Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

The Irish Longitudinal Study on Ageing:

IMPACTING SCIENCE and TECHNOLOGY

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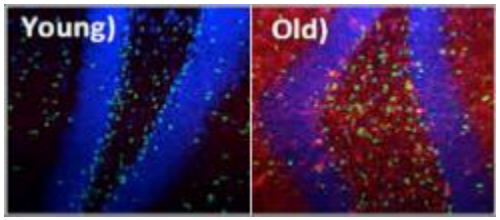
Health Innovation in Ageing



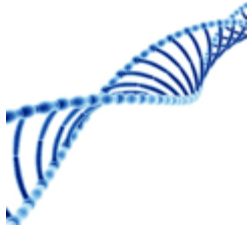
Innovation in understanding ageing process
- mathematical analysis, biomedical methods, genetics

Technological change
- Precision measurement, better evidence
- role of technology is to improve the cost-effectiveness of delivery of care, not to replace it.

$$f(z_0) = \frac{1}{2\pi i}\oint_C \frac{f(z)}{z - z_0}\,dz$$

Substitution of old treatments with novel ones
- improved health outcomes

$$\oint_C f(z)\,dz = 2\pi i \sum_n \operatorname{Res}\left[f(z_n)\right]$$



Expansion of innovative treatments
- Increase in diagnosed and treated patients, improved health outcomes
- demand & supply match

Business & growth opportunities
- pharmaceutical, medical devices & products sectors

TILDA: Precision measurement → better evidence

Health screening of functional and cognitive abilities

Questionnaire data

- wide-ranging

Health Centre data

- **Cognition/Neuropsychological**
- **Cardiovascular function**
- **Strength and Bone Density**
- **Gait, Balance and Sensory function**
- **Macular Degeneration**

Cardiovascular Assessment

A major successes of the TILDA health assessments

- number of new insights into role of cardiovascular function and disease determined on analysis data collected in TILDA Wave1

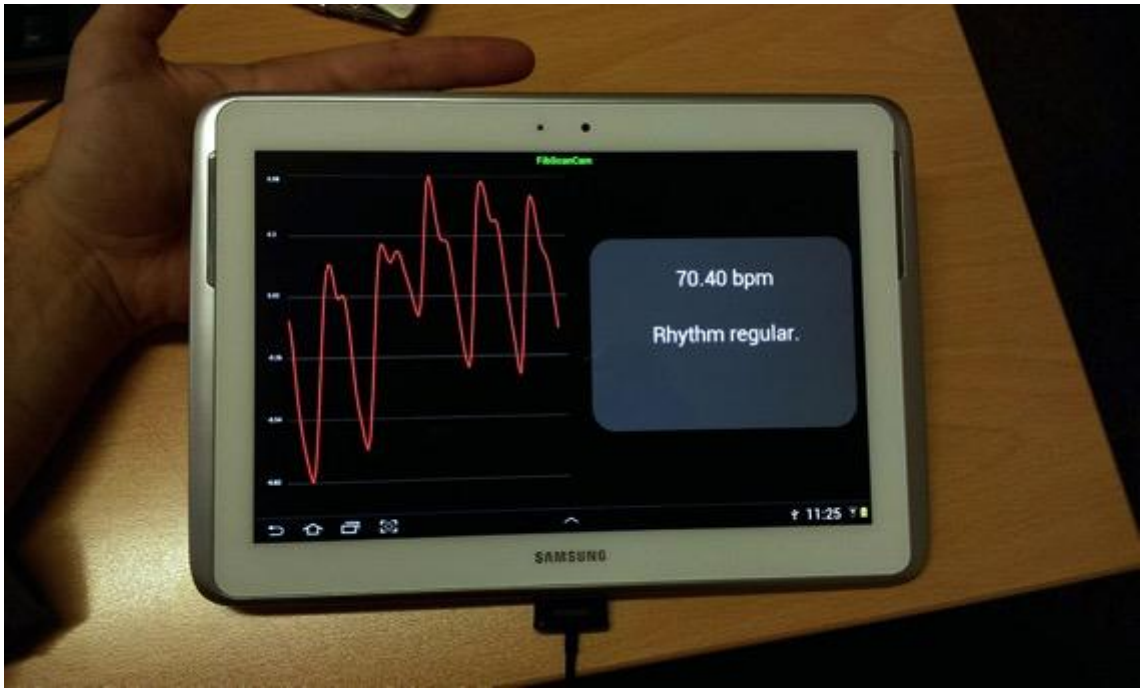
Provide a more detailed picture of the circulatory system and its response to stressors

- ECG
- Blood Pressure

New analysis methods to analyse cardiovascular data

Scale and Capacity

from small scale to large scale



Atrial Fibrillation

Cardiovascular Assessment

Current phase of data collection in TILDA

Near-infrared spectroscopy (NIRS)

- New measure has been introduced into TILDA
- Allows measurement of blood flow through brain along with measurements of the central cardiovascular system.
  - specifically important when moving from sitting to standing
  - neurocardiovascular changes complicated by co-morbidity/polypharmacy

Challenge

- Combining these measurements greatly increases the information content, therefore need for new mathematical modelling methods to optimally analyse this data.

Translation into the Falls and Blackout Unit in St James's Hospital

- New models of cardiovascular system and the NIRS measurement translated into the Falls and Blackout Unit to probe and explain the epidemiology of faints and falls.

ST. JAMES'S HOSPITAL

Monitoring of Activity

Current phase of data collection in TILDA

Wrist-worn activity monitor

- Wrist-worn activity monitor
- Ongoing data collection, 2000 participants projected
- 7 days of recording, 300 records per second

Data type

- acceleration in 3 axes,
- physical activity intensity
- sleep/wake measurements.

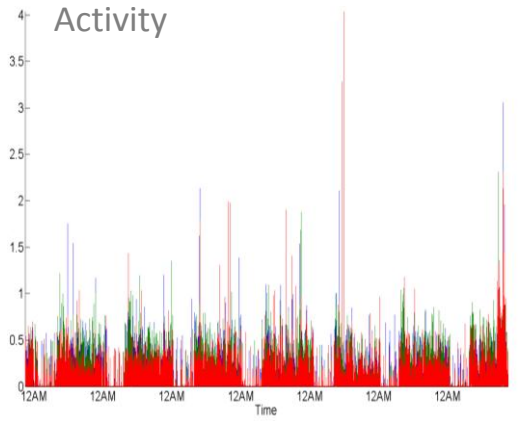
- Ambient light & temperature sensor provides valuable information about subject's environment

Monitoring of Activity

Current phase of data collection in TILDA

Outcome Measures

- Physical activity levels
  - times and patterns of activity, different types of activity, sedentariness
- Sleep measures
  - daily sleep times + length, napping, sleep disturbance
- Integration with TILDA dataset for health outcomes
  - Allows investigation how these detailed measures of physical activity affect health outcomes over the course of ageing.



Monitoring of Activity

Current phase of data collection in TILDA

Data infrastructure

- devices provide considerable volumes of information but present a big challenge to develop methods for interpreting data.

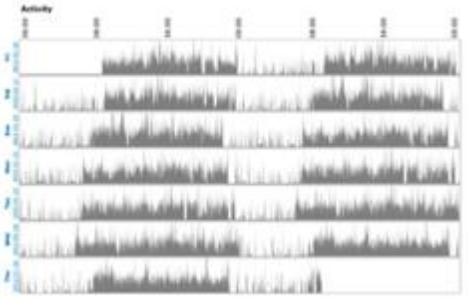
Algorithm development

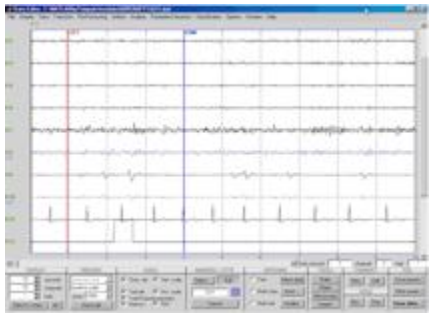
- New mathmatical methods to process data efficiently as possible.
- New mathmatical methods to integrate activity data with other measures of health.

Software for epidemiological studies

- TILDA is collaborating with other studies (ELSA) and manufacturers of monitoring devices (Axivity, Openmovement) to bring TILDA analysis methods to their studies and devices.
- Allowing widespread use of developed analytical methods.

Activity





ELSA English Longitudinal Study of Ageing

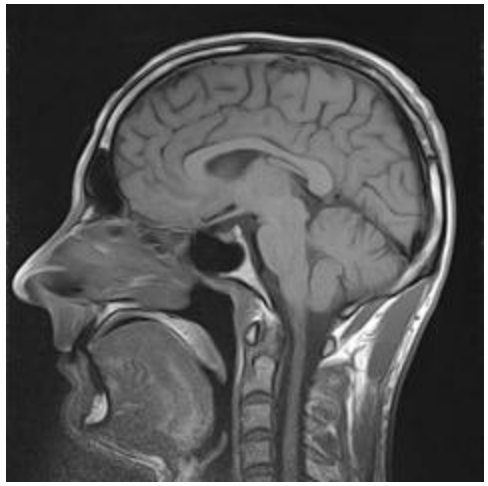
Axivity

Neuroimaging brain activity

Current phase of data collection in TILDA

MRI for structural & functional brain health measurements

600 TILDA participants



Ongoing data collection in collaboration with Centre for Advanced Medical Imaging (CAMI) in St. James's hospital

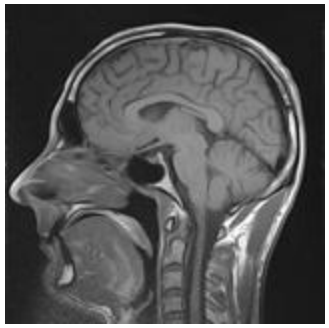
CAMI Centre for Advanced Medical Imaging

Neuroimaging brain activity

Current phase of data collection in TILDA

Outcome Measures

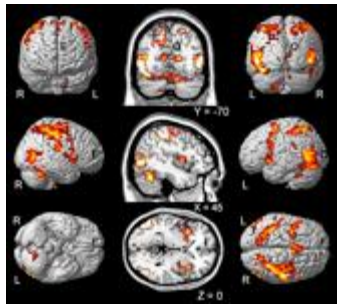
- Structural Brain Integrity
- Functional Brain Mapping providing connnectivity information



How brain changes its structure with age?
How brain changes affect **function in all areas of life?**

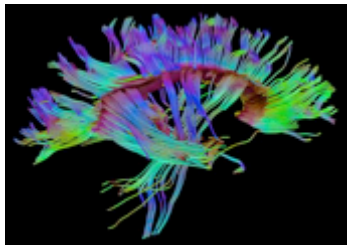
Analysis Methods

- New data processing algorithms to generate meaningful comparable measures and link them to the TILDA dataset
- Collaboraring with colleagues at University of Minnesota to develop suitable data processing approaches for this type of data



Cardiovascular Reactivity

- a novel approach to study the effect of transient hypo-oxygenation on the brain has also been included
- Provides a means to understand how orthostatic hypotension may affect the brain and the long-term consequences of living with such a condition



Innovative Treatments

Using knowledge from TILDA for new treatments

Multisensory integration using Virtual Reality and neuroimaging

FP7 funded project investigating use of high resolution VR in diagnosis but also as an intervention in Fear of falling (FOF) and Freezing of gait (FOG)

Customisable interventions for patients

- Customisable by clinican

Cochlear Implants for restoration of hearing

Using knowledge from TILDA for new treatments

Cochlear Implants

- Artificial hearing device, designed to produce useful hearing sensations by electrically stimulating nerves inside the inner ear.

How does it function?

- Electrical stimulation consists of a series of voltage pulses delivered at specific electodes with a specific frequency.

Typical for younger childer and adults

- Older adults also now being implanted more regularly

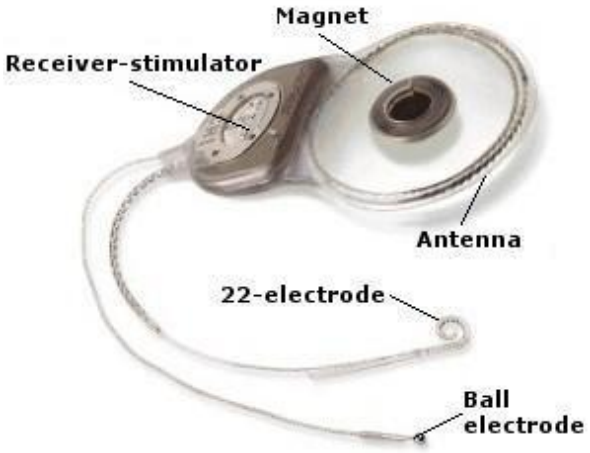


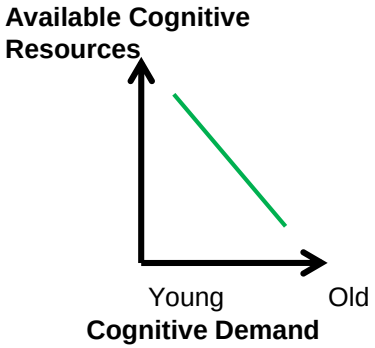
Figure 1. The internal component of the cochlear implant

Cochlear Implants for restoration of hearing

Using knowledge from TILDA for new treatments

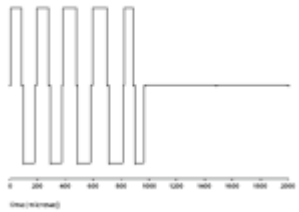
Cognitive Spare Capacity

- Older Cochlear Implant users find it particularly difficult to follow speech in noisy environments.
- May be due to a reduced cognitive spare capacity as we age.



Higher stimulation pulse rate is correlated with higher cognitive load, and consequently with diminished cognitive spare capacity in older CI users.

- **Thus by reducing the stimulation pulse rate the CSC can be increased allowing users to more easily engage in language processing**



Endpoint of this clinical study

- to identify correlates of cognitive performance with stimulation rates that can be used as objective measures in clinical care.
- National Cochlear Implant Program at Beaumont Hospital and Cochlear Ltd

Cochlear™

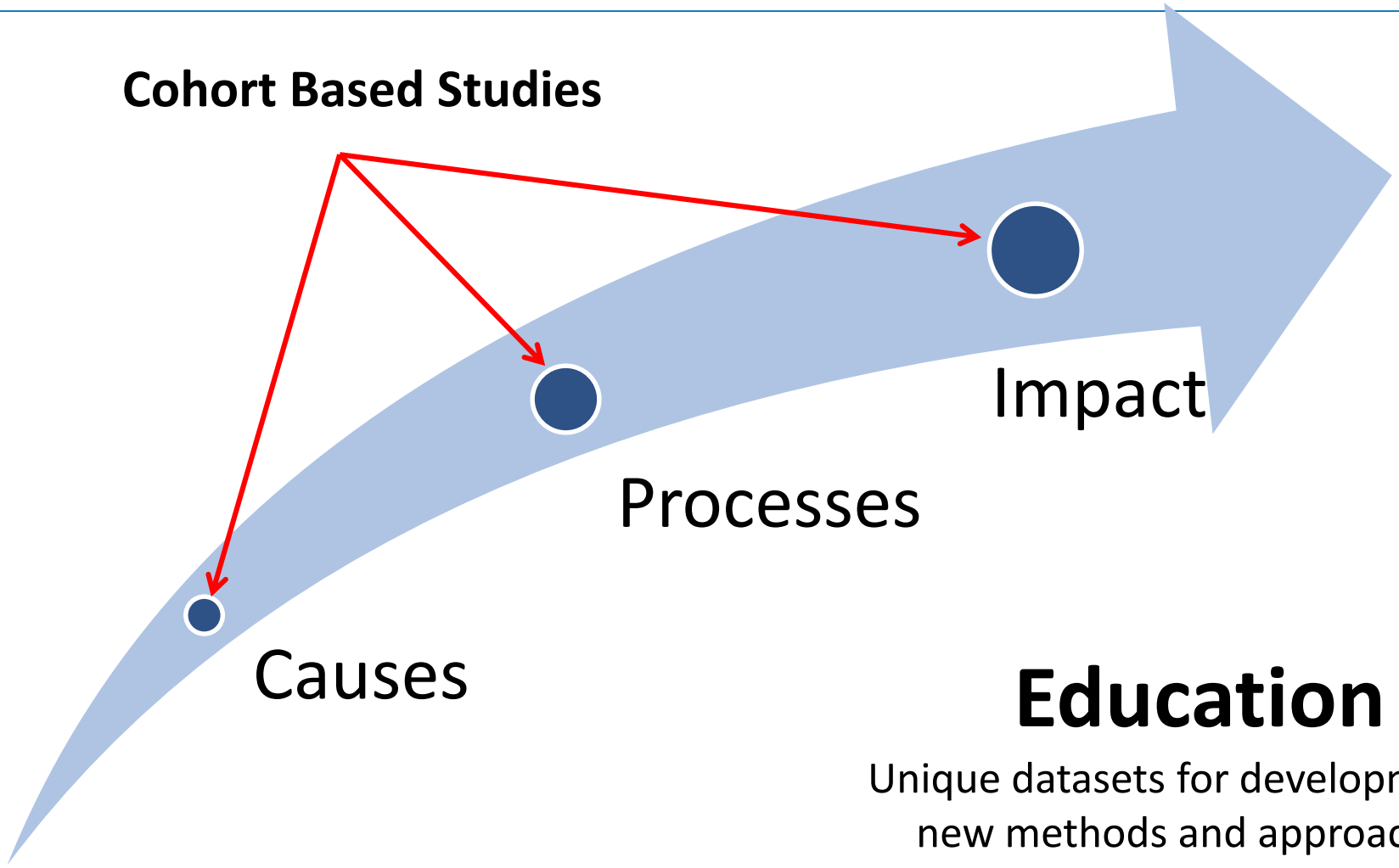
IMPACT

EIT Health promotes entrepreneurship and innovates in healthy living and active ageing

- Aim to improve quality of life and healthcare across Europe
- 140 partners across Europe.

http://eithealth.eu

TILDA impacting science



Education

Unique datasets for development of new methods and approaches.

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Thank You

TILDA future

Can we find neural correlates of complex behaviour not just simple behaviours?

Linking neural activity and behaviour.

What scale should we be looking at?
micro, macro or meso?

Can we model large scale populations with TILDA data acquired?
Can we predict future healthcare status based on these models?

Should we using Social Networks to gather information?

What will be the titles of publications in 2020 or 2025?