **term-born** children

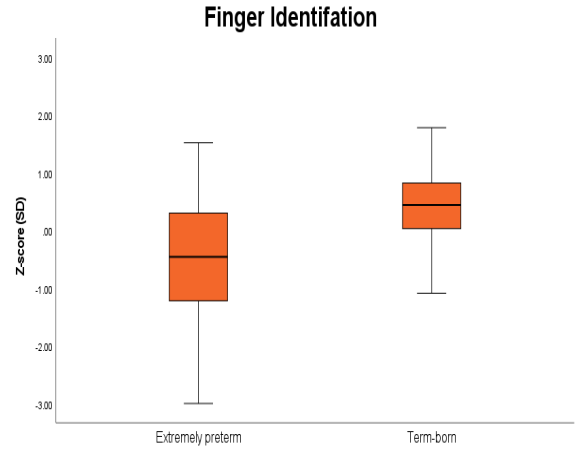
-1SD to -3SD	8% – 40%	3% – 12%

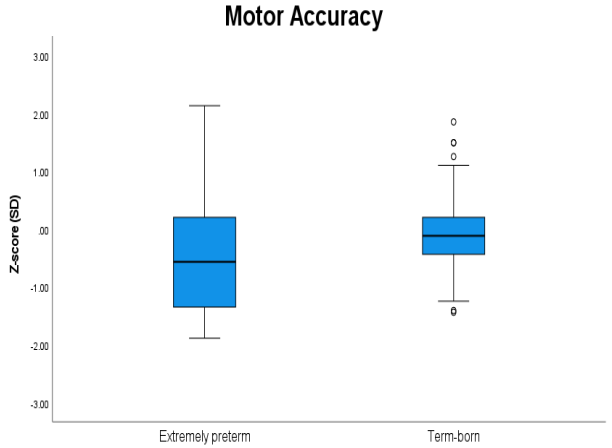
UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

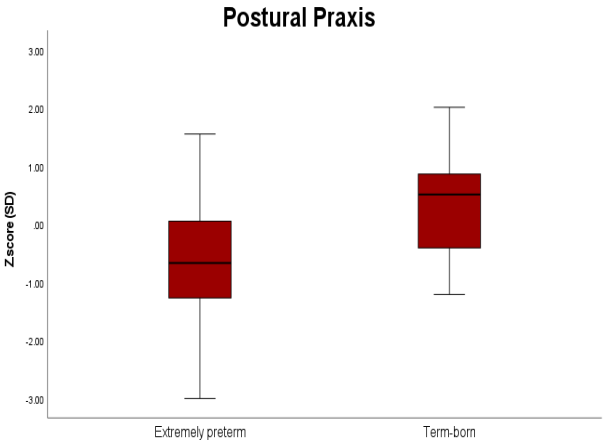
Sensory Integration and Praxis Test, SIPT

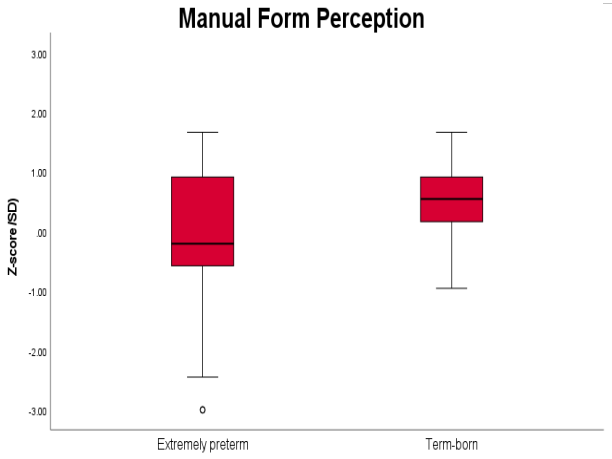
Age 7 years

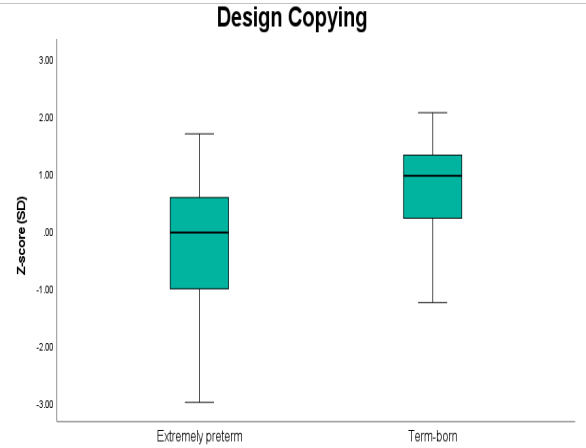
KeKeKe cohort (Lönnberg et al 2018)

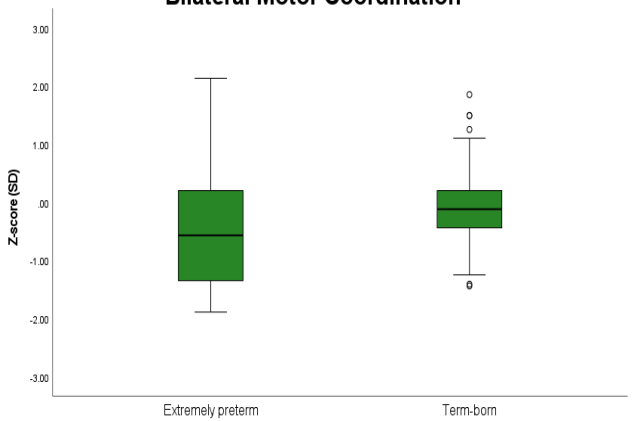










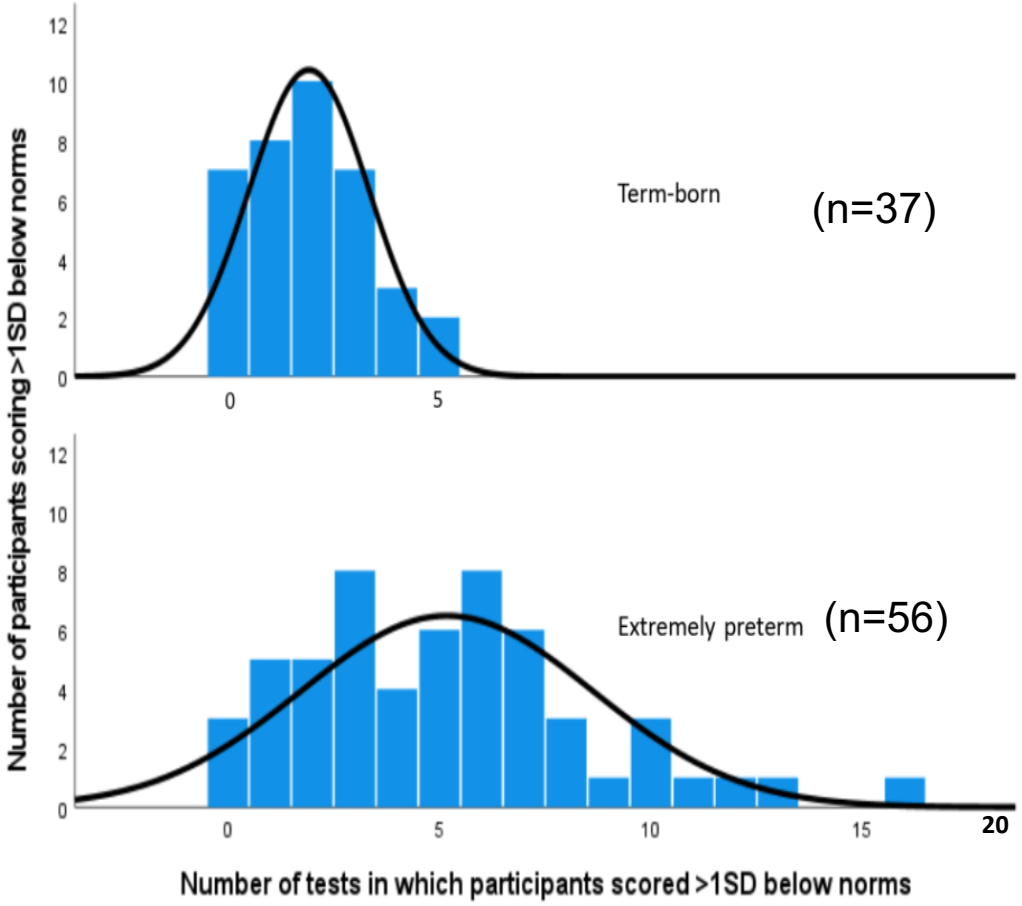


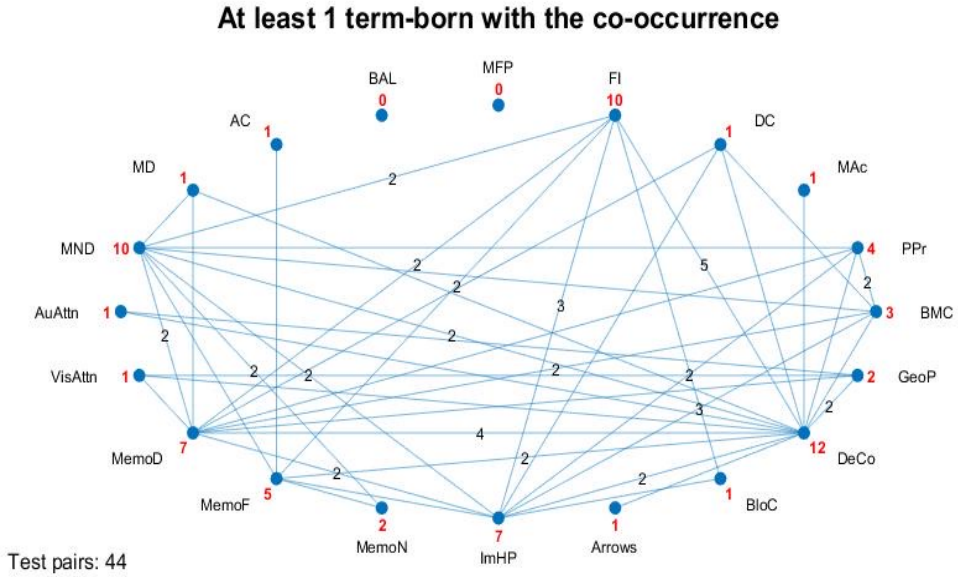
UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

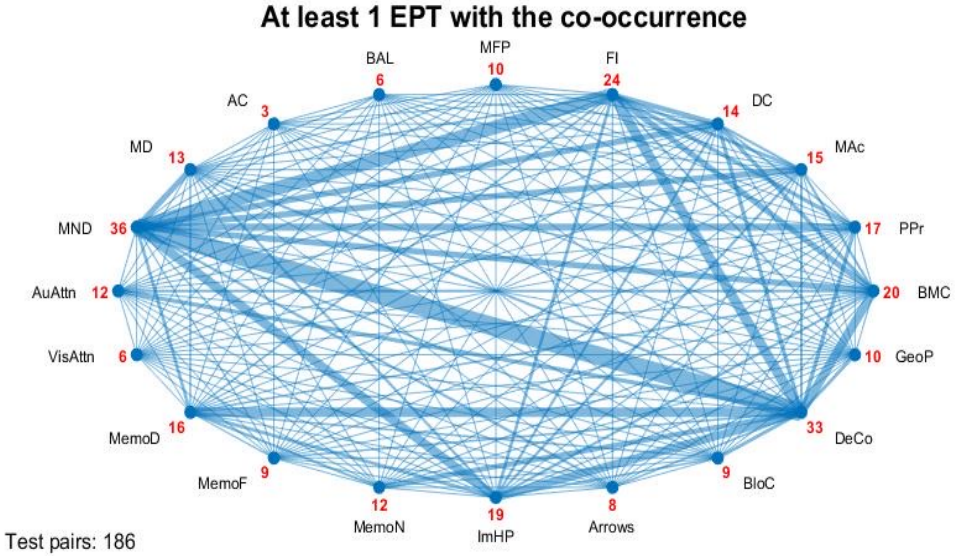
Co-occurring minor neurodevelopmental impairments

Age 6 – 7 years
Comparison ≥1SD in 20 tests:
Touwen neurological examination,
Movement ABC-2, SIPT, NEPSY-II

KeKeKe cohort (Niutanen et al 2022, Manuscript in review)







UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Intervention studies

2 studies

1. **Pekcetin et al 2016**:
   Preterm intervention (n=34) vs. **term-born no-intervention** (n=34)
   8x 45min individualized SI, Age 7mo – 9mo (CA),

2. **Lecuona et al 2017**:
   Preterm intervention (n=12) vs. **Preterm no-intervention** (n=12)
   10x45 min **ASI** (Fidelity), age 4-10 mo CA,

- Post-**intervention scores** improved considerably (p <.001)
  - Adaptive motor functions ↑ (p=0.003)
- Cognitive, language and motor development ↑ (Bayley-III)

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

4. Conclusion

Prematurity affects negatively sensory integration and processing

Strong evidence

- Sensory modulation (28%–87%)
- Sensory-motor processing (9%–70%)

Moderate evidence in

- Somatosensory processing (tactile and proprioception, 20–70%)

Wide variance in nature and severity of impairments

ASI interventions led to positive treatment effect, compared to non-treated control infants

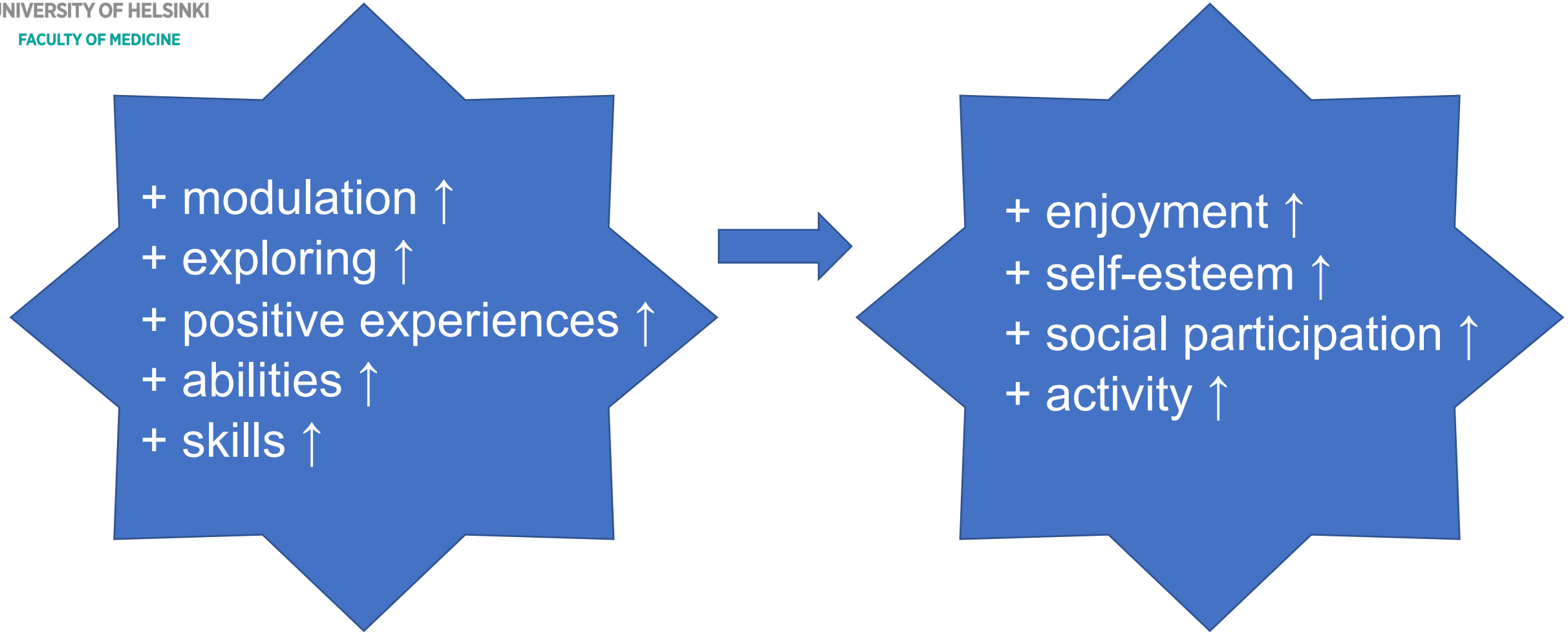
UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Recommendations

- Assessments of sensory integration and processing should become regular routine until school age, at least annually
- SI interventions should be started early
- Continuing regular support is needed for the
  - Child
  - Parents and family network

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Possible gains of follow-up and interventions



UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

Research team

Ulla Niutanen

Piia Lönnberg

Elina Wolford

Toini Harra

Aulikki Lano

Marjo Metsäranta

New Children's Hospital, Pediatric Research Center,
University of Helsinki and Helsinki University Hospital, Helsinki, Finland

Department of Psychology and Logopedics, University of Helsinki,
Helsinki, Finland

Participation and Human Functioning,
Metropolia University of Applied Sciences, Helsinki, Finland

www.slideshare.net/limgengyan/preventing-preterm-labour

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

REFERENCES 1/2

Blencowe, H., Cousens, S., Oestergaard, M. Z., Chou, D., Moller, A. B., Narwal, R., … Lawn, J. E. (2012). National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: A systematic analysis and implications. *The Lancet*, *379*(9832), 2162–2172. https://doi.org/10.1016/S0140-6736(12)60820-4

Chawanpaiboon, S., Vogel, J. P., Moller, A. B., Lumbiganon, P., Petzold, M., Hogan, D., … Gülmezoglu, A. M. (2019). Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. *The Lancet Global Health*, *7*(1), e37–e46. https://doi.org/10.1016/S2214-109X(18)30451-0

Chen, Y. C., Tsai, W. H., Ho, C. H., Wang, H. W., Wang, L. W., Wang, L. Y., … Hwang, Y. S. (2021). Atypical sensory processing and its correlation with behavioral problems in late preterm children at age two. *International Journal of Environmental Research and Public Health*, *18*(12), 1–11. https://doi.org/10.3390/ijerph18126438

de Paula Machado, A. C. C., de Castro Magalhães, L., de Oliveira, S. R., & Bouzada, M. C. F. (2019). Is sensory processing associated with prematurity, motor and cognitive development at 12 months of age? *Early Human Development*, *139*(July), 104852. https://doi.org/10.1016/j.earlhumdev.2019.104852

Lecuona, E., Therapy, M. O., Jaarsveld, A. Van, Therapy, M. O., Raubenheimer, J., Care, B. D., … Africa, S. (2017). *Sensory integration intervention and the development of the premature infant : A controlled trial*. *107*(11), 10–12. https://doi.org/10.7196/SAMJ.2017.v107i11.12393

Lönnberg, P., Niutanen, U., Parham, L. D., Wolford, E., Andersson, S., Metsäranta, M., & Lano, A. (2018). Sensory-motor performance in seven-year-old children born extremely preterm. *Early Human Development*, *120*(January), 10–16. https://doi.org/10.1016/j.earlhumdev.2018.03.012

Maitre, N. L., Key, A. P., Slaughter, J. C., Yoder, P. J., Neel, M. L., Richard, C., … Murray, M. M. (2020). Neonatal Multisensory Processing in Preterm and Term Infants Predicts Sensory Reactivity and Internalizing Tendencies in Early Childhood. *Brain Topography*, *33*(5), 586–599. https://doi.org/10.1007/s10548-020-00791-4

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

REFERENCES 2/2

Mclean, M. A., Niknafs, N., Scoten, O. C., Chau, C. M. Y., Mackay, M., Weinberg, J., … Grunau, R. E. (2021). Sensory processing and cortisol at age 4 years : Procedural pain-related stress in children born very preterm. *Developmental Psychology*, *63*, 915–930. https://doi.org/10.1002/dev.22079

Niutanen, U., Harra, T., Lano, A., & Metsäranta, M. (2020). Systematic review of sensory processing in preterm children reveals abnormal sensory modulation, somatosensory processing and sensory-based motor processing. *Acta Paediatrica*, *109(1)*(Jan), 45–55. https://doi.org/10.1111/apa.14953

Pekçetin, S., Akı, E., Üstünyurt, Z., & Kayıhan, H. (2016). The efficiency of sensory integration interventions in preterm infants. *Perceptual and Motor Skills*, *123*(2), 411–423. https://doi.org/10.1177/0031512516662895

Pekçetin, S., Saridaş, B., Üstünyurt, Z., & Kayihan, H. (2019). Sensory-processing patterns of preterm children at 6 years of age. *Infants and Young Children*, *32*(1), 33–42. https://doi.org/10.1097/IYC.0000000000000131

Pierrat, V., Marchand-Martin, L., Marret, S., Arnaud, C., Benhammou, V., Cambonie, G., … Ancel, P. Y. (2021). Neurodevelopmental outcomes at age 5 among children born preterm: EPIPAGE-2 cohort study. *The BMJ*, *373*. https://doi.org/10.1136/bmj.n741

Who. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/preterm-birth. Accessed 22.03.2022

Vlaeminck, F., Vermeirsch, J., Verhaeghe, L., Warreyn, P., & Roeyers, H. (2020). Predicting cognitive development and early symptoms of autism spectrum disorder in preterm children: The value of temperament and sensory processing. *Infant Behavior and Development*, *59*(March 2019), 101442. https://doi.org/10.1016/j.infbeh.2020.101442

Walani, S. R. (2020). Global burden of preterm birth. *International Journal of Gynecology and Obstetrics*, *150*(1), 31–33. https://doi.org/10.1002/ijgo.13195

Yardımcı-Lokmanoğlu, B. N., Mutlu, A., & Livanelioğlu, A. (2021). The early spontaneous movements, and developmental functioning and sensory processing outcomes in toddlers born preterm: A prospective study. *Early Human Development*, *163*(May). https://doi.org/10.1016/j.earlhumdev.2021.105508

UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

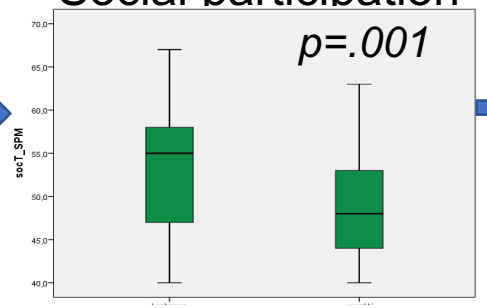
UNIVERSITY OF HELSINKI
FACULTY OF MEDICINE

+ Sensory Processing Measure, SPM?

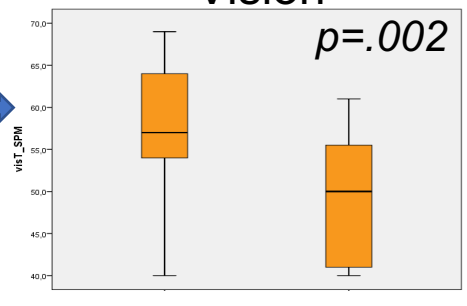
KeKeKe cohort, extremely preterm (EPT) <28 gwk (Niutanen et al 2022, Manuscript in preparation)

Age 7 years

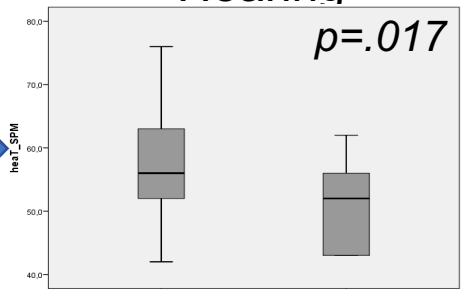
Social participation



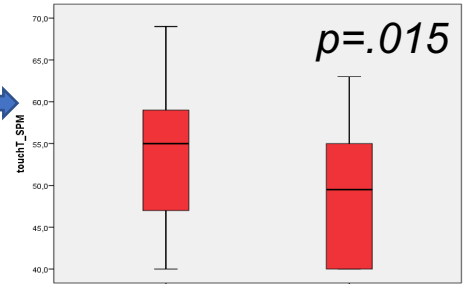
Vision



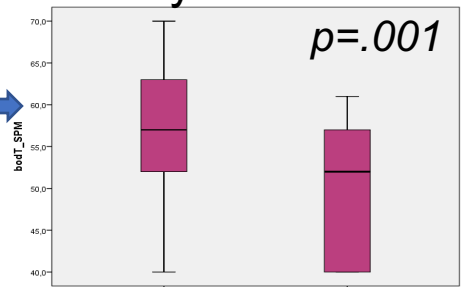
Hearing



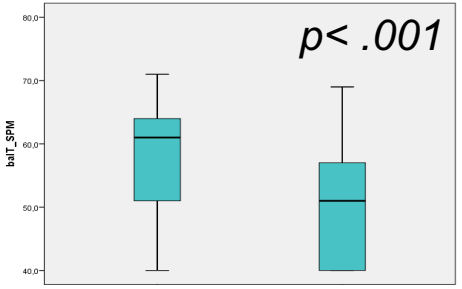
Touch



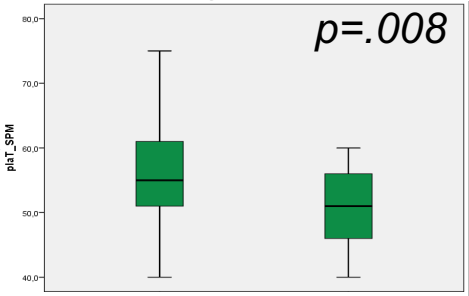
Body awareness



Balance and motion



Planning and ideas



- T score ≥ 60 Possible problems
- T score ≥ 70 Definite problems