REGIONAL MEETING ON EARLY CHILDHOOD DEVELOPMENT MEASUREMENTS IN SOUTHERN AND EASTERN AFRICA
24-27 October 2023 KIGALI, RWANDA

Latest developments in measuring child development

Sunil Sazawal
Center for Public Health Kinetics

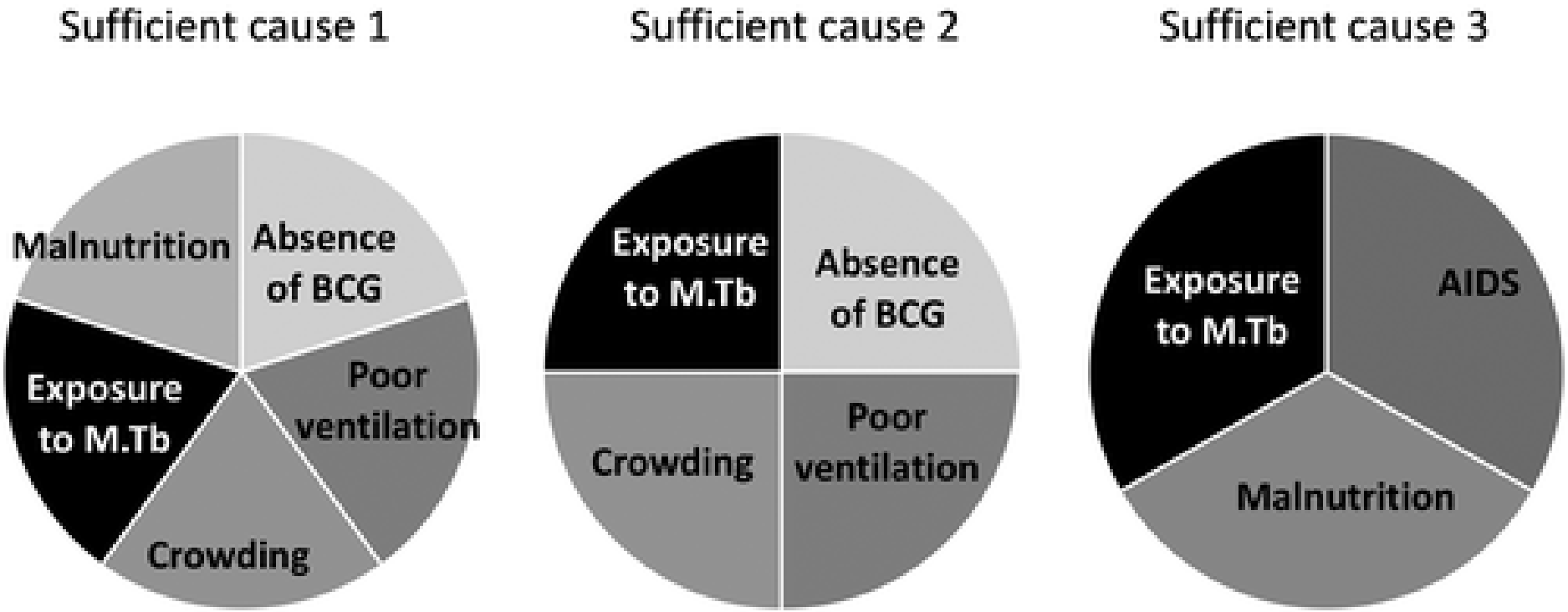
World Health Organization

CPHK
Catalysing Improved Health Research & Policy

Separating child development from Growth faltering and Stunting –

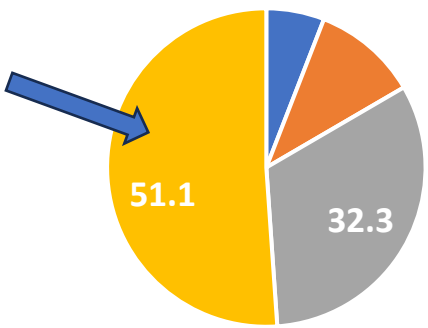
Taller is not always smarter

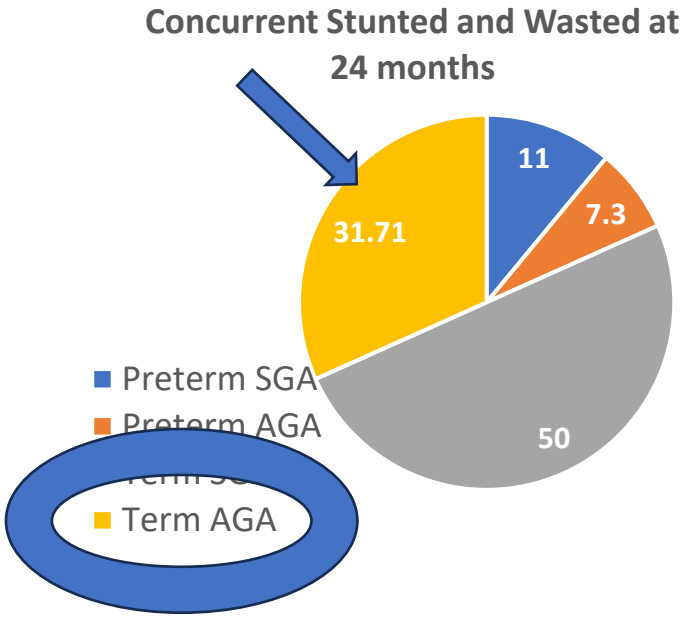
Sufficient Causes of Tuberculosis

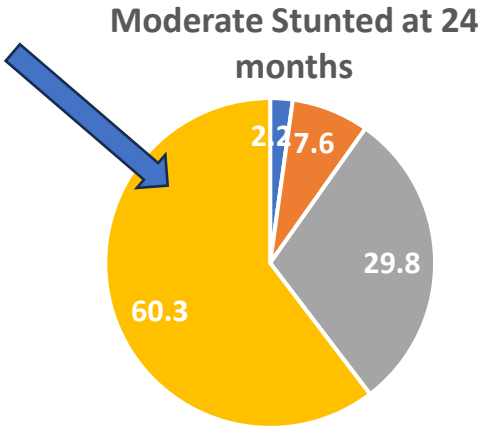


The oxidative stress theory of disease: levels of evidence and epistemological aspects. **British Journal of Pharmacology, Volume: 174, Issue: 12, Pages: 1784-1796, First published: 18 July 2016, DOI: (10.1111/bph.13544)**

Etiological Fraction: Nutritional Status at 24 months







Risk of NDD at 24 months: By birth Characteristics and nutritional status at 6 months

		<-2 DAZ (Yes/No)
Predictors	(%)	RR (95% CI)
Birth Characteristics		(n=232)
PT+SGA (n=67)	13.4	2.08 (1.10-3.91)*
PT+AGA (n=223)	14.8	2.29 (1.60-3.28) §
TRM+SGA (n=704)	9.9	1.54 (1.16-2.04) †
TRM+AGA (n=1856)	6.5	Ref
Nutritional Status at 6 Months		(n=235)
Stunted (n=540)	11.1	1.60 (1.20-2.13) †
Wasted (n=213)	12.7	1.82 (1.24-2.68) †
Underweight (n=457)	14.9	2.14 (1.63-2.81) §
Normal (n=2058)	7.0	Ref

Risk of NDD at 24 months: By birth Characteristics

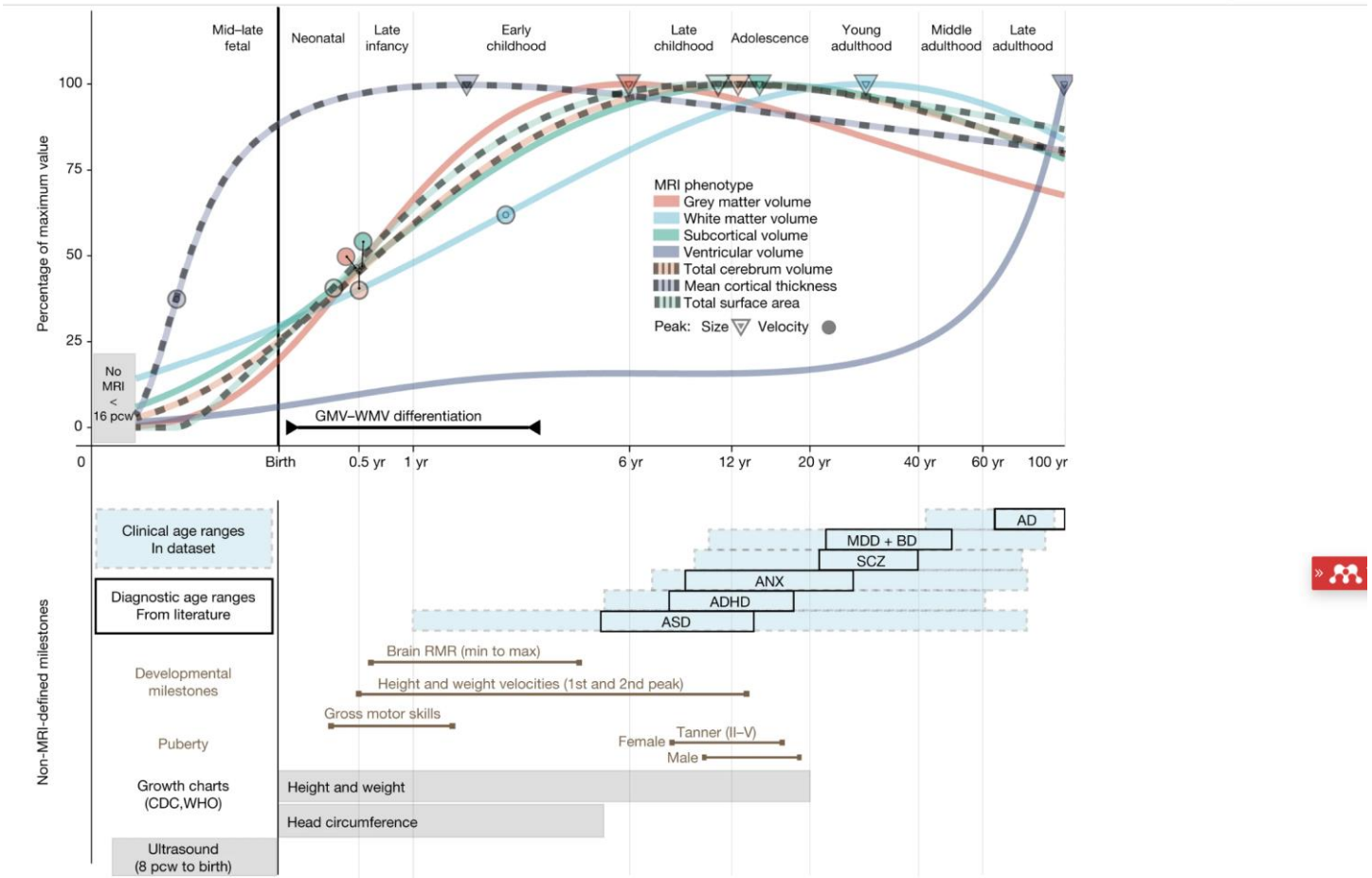
Birth Status	Total	n	% NDD (among birth status)	% among NDD @24 months
PT+SGA	67	9	13.4%	4%
PT+AGA	223	33	14.8%	14%
TRM+SGA	704	70	9.9%	30%
TRM+AGA	1856	120	6.5%	52%
TOTAL	**2850**	**232**	**8.1%**	**100%**

Risk of NDD at 24 months: By nutritional status at 6 months

Birth Status	Total	NDD (n)	% NDD (among status at 6 months)	% among NDD @24 months
Stunted	540	60	11%	26%
Wasted	213	27	13%	12%
Underweight	457	68	15%	29%
Normal	2058	143	7%	62%
TOTAL	**3268**	**298**	**9%**	**100%**

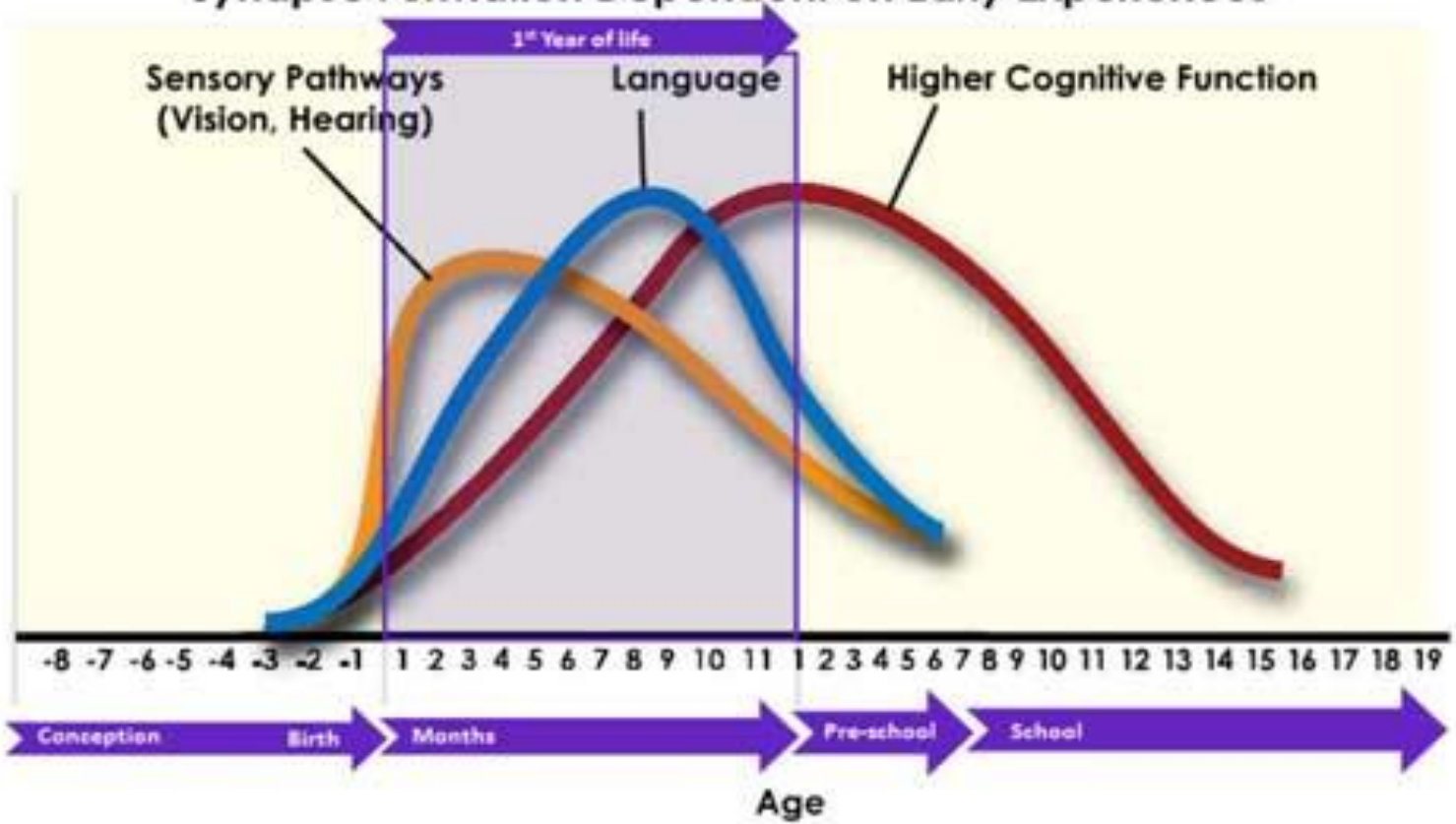
Newer tools for measuring child development

Neurodevelopmental milestones: Brain charts for the human lifespan

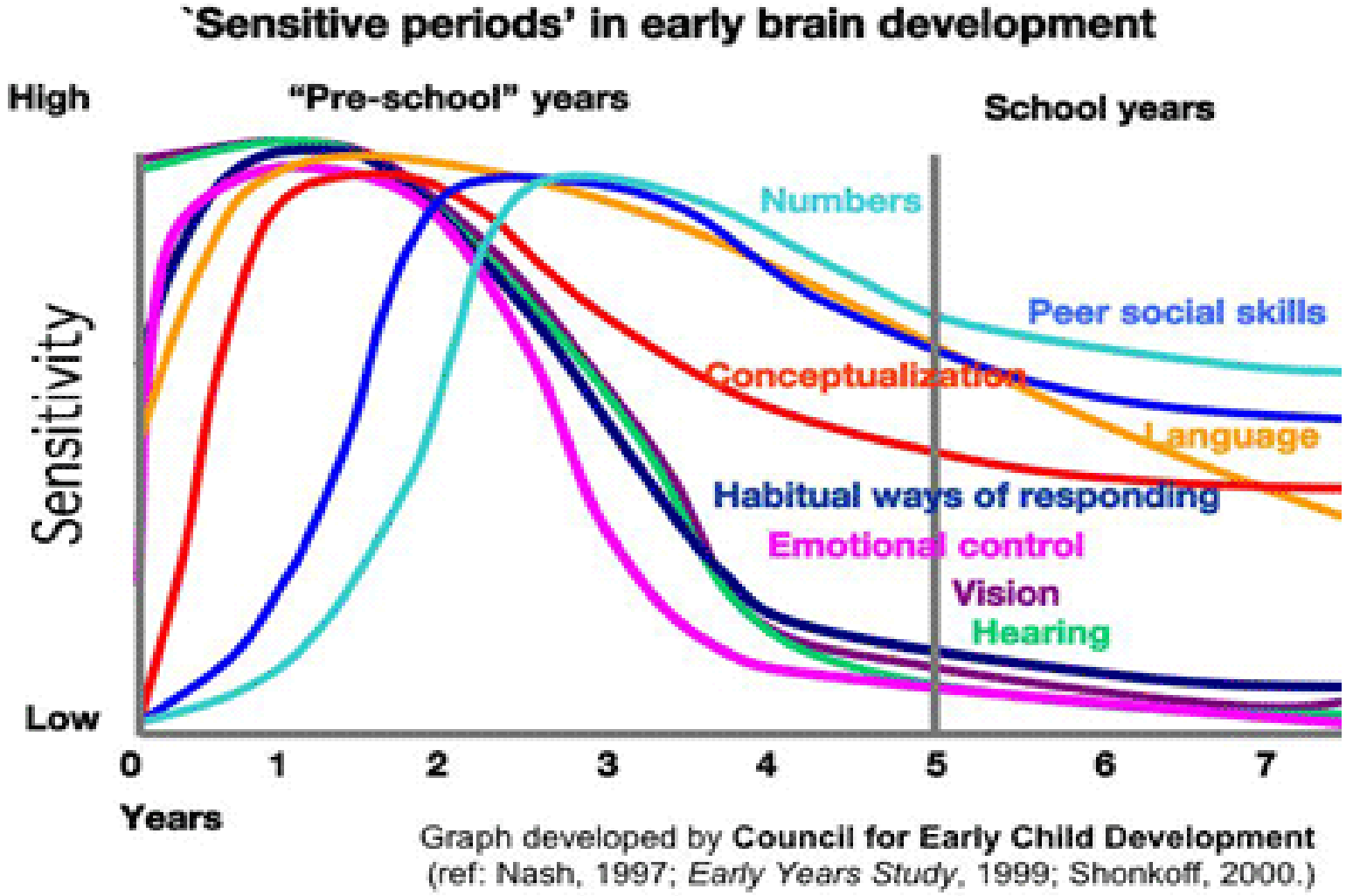


Human Brain Development

Synapse Formation Dependent on Early Experiences



Source: Nelson, C. A., in *Neurons to Neighborhoods* (2000). Shonkoff, J. & Phillips, D. (Eds.)


`Sensitive periods' in early brain development
High
"Pre-school" years
School years
Numbers
Peer social skills
Conceptualization
Language
Habitual ways of responding
Emotional control
Vision
Hearing
Sensitivity
Low
0
1
2
3
4
5
6
7
Years
Graph developed by Council for Early Child Development
(ref: Nash, 1997; Early Years Study, 1999; Shonkoff, 2000.)

What drives search for newer measurements?

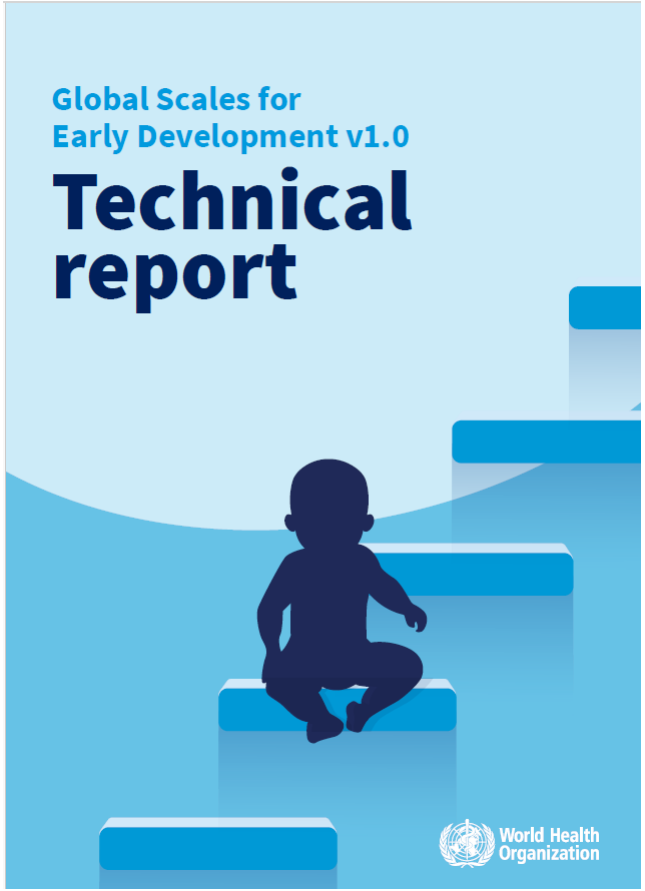
A) Assessment tests that are

- Less prone to cultural bias, measurement bias. - can be tailored to local context
- Local standardized norms available
- Easy to administer- with minimal training
- With good predictive validity
- Relatively cheaper or freely available

B) Assessments that could shed light on

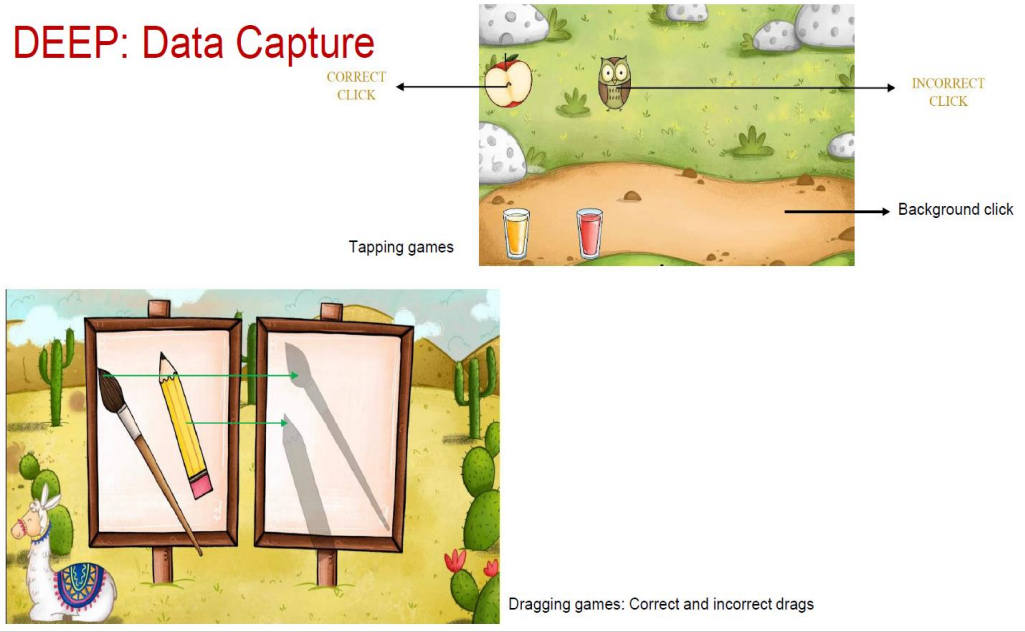
- How early experiences affect brain development
- Reveal neurobiological processes affected or resilient to early exposures
- Relate structure to function and track improvement

- For population and programmatic level
  - Valid globally
  - Easy to administer with limited training
  - Easy to interpret and open access
- For children aged under three years
- Takes into account- cognition, motor, language and socio-emotional skills
- Generate D- score/DAZ scores (Preliminary)



Electronic testing and data recording

- Laptops, tablets, and smartphones for conducting computerized cognitive tests
- Child interacts directly with the device
- Child's score calculated on the accuracy and speed of responses
- Administered to children as young as age four years



Courtesy: SANGATH, DELHI

Cambridge Neuropsychological Test Automated Battery

From Wikipedia, the free encyclopedia

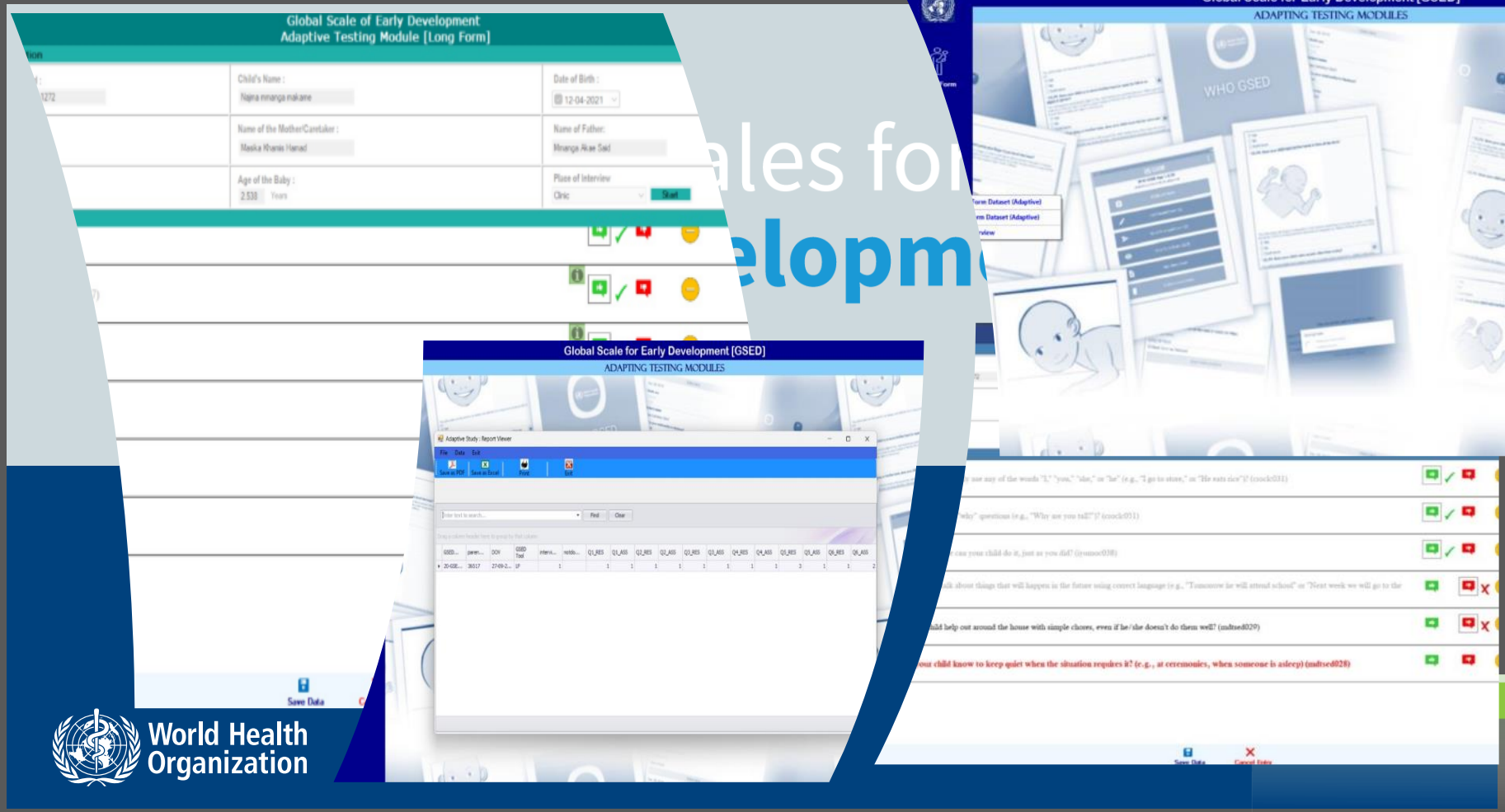
Cambridge Neuropsychological Test Automated Battery	
Purpose	cognitive assessment

The **Cambridge Neuropsychological Test Automated Battery** (**CANTAB**),[1] originally developed at the University of Cambridge in the 1980s but now provided in a commercial capacity by Cambridge Cognition, is a computer-based cognitive assessment system consisting of a battery of neuropsychological tests, administered to subjects using a touch screen computer. The CANTAB tests were co-invented by Professor Trevor Robbins and Professor Barbara Sahakian.[2][3][4] The 25 tests in CANTAB examine various areas of cognitive function,[5][6][7][8][9][10][11][12] including:

- general memory and learning,
- working memory and executive function,
- visual memory,
- attention and reaction time (RT),
- semantic/verbal memory,
- decision making and response control.

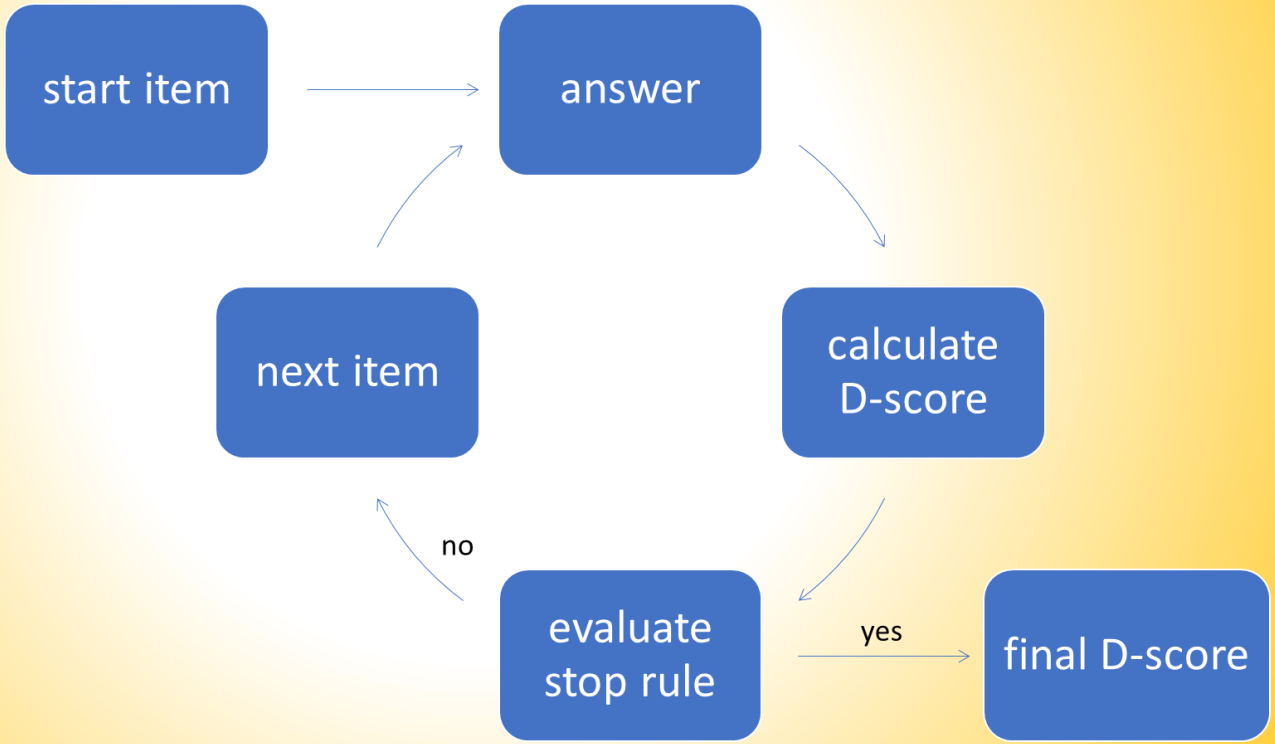
The CANTAB combines the accuracy and rigour of computerised psychological testing whilst retaining the wide range of ability measures demanded of a neuropsychological battery. It is suitable for young[13] and old[14] subjects, and aims to be culture and language independent through the use of non-verbal stimuli in the majority of the tests.

The CANTAB PAL touchscreen test, which assesses visual memory and new learning, was included in a REF submission at the University of Cambridge. This submission (which included research from across the University unrelated to CANTAB PAL) received a 4* grade from the Research Excellence Framework (REF) 2014.[*citation needed*] CANTAB and CANTAB PAL were highlighted in the Medical Schools Council 'Health of the Nation' 2015 publication.[15]



World Health Organization

Adaptive GSED



Evaluating Adaptive GSED Field test

- Adaptive and fixed test within a week

	Short Form	Long Form
Bangladesh	473	473
Pakistan	462	458
Tanzania	473	471

- Adaptive test D-score versus Fixed test D-score
- Leniency and user experience
- Administration time and user experience

Comparison of Average Assessment time of GSED tools (full vs adaptive) by age group.

	Mean duration (minutes)			
Age Group	**SF (Full)**	**SF (Adaptive)**	**LF (Full)**	**LF (Adaptive)**
0 to 6 months	12	-	26	-
7-12 months	15	4	41	12
13-24 months	13	3	48	14
>24 months	11	3	56	17

Conclusions

- ✓**Measurements made by the adaptive and fixed tools are unbiased and close for both SF and LF. A formal equivalence test confirmed these findings.**
- ✓**The adaptive test is evaluated positively and is easy to administer.**
- ✓**Both adaptive tests were short: 3 to 5 minutes for SF and 10 to 14 minutes for LF.**

Structural MRI

Non-invasive

Brain Dev. 2021 Mar;43(3):363-371. doi: 10.1016/j.braindev.2020.11.002. Epub 2020 Nov 22.

Transient structural MRI patterns correlate with the motor functions in preterm infants

Low motor performance at 1-year corrected age associated with the poor visibility of sagittal strata on MRI done at 40 weeks of term-equivalent age

cortical and subcortical structures

- Comparisons of volume and density
- Any diffuse changes

frontiers | Frontiers in Neurology

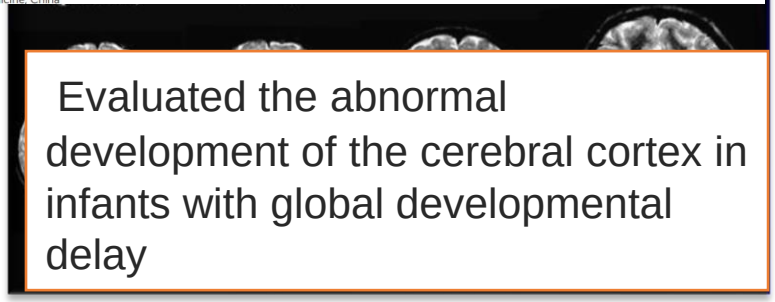
TYPE Original Research
PUBLISHED 18 August 2022
DOI 10.3389/fneur.2022.952405

Check for updates

OPEN ACCESS

EDITED BY
Yihuai Zou,
Beijing University of Chinese Medicine, China

A structural MRI study of global developmental delay in infants (<2 years old)



Evaluated the abnormal development of the cerebral cortex in infants with global developmental delay

Functional Magnetic Resonance Imaging

Asian J Psychiatr. 2020 Apr;50:101945. doi: 10.1016/j.ajp.2020.101945. Epub 2020 Feb 11.

Study of functional magnetic resonance imaging (fMRI) in children and adolescents with specific learning disorder (dyslexia)

Sambhu Prasad [1], Rajesh Sagar [2], S Senthil Kumaran [3], Manju Mehta [4]

reactions and stimuli

Participants with dyslexia fail to use normal brain regions specialized in language processing, but rather use different areas

Using fMRI to Investigate Memory in Young Children Born Small for Gestational Age

Henrica M. A. de Bie, Michiel B. de Ruiter, Mieke Ouwendijk, Kim J. Oostrom, Marko Wilke, Maria Boersma, Dick J. Veltman, Henriette A. Delemarre-van de Waal †

Published: July 1, 2015 • https://doi.org/10.1371/journal.pone.0129721

Decreased memory related activity in posterior parahippocampal gyrus as well as the hippocampus proper in SGA, compared to AGA babies

the brain are involved in a particular mental process

BOLD- Blood Oxygenation Level Dependent signal

Functional MRI of a 12-month-old child depicting visual activity in the striate cortex

Functional Near Infrared Spectroscopy (fNIRS)

Early adversity in rural India impacts the brain networks underlying visual working memory

Sobanawartiny Wijeakumar, Aarti Kumar, Lourdes M. Delgado Reyes, Madhuri Tiwari, John P. Spencer

First published: 25 February 2019 | https://doi.org/10.1111/desc.12822 | Citations: 33

Children (aged 4-48 months) from families with low maternal education and income showed weaker brain activity in working memory areas in the left frontal cortex.

the newborn stage through childhood

Open Access Article

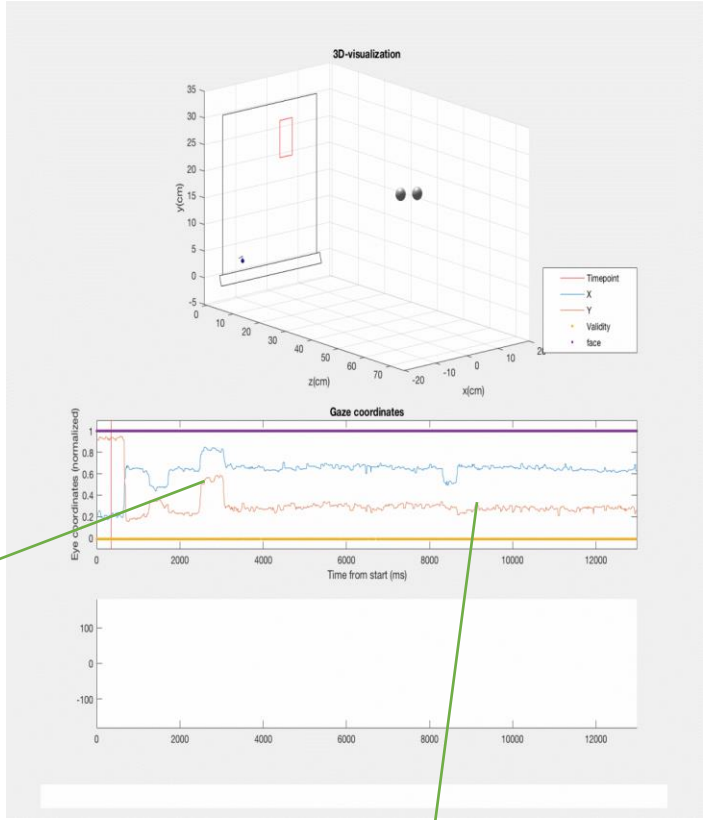
Tablet Use Affects F … S Evidence from the Dimension …

by Hui Li [1,*], Danda … Sha Xie [4] and Chunqi Chang [2,*]

Examined th … f tablets on pr … function; 'no … the 'heavy-u … executive fu …

Courtesy: Bangladesh Early Adversity Neuroimaging (BEAN) Project

Eye tracking



Saccades
- Latency
- Amplitude (accuracy)
- Duration, velocity

Fixations
- Duration
- Spatial distribution

Eye tracking

Measures looking behaviour (location, duration, and shifting of gaze as the child views pictures or videos)

Control of attention and gaze involves areas of brain that are also associated with higher level of cognition (occipital, temporal, parietal and frontal cortices, limbic system)

Likely to be affected by interventions, producing measurable and significant findings

Article

Long-Chain Polyunsaturated Fatty Acid Supplementation in Infancy Reduces Heart Rate and Positively Affects Distribution of Attention

In this randomized trial of docosahexaenoic acid (DHA) supplementation in infancy:

- No differences between intervention groups on Bayley scores at age 18 months.
- Group differences found in sustained attention using a visual habituation task

Evoked/Event Response Potentials (ERPs)

- Non-invasive
- Electrode sensors measure changes in the electrical activity of cortical neurons
  - Latency
  - Amplitude (of the voltage)
  - Scalp distribution

- Highly accurate temporal information
- Difficult to identify spatially the source of the activity within the brain

Original Research Article

Effects of iron supplementation on neural indices of habituation in Bangladeshi children

Examined the effects of supplementation with iron on neural indices of habituation using auditory event-related brain potentials (ERPs)- No effect noted

ltage wave-forms)
nitive, or motor stimuli

Data Collection: PDC vs EDC

Technological Advancement: USG Machines

- Large machine size
- Operation requires a highly skilled and experienced sonographer.

- Portable machine, but still requires a full clinical setup
- Operation requires a trained medical personnel

- Handheld Device
- Can be operated by semi-skilled community workers
- AI based algorithm

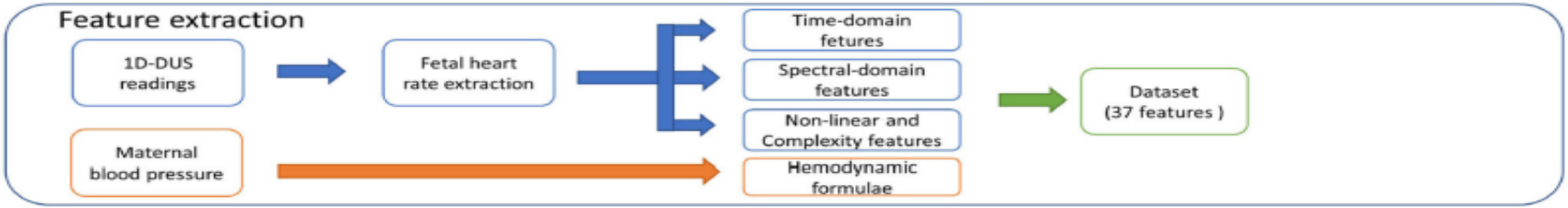
Testing a low-cost Identification of gestational age, fetal growth restriction and placental insufficiency using newly developed, portable, low-cost technologies

Pilot testing a novel system developed by Clifford et al ,

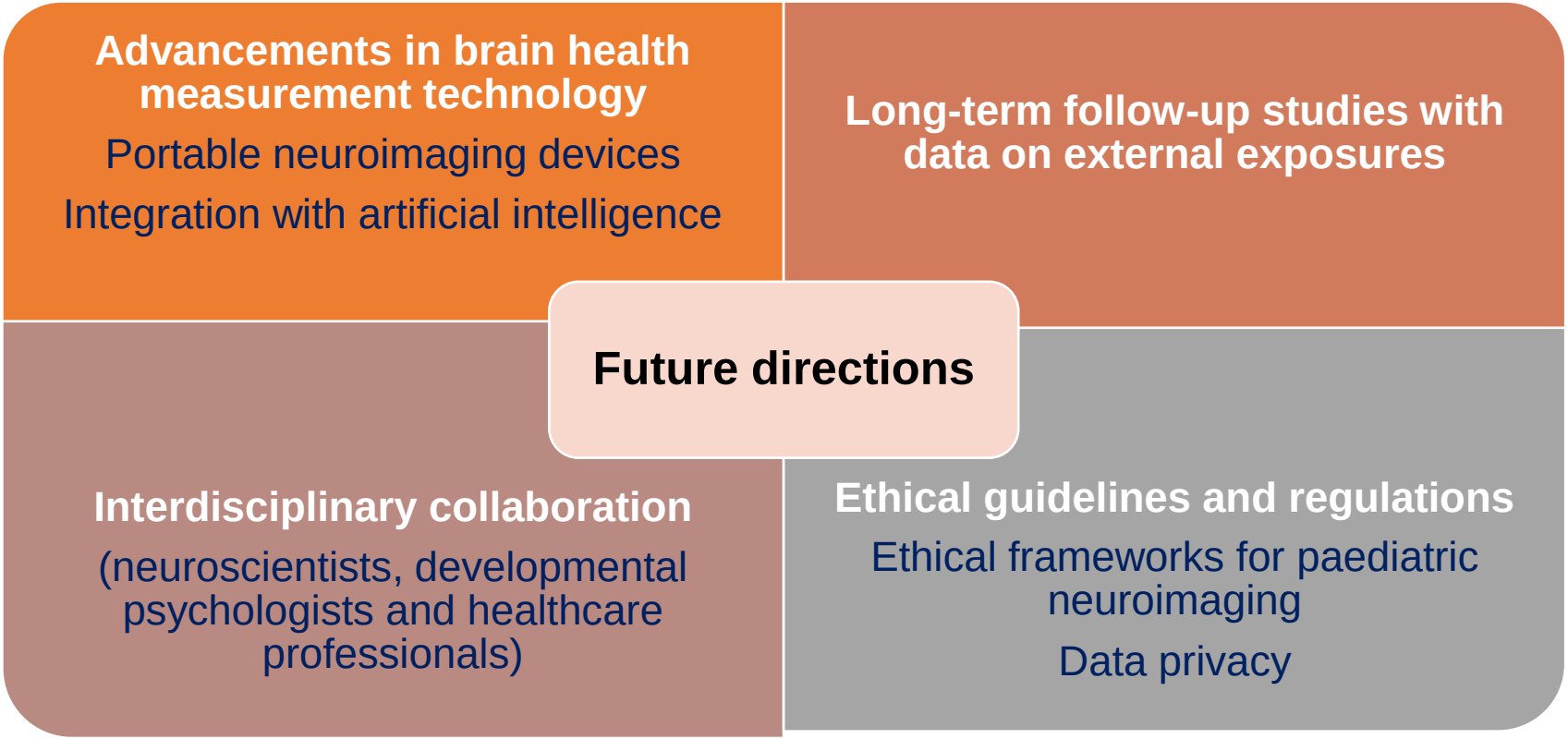
A low-cost one-dimensional ultrasound audio recording to identify IUGR and placental insufficiency in 2nd and 3rd trimester

Develop algorithms for the estimation of Gestational age, IUGR and Placental insufficiency based on 5-10 mins of audio recording.

If successful use preliminary data for full scale community testing in Pemba



Way forward


Advancements in brain health measurement technology
Portable neuroimaging devices
Integration with artificial intelligence
Long-term follow-up studies with data on external exposures
Future directions
Interdisciplinary collaboration
(neuroscientists, developmental psychologists and healthcare professionals)
Ethical guidelines and regulations
Ethical frameworks for paediatric neuroimaging
Data privacy