UNIVERSITÉ DE GENÈVE

Intraindividual variability across the lifespan

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Plan

- **The Geneva Variability Study**
- **Within-task IntraIndividual Variability (IIV): inconsistency**
- **Across-tasks IIV: dispersion**

The Geneva Variability Study

- **Cross-sectional** study of variability (9-89 years) 2005-2008, continuing into a **longitudinal** study (59-89 years) 2008 – now...

- **Participants to the cross-sectional study**
  - 199 children (9-12 years old)
  - 247 young adults (19-25 years old)
  - 204 older adults (59-89 years old)

- Multivariate design: 9 cognitive tasks of varying complexity (working memory, processing speed, inhibition, etc.).

The Geneva Variability Study

5 Reaction Time tasks

- 1 **simple reaction time (SRT)** task (120 trials)

- 2 **choice reaction time** tasks
  - Line comparison **LI** (120 trials)
  - Cross-Square **CS** (120 trials)

- 2 **processing speed** tasks
  - Letters Series (6 or 9 letters) **LC6, LC9** (120 trials)
  - Digit Symbol **DI** (144 trials)

The Geneva Variability Study

2 working memory tasks

- Verbal WM (Reading Span), 2 conditions (20 trials each)
- Visuo-Spatial WM (Matrices), 6 conditions (20 trials each)

Other tasks

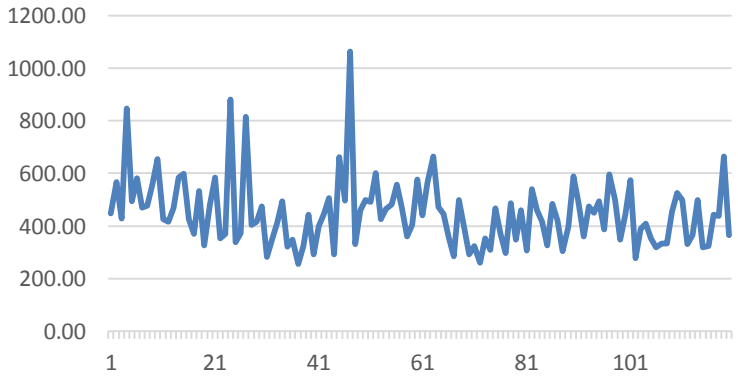
- Resistance to interference:
  - Stroop color (144 trials)
  - Arrow task (100 trials)
- Fluid intelligence (PM38)
- Vocabulary (MillHill)

Measures of inconsistency

- Within-task intraindividual variability

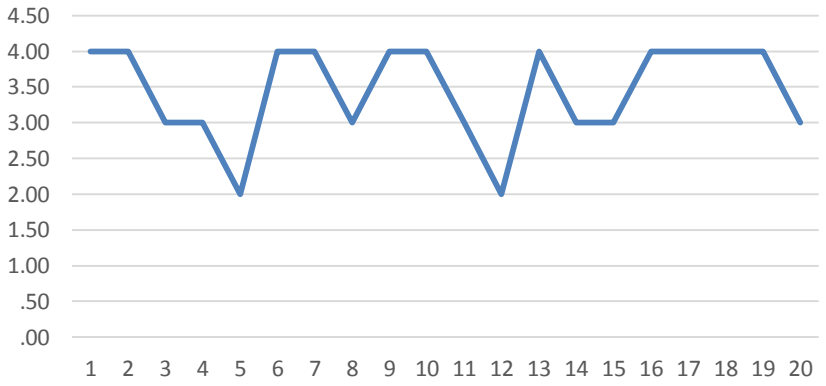
Reaction times

Temporal course of an individual's response times in a CRT



Accuracy measures

Temporal course of an individual's performance in a WM task



Most widely studied

Measures of inconsistency

- **<u>intraindividual Standard Deviation</u> (iSD)**

$$s_N = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2},$$

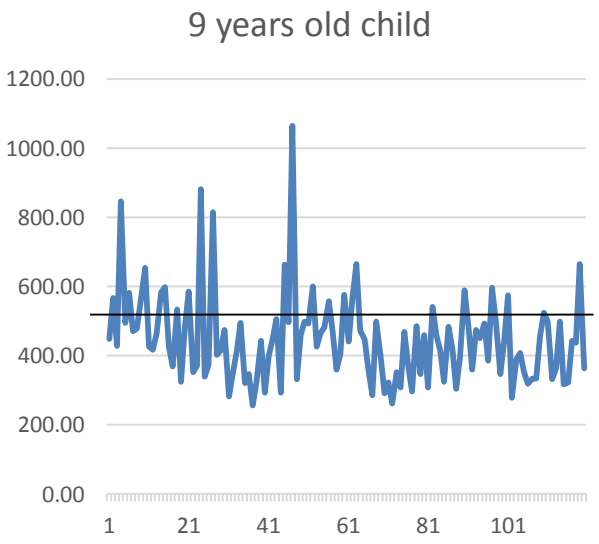
- Sensitive to age differences (Hultsch et al., 2002; de Ribaupierre et al., 2006)

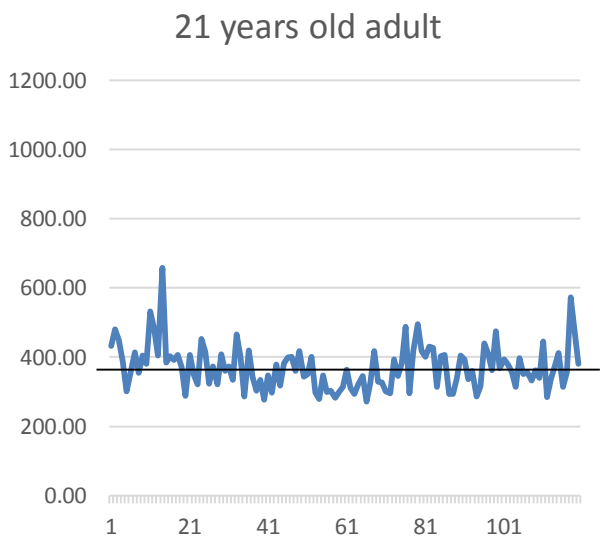
But:

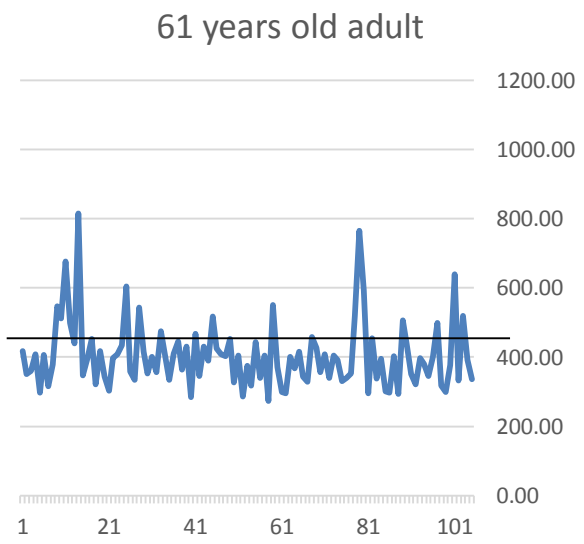
- In RT tasks, linear relation with individual Mean (iM): difficult to disentangle IIV from level of performance
- Repeated measures may be influenced by retest effects such as practice and fatigue

Inconsistency across the lifespan

- Examples of temporal courses of RTs over 120 trials in a choice RT task, according to age.







Measures of inconsistency

- **<u>Coefficient of Variation (CV)</u>** $CV = \frac{\text{std dev}}{\text{mean}}$

- Allows for the comparison of IIV across age-groups

But:

- Influenced by the number of items (missing data ?)

- Problematic with accuracy measures (Golay et al., 2013)
  - No linear relation between iM and iSD
  - Fixed minimum and maximum score

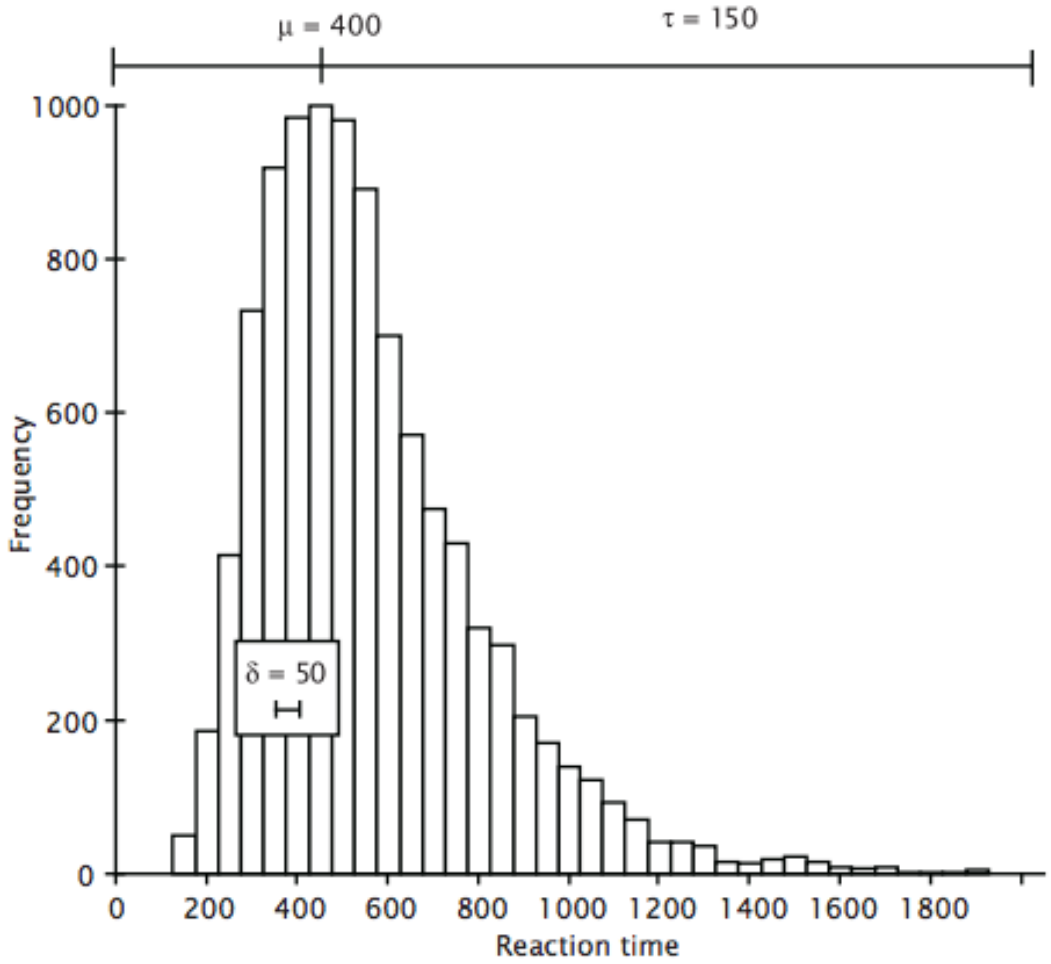
Measures of inconsistency

- **<u>Residualized intraindividual standard deviation (iSDr)</u>**
  - Account for within-subject retest effects and between subject differences in terms of levels of performance (Hultsch et al., 2002)
  - Linear regression of each score on individual mean performance, order of item, occasion of measurement, and their interactions ► SD of the residuals.

- Little difference with classical iSD (Lövden et al., 2007)

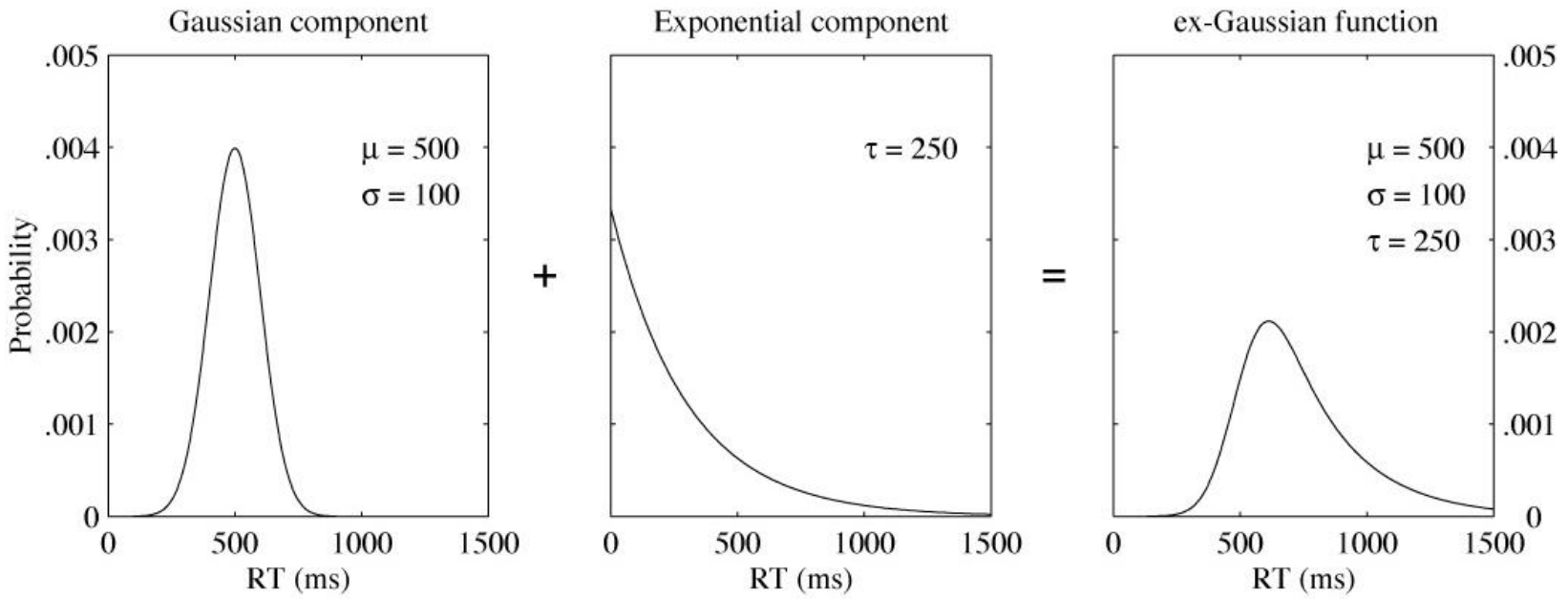
But: Assumption of a Gaussian distribution of measures

Measures of inconsistency



Measures of inconsistency

➢ **<u>Parameters of Ex-Gaussian distribution</u>**:



From Lacouture & Cousineau, 2008

μ: mean of the Gaussian composite

σ: SD of the Gaussian composite (width of the distribution)

τ: both the mean and SD of the exponential composite

IIV

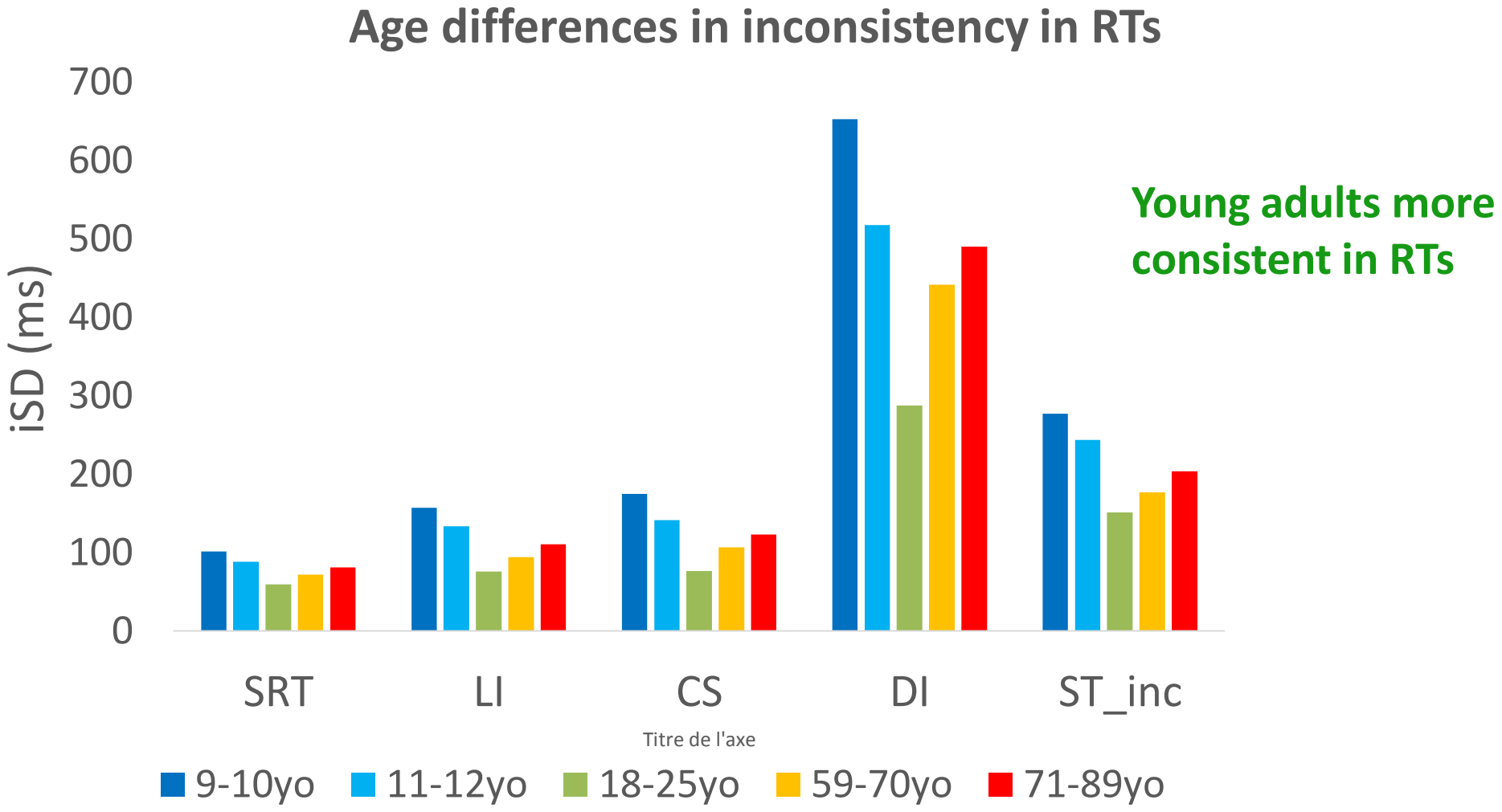
IIV for slow RTs

Measures of inconsistency

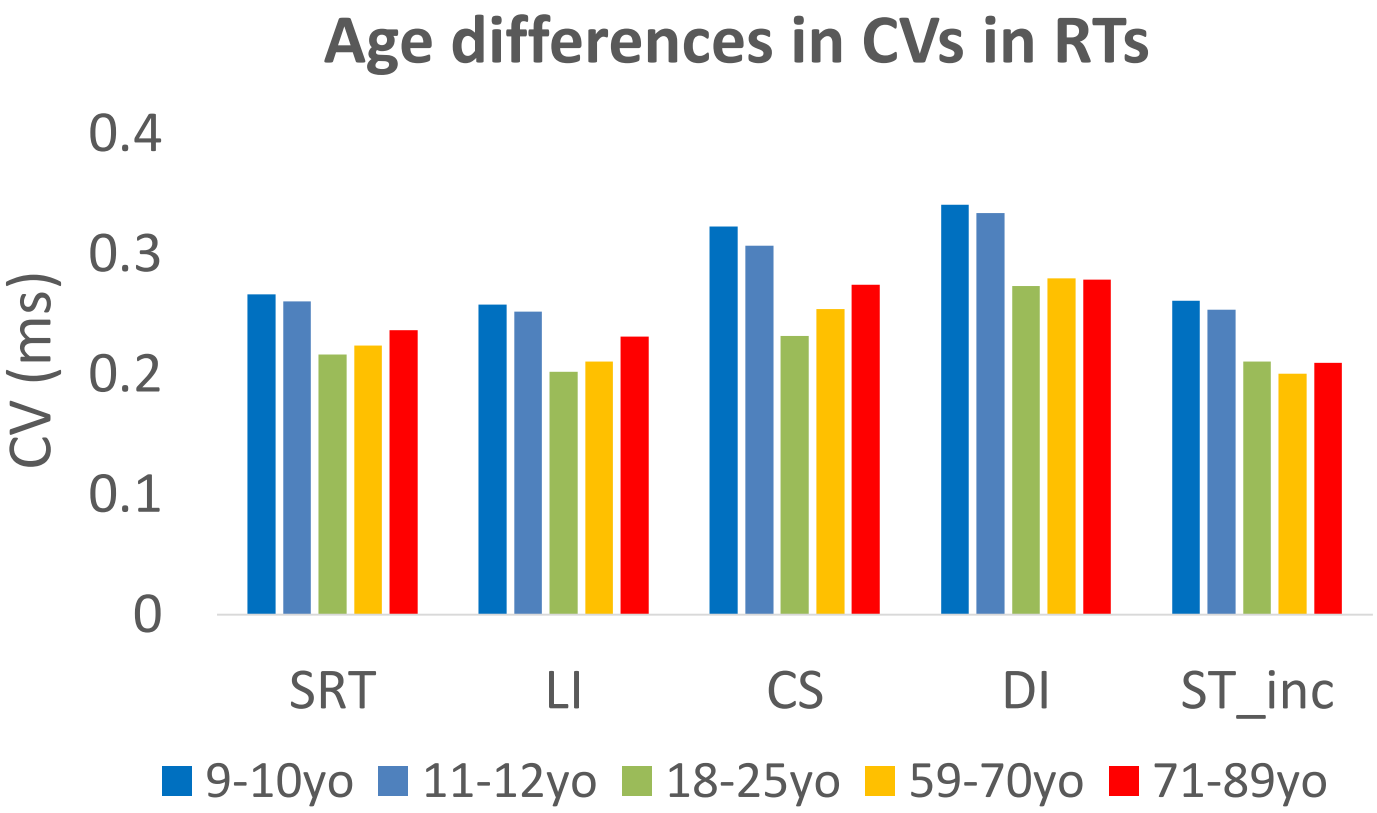
- **Different indexes to study within task IIV**
  - All sensitive to detect increased response variability in aging.
  - Vary in terms of their efficacy to control for mean level of performance.
  - Necessitate a large number of trials

- Examples of data from GVS: **iSDs** vs **CVs**

Inconsistency across the lifespan



Inconsistency across the lifespan

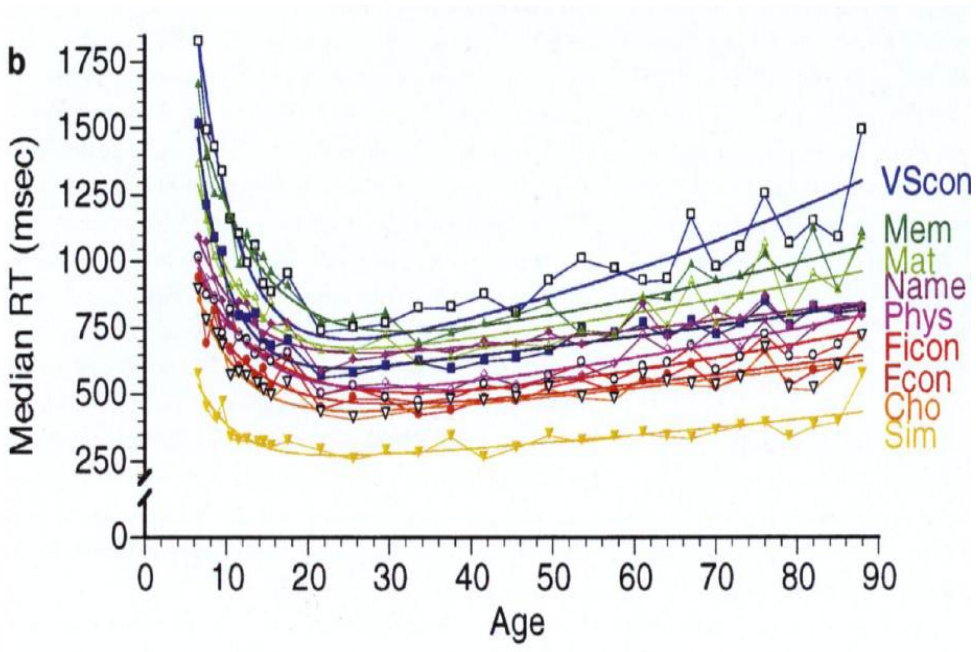


Young adults more consistent in RTs

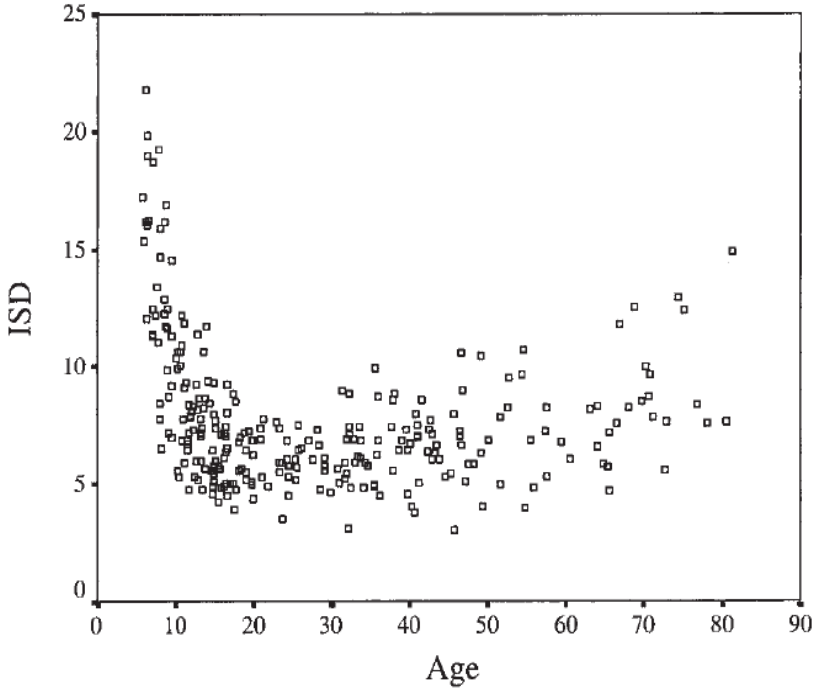
Similar results to iSDs

Inconsistency across the lifespan

Consistent with the few lifespan studies of inconsistency

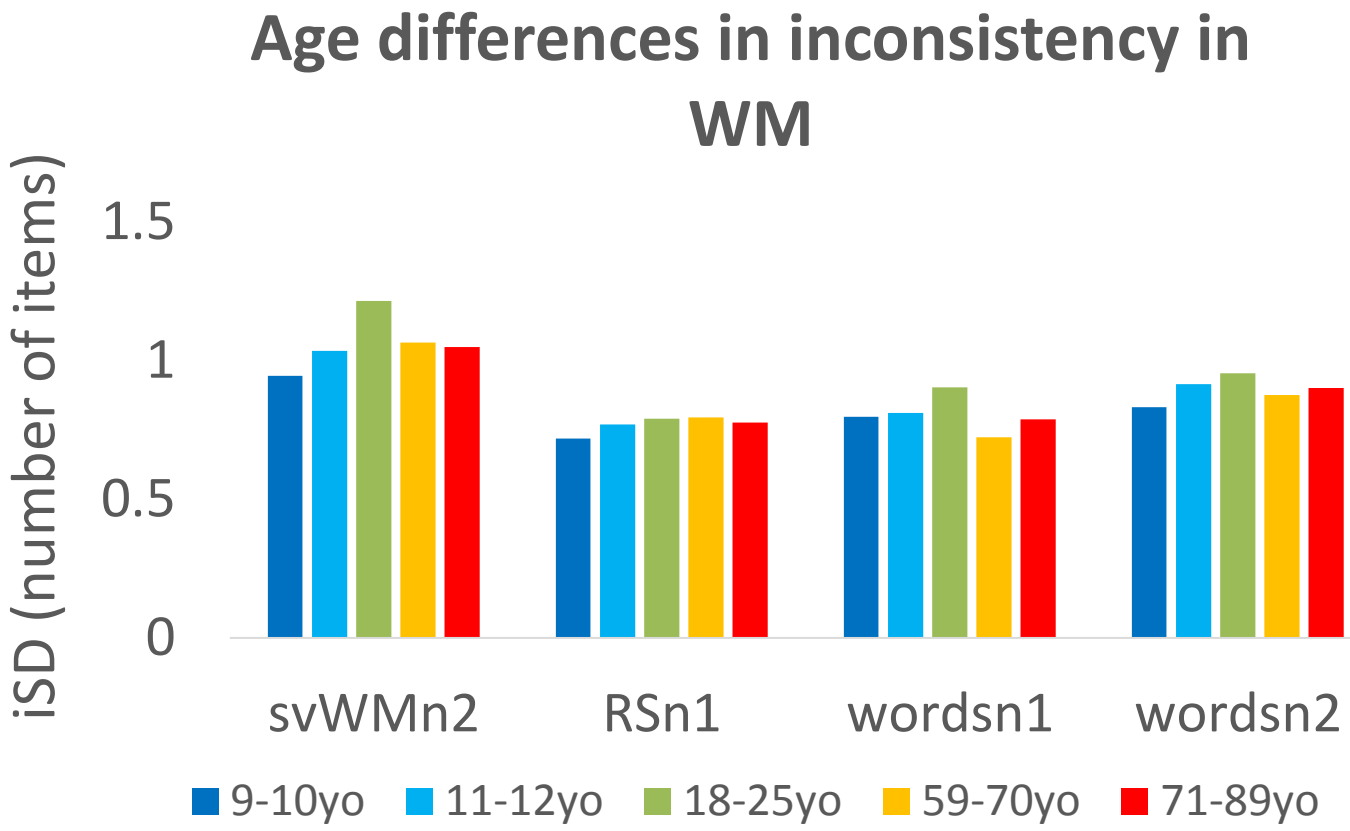


Li et al., 2004



Williams et al., 2005

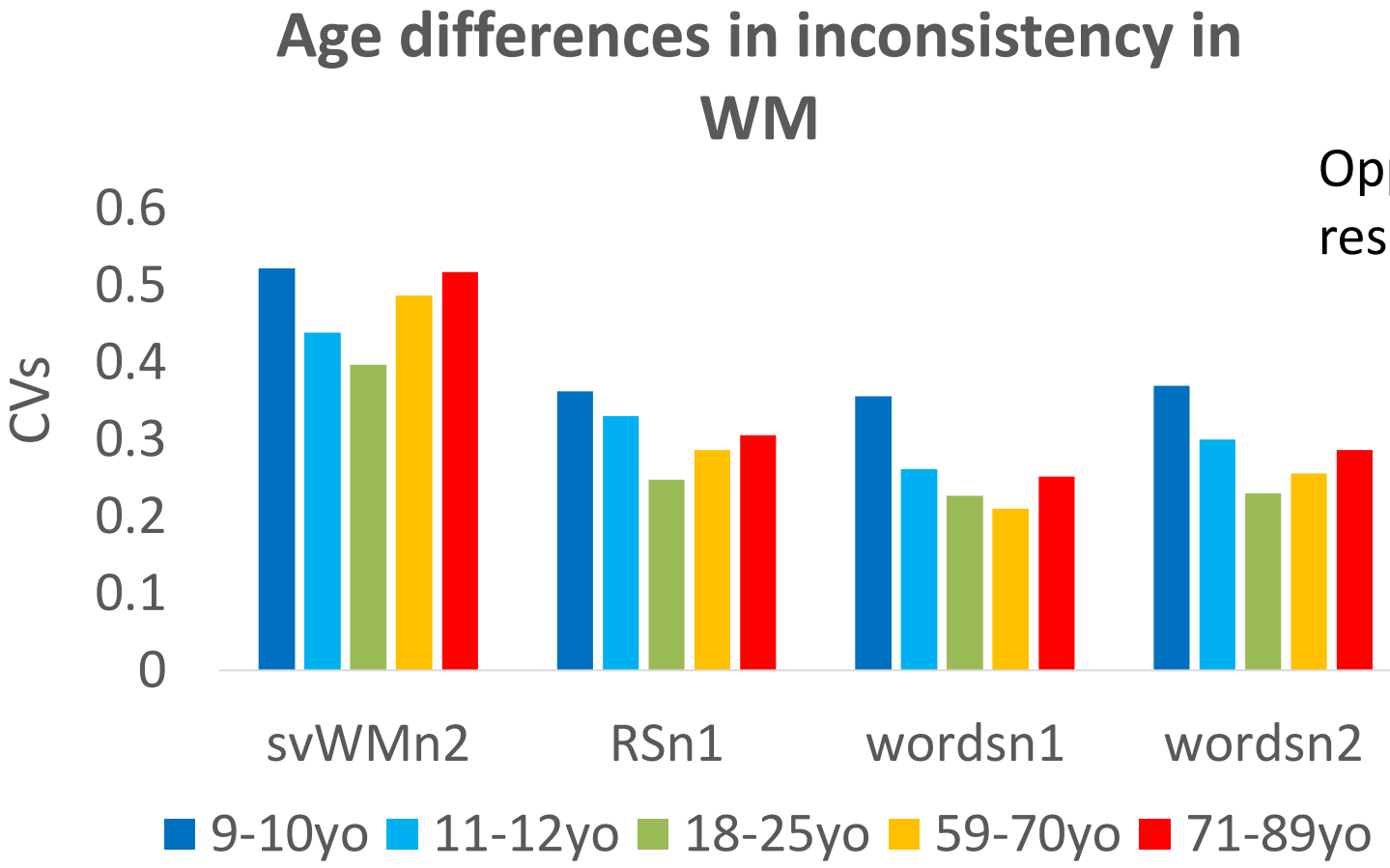
Inconsistency across the lifespan



Results less clear with WM data

Young adults seem **less consistent** in WM

Inconsistency across the lifespan



Opposite trend of results with CVs !

Inconsistency across the lifespan

To sum up:

- Evolution of inconsistency follows a U-shape curve across the lifespan as far as RTs are concerned.
- Results are less clear concerning accuracy measures.
- Studies are still lacking to have a broader view of lifespan development of inconsistency.

Dispersion

- **Across-tasks IIV**
  - Indicative of the underlying processes and **their relations**
  - Evolution of dispersion helps understanding the **temporal relation between processes**

- **Measuring dispersion**
  - Necessity to use multivariate designs
  - **Cluster analyses** (Gunstad, et al., 2006; Sylvain-Roy & Belleville, 2014), … : group level.
  - **iSDs**: allows characterizing dispersion in each individual.

Dispersion across the lifespan

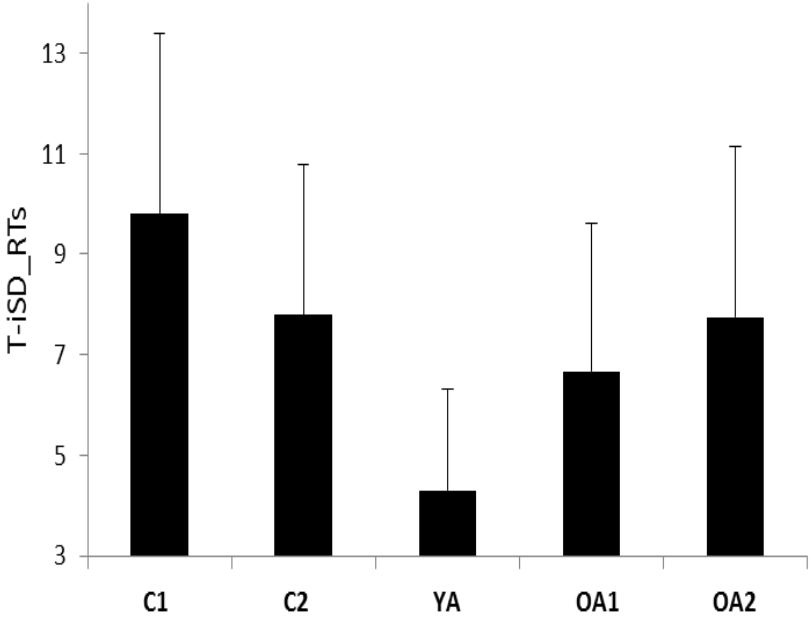
- **Dispersion within 2 cognitive abilities** : **2 different scores**
  - Working memory (8 tasks/conditions) - **Accuracy**
  - Processing speed (12 tasks/conditions) - **RTs**

- **<u>Scores processing</u>**
  - **Residualization** for age-group effects (controls age-related differences in the average level of performance)
  - **Standardization** to have the metrics / transformed into T-scores (allows comparison between conditions)
  - **Computation of** two iSDs for RTs / WM

Dispersion across the lifespan

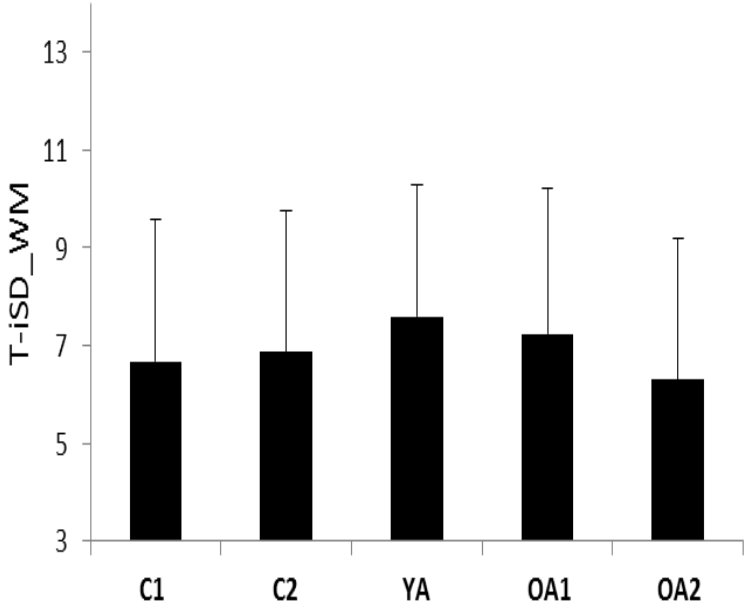
T-iSD for RT tasks

Young adults **less** variable across RTs tasks



T-iSD for WM tasks

Young adults **more** variable across WM tasks

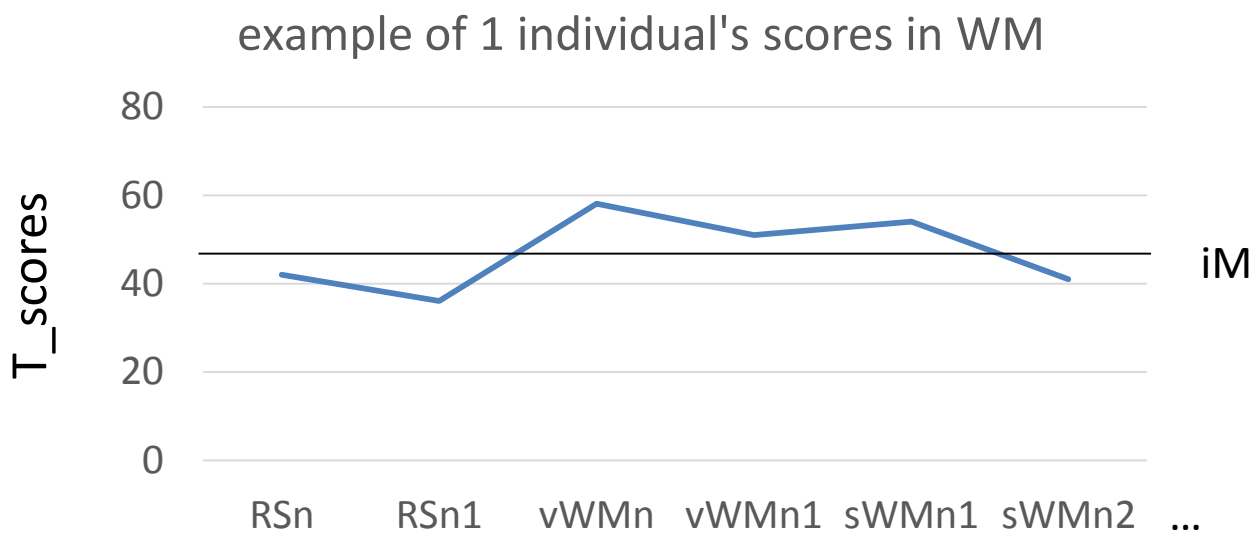


Mella, Fagot, de Ribaupierre, 2015

Dispersion across the lifespan

Dispersion profiles analysis:

- Compute ipsatized scores to have a strength of weakness for one individual

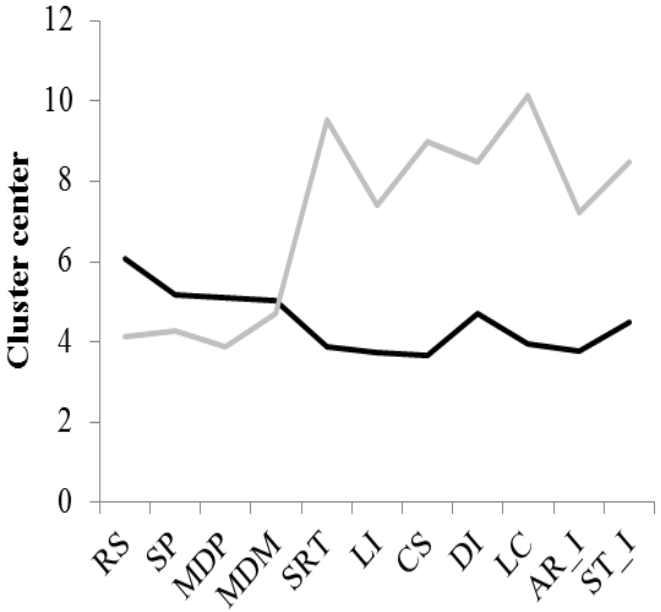


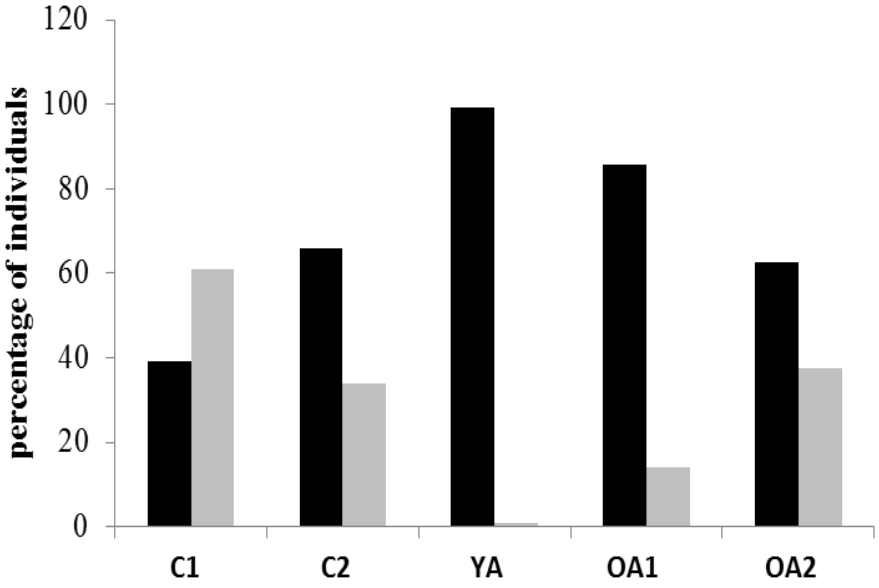
Mella, Fagot, de Ribaupierre, 2015

Dispersion across the lifespan

Dispersion profiles analysis:

- Cluster analysis of absolute values of ipsatized scores





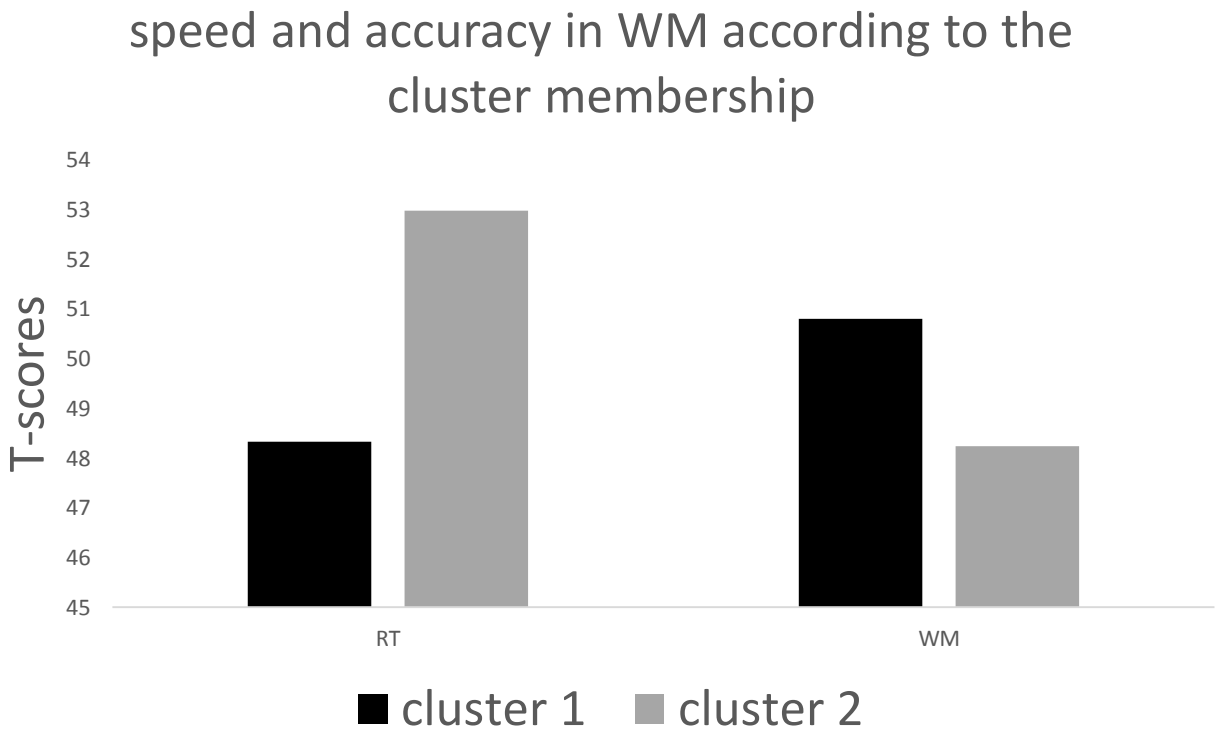
– **Cluster 1: 376 individuals**

– **Cluster 2: 146 individuals**

Mella, Fagot, de Ribaupierre, 2015

Dispersion across the lifespan

Relation dispersion and average performance



More variable individuals are

- **slower**
- **poorer performers in WM tasks**

Mella, Fagot, de Ribaupierre, 2015

Conclusions

- Children and older adults are more variable in both intra-task and inter-task variability than young adults as concerns processing speed.

  Reverse pattern observed with accuracy measures of WM

  ➢ IIV in speed processing and IIV in accuracy performance do not have the same underlying processes.

- IIV: valuable tool in the study of age differences.

- IIV offers interesting additional information beyond mean level performance across age groups.

Thank you for your attention