Five Methodological Needs in Cognitive Aging Research

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Overview

Five Methodological Needs in Cognitive Aging:

1. A “Multivariate Perspective” on Cognitive Profiles

2. “Adaptive Tests” to Avoid Fatigue and Practice

3. “Age as Part of the Dependent Variable” in Rates of Change

4. “Dealing with Death” in Cognitive Trajectories

5. Measuring “Dynamics Determinants of Cognitive Processes”

Need 1: Good Multivariate Outcomes

- Prior results in cognitive aging suggest many different functions are required to understand the variability in individual changes. The "cognitive profile" of one person or group needs to be measured in every study.
- Recent work on measurements of cognition have led to remarkable improvements, and now a variety of new measures (WJ-III, DAT, etc.) can be said to have interval properties – important for the analysis of age changes.
- The newest results we have found support the classic idea that the growth and decline curves for *Gf-Gc exhibit different trajectories*, the combination of both is compensatory, and other measures feed into this system.
- If the same interval measures were used across studies, or if a cross-calibration of measures existed, it would be possible to combine the raw data of many studies.

Cattell (1941) & Horn's (1967) theory of Cognitive Changes

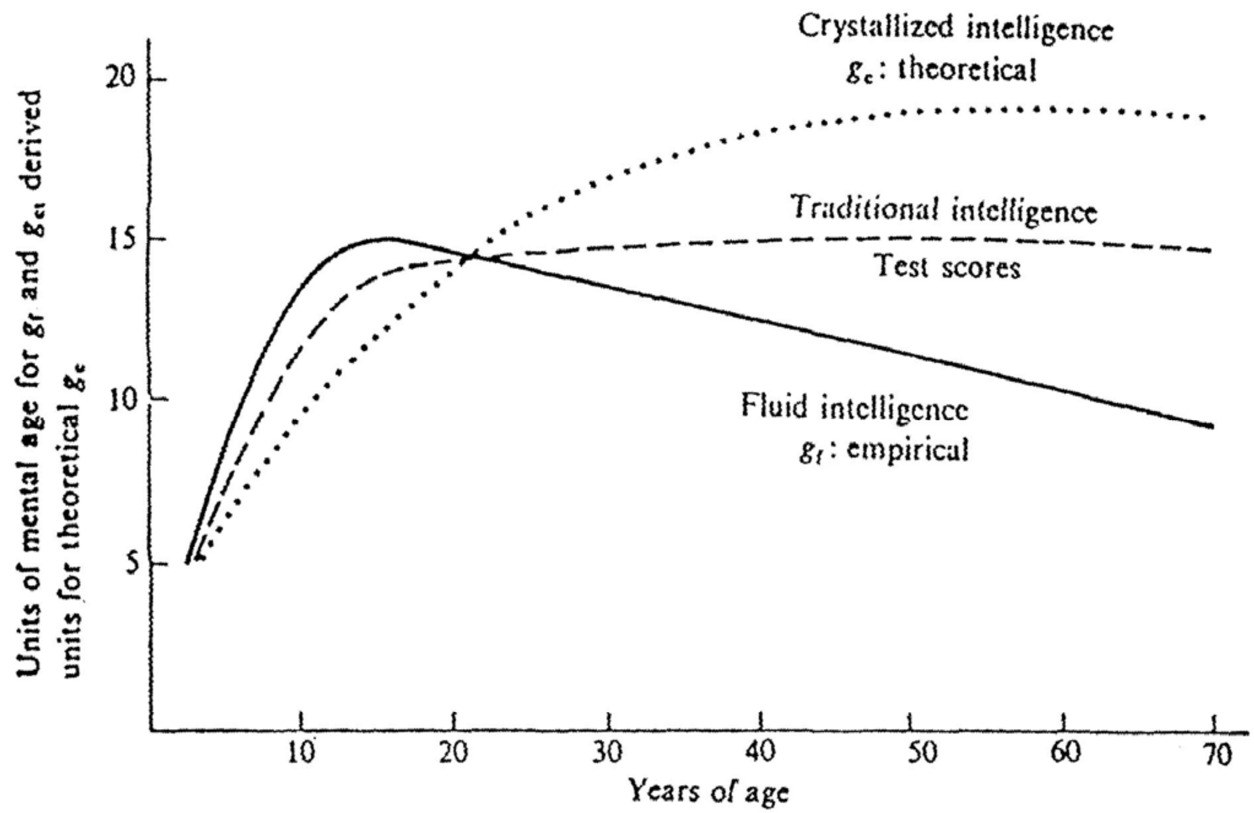
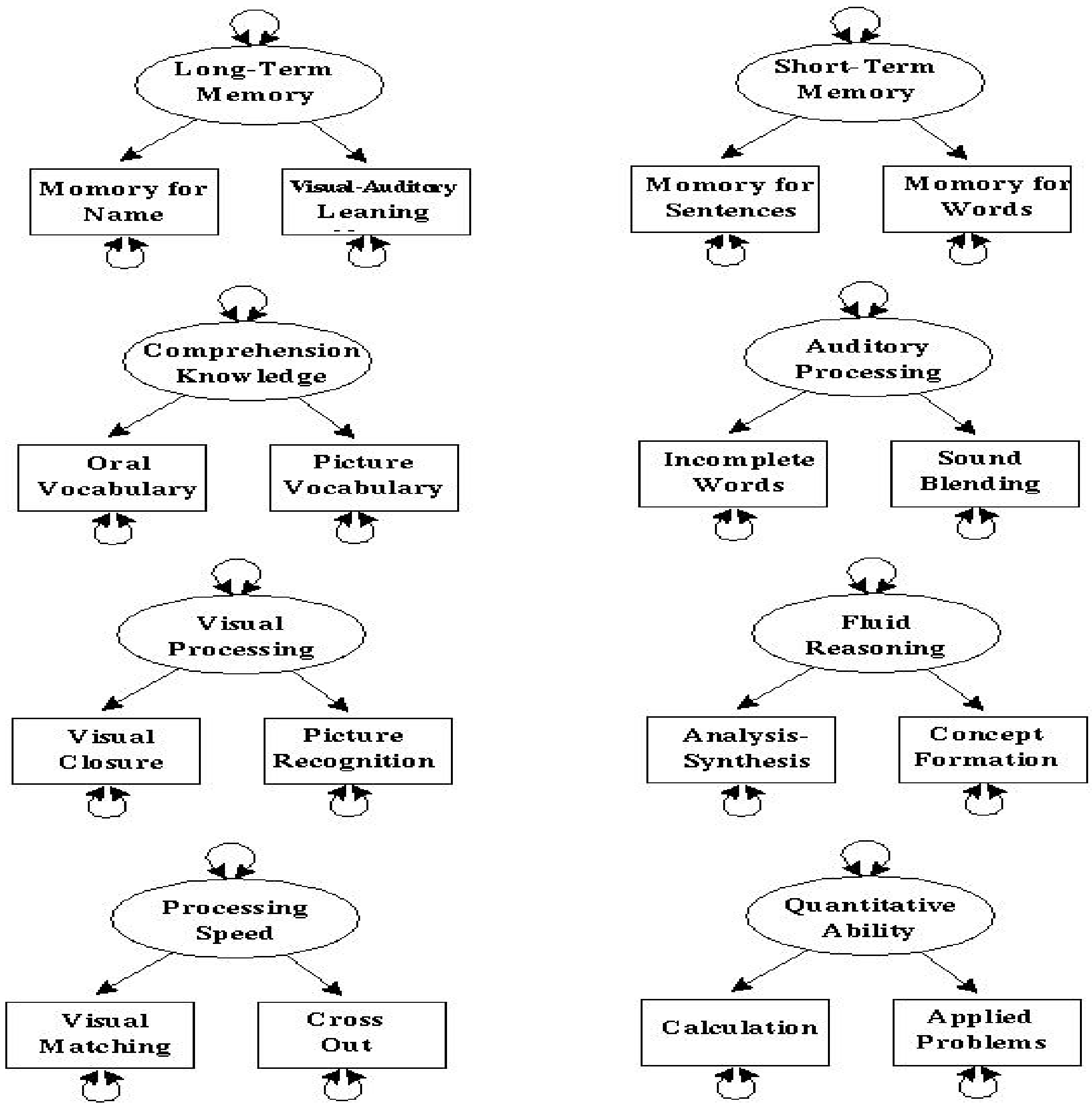


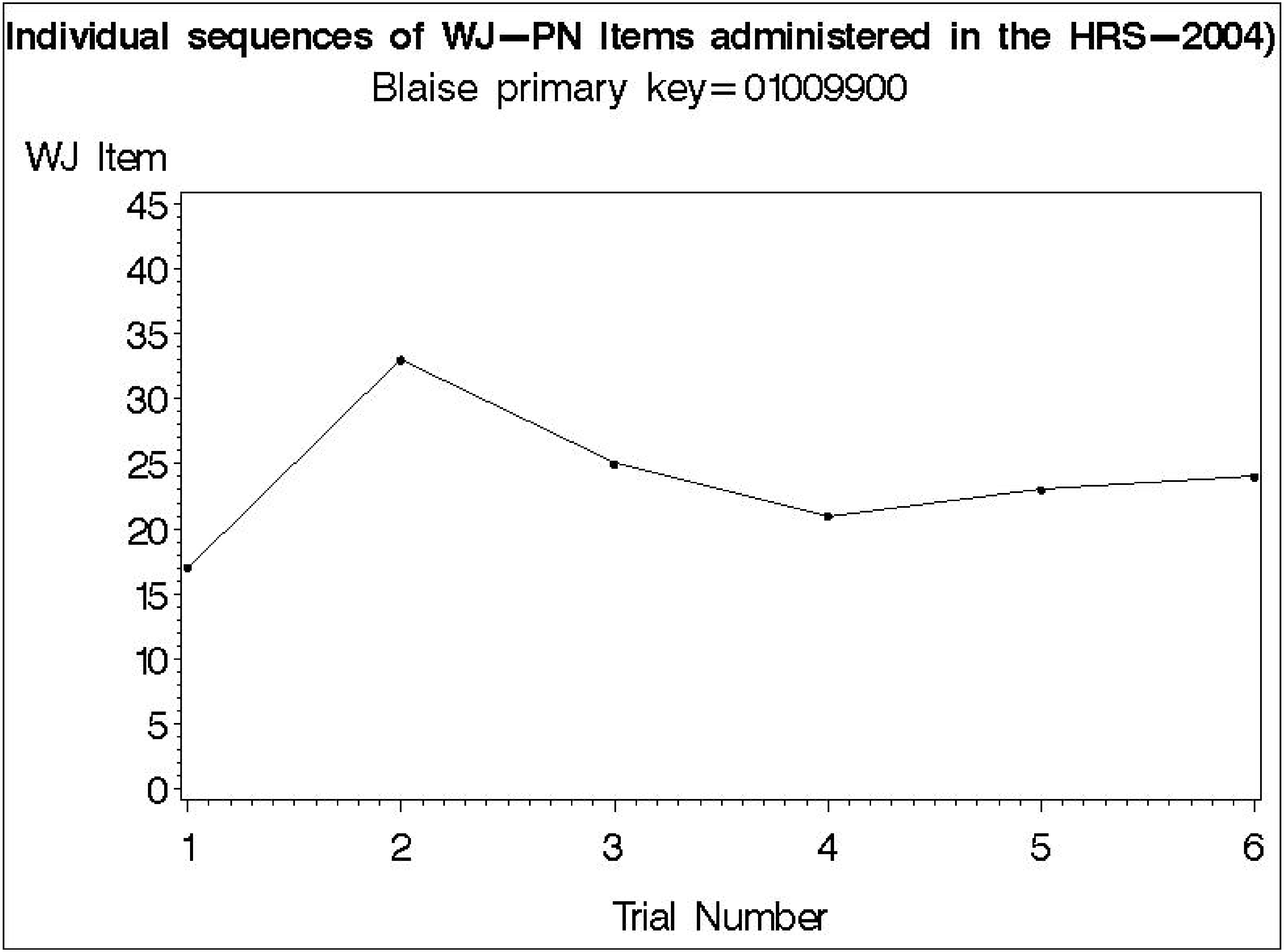
FIG 2.2. Age plots of the investment theory of fluid into crystallized intelligence. Age: 5, 15, 25, 35, 45, 55, 65, 75; g_f values: 9, 15, 14, 13, 12, 11, 10, 9; g_c values: 6.7, 13.0, 16.2, 17.9, 18.8, 19.3, 19.5, 19.6; g_{ct} traditional intelligence test curve.

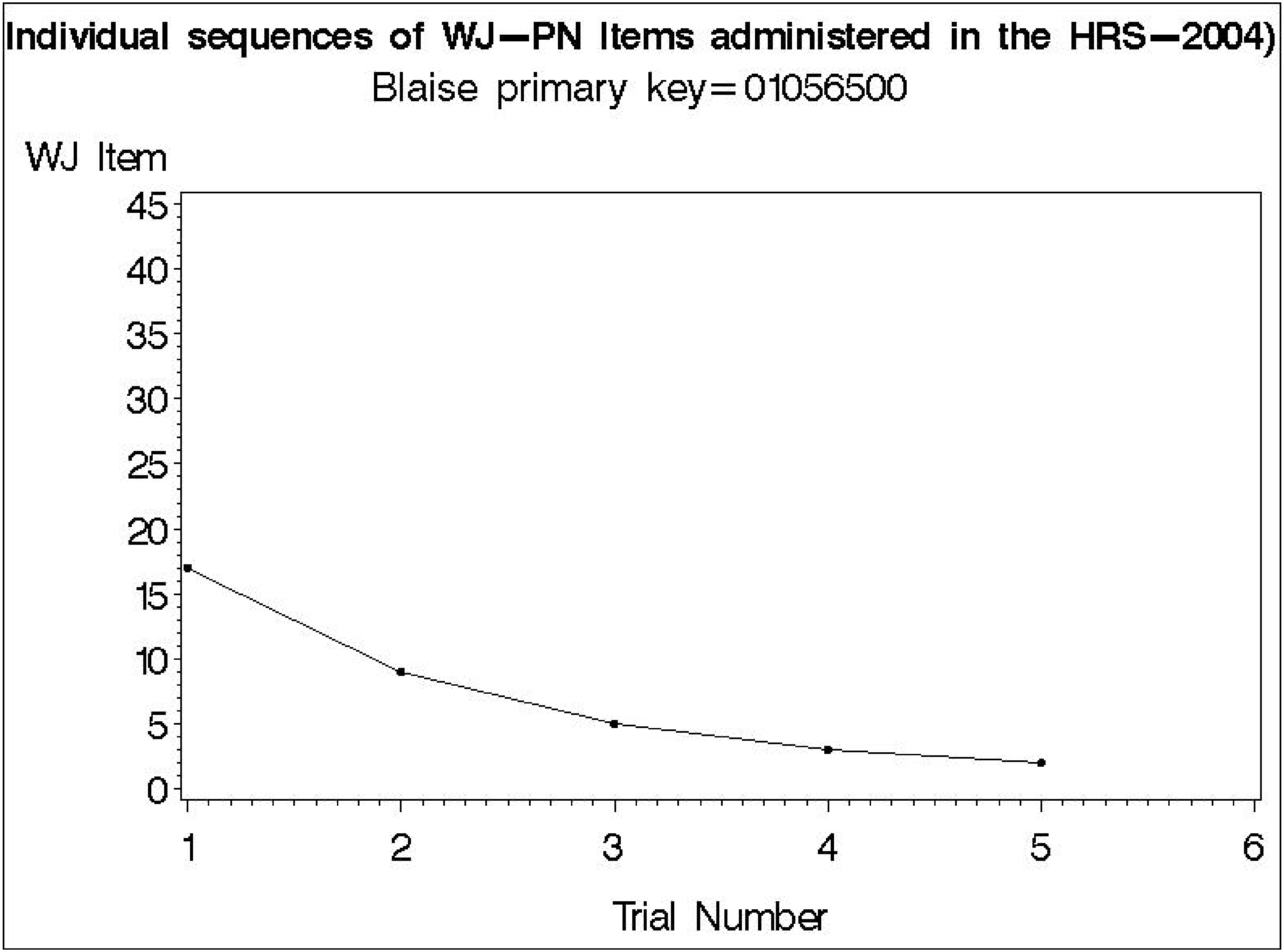
A Multiple Abilities model of Cattell-Horn in the Woodcock-Johnson Battery



Need 2: Emphasis on "Adaptive" testing

- Two practical problems of using multiple measure testing with an the elderly population are unwanted "cognitive fatigue" and "practice effects." Short tests are essential.
- Adaptive tests are "abbreviated" (not "shortened") forms of classic tests based on *item response models* (i.e., IRT). New tests come from data on a large pool of "calibrated items," and programmed on a computer (CATI).
- All items are possible, but the CATI narrows the specific questions asked based on the participant prior responses. The estimated ability is based on *far less than complete items* (e.g., 1/5th), *without major loss of reliability, and without the need to repeat any item in a second testing*.
- An experiment in cognitive CATI has recently been used with success in the NGCS-HRS (2004-06) collaboration to measure *Gf* using the WJ-III Number Series test.


Individual sequences of WJ—PN Items administered in the HRS—2004)
Blaise primary key=01009900
WJ Item
45
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
Trial Number


Individual sequences of WJ—PN Items administered in the HRS—2004)
Blaise primary key=01056500
WJ Item
45
40
35
30
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15
10
5
0
1
2
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4
5
6
Trial Number

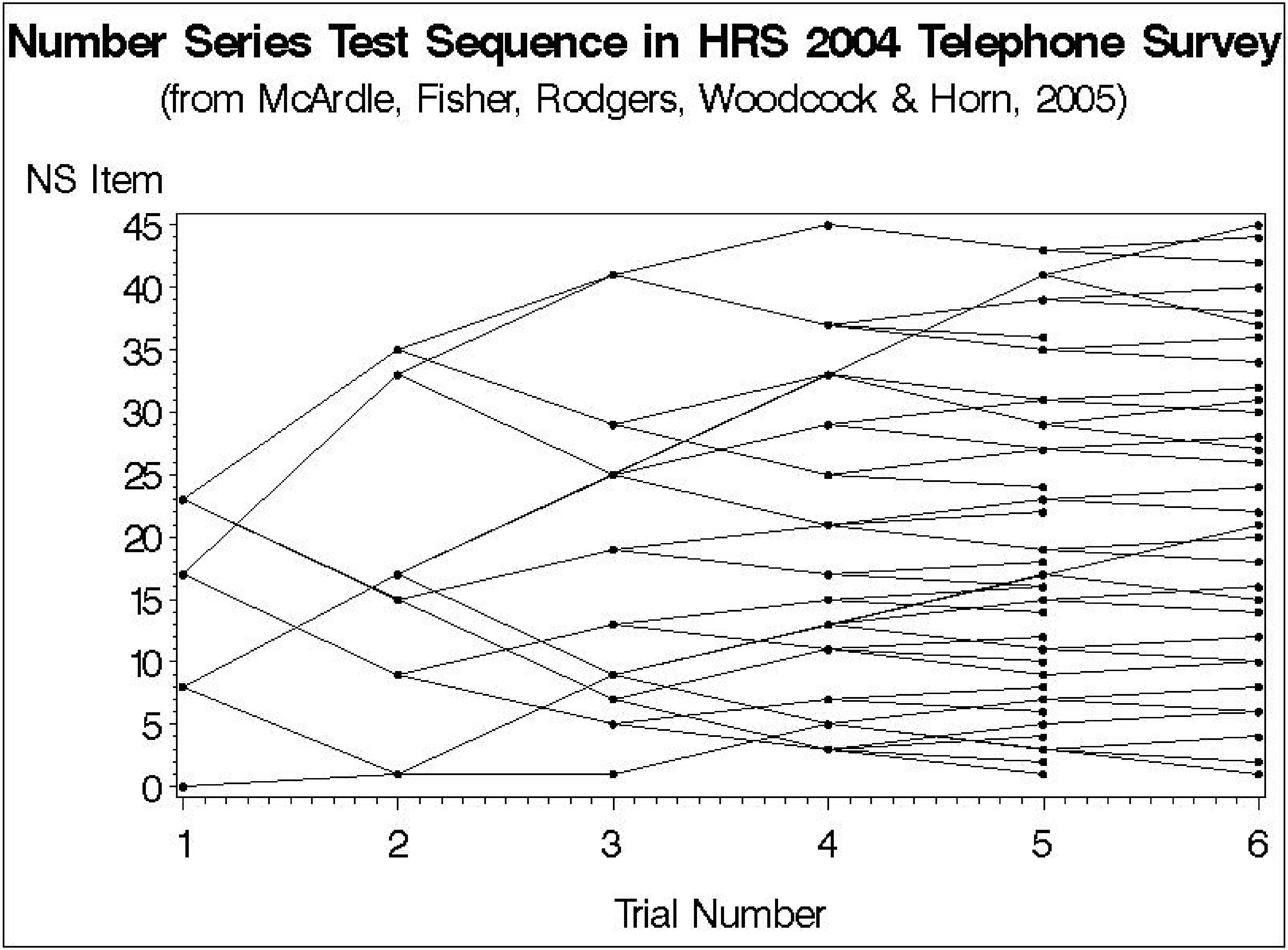
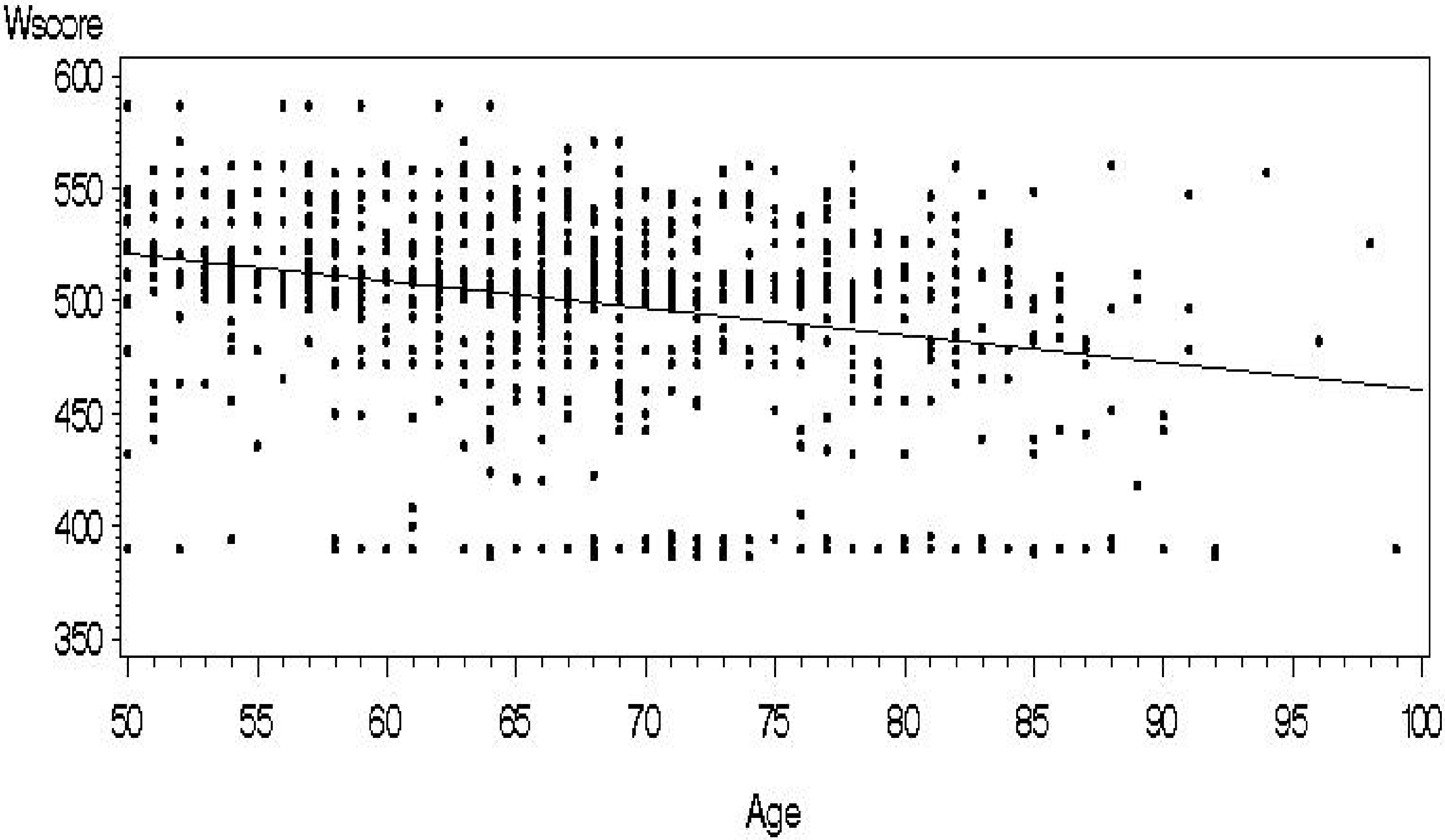

Number Series Test Sequence in HRS 2004 Telephone Survey
(from McArdle, Fisher, Rodgers, Woodcock & Horn, 2005)
NS Item
0
5
10
15
20
25
30
35
40
45
1
2
3
4
5
6
Trial Number

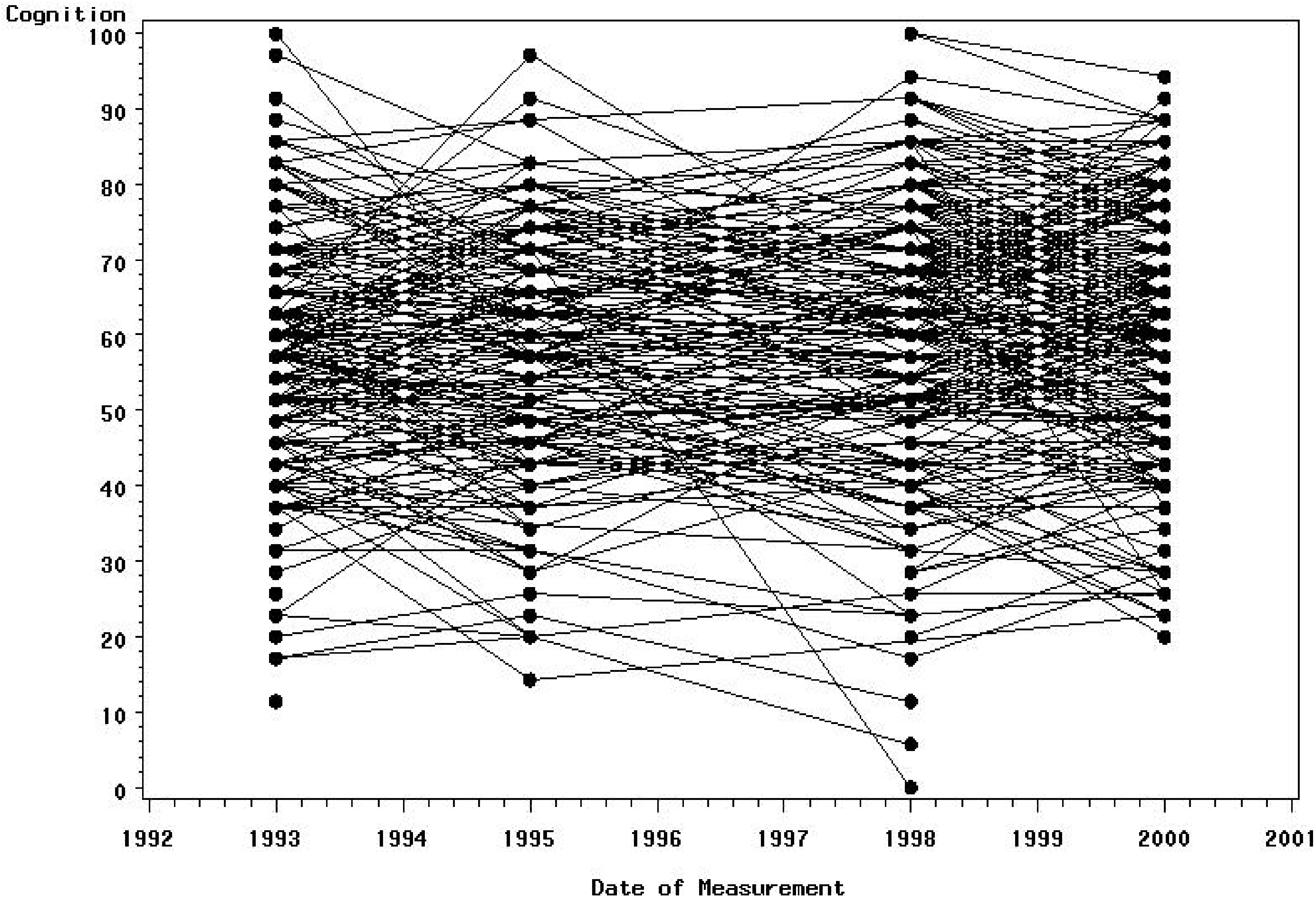
Figure [A3–3]: Distribution of W–Scores vs Age (N= 1,039)



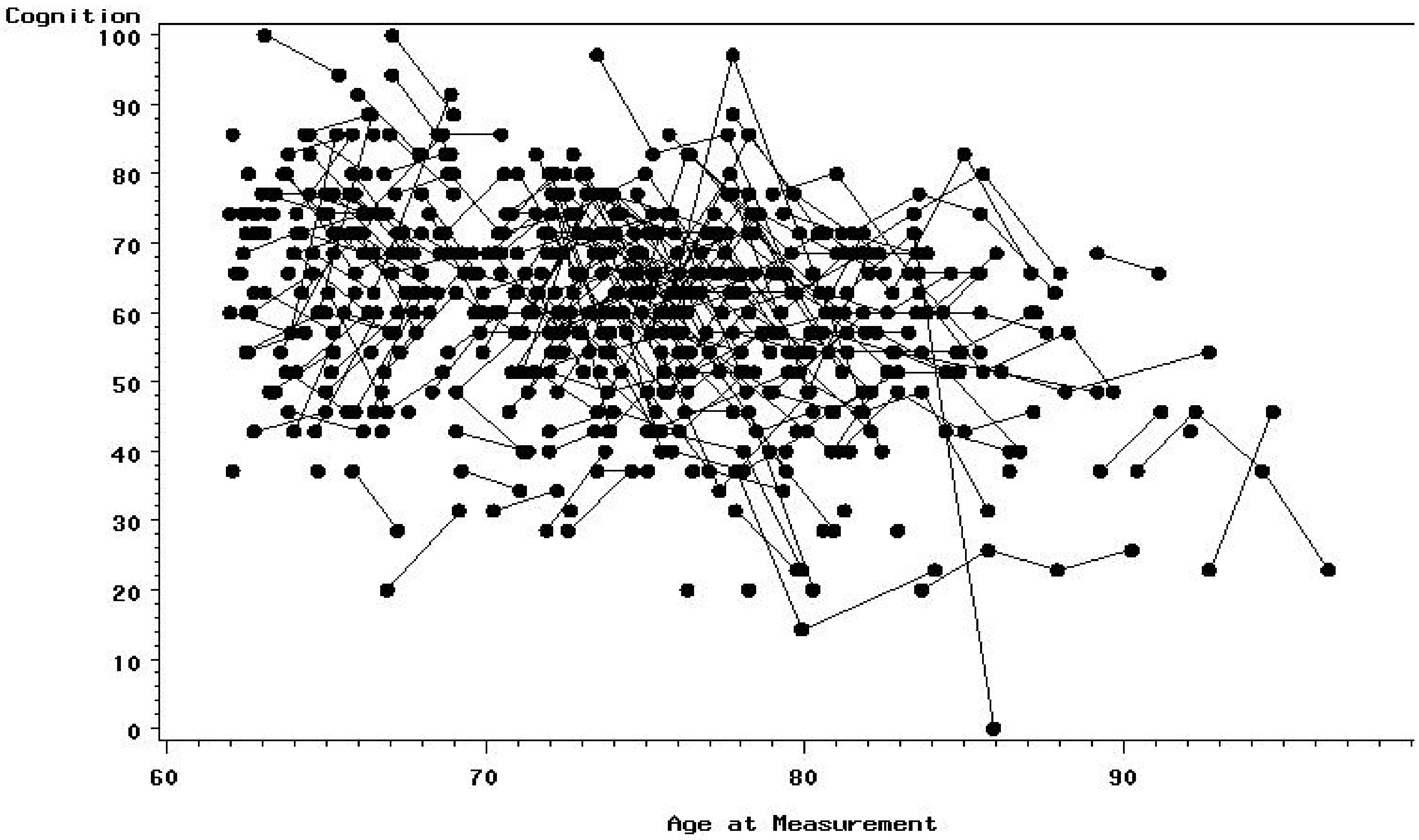
Need 3: Age as the Basis of Change

- The major classification of cognitive aging studies is a separation of the way inferences are made about aging:
  1. *Cross-Sectional "Age Differences*" = made from differences **between** people at different ages.
  2. *Longitudinal"Age Changes*" = additionally made from differences **within** the same people at specific ages.
- Recent efforts in longitudinal statistical methods have led to remarkable flexibility in model fitting (e.g., latent growth, multi-level, hierarchical models) including the ability to deal with unbalanced and incomplete data.
- If a study includes two-or-more repeated observations of the same persons, these math-stat models allow the direct examination of "rates of change over age" (Δy[t]) without random error, and with correction for non-random dropout.
- One new example is our 2007 study on the nature and sources of Age Changes in Episodic Memory in the HRS.

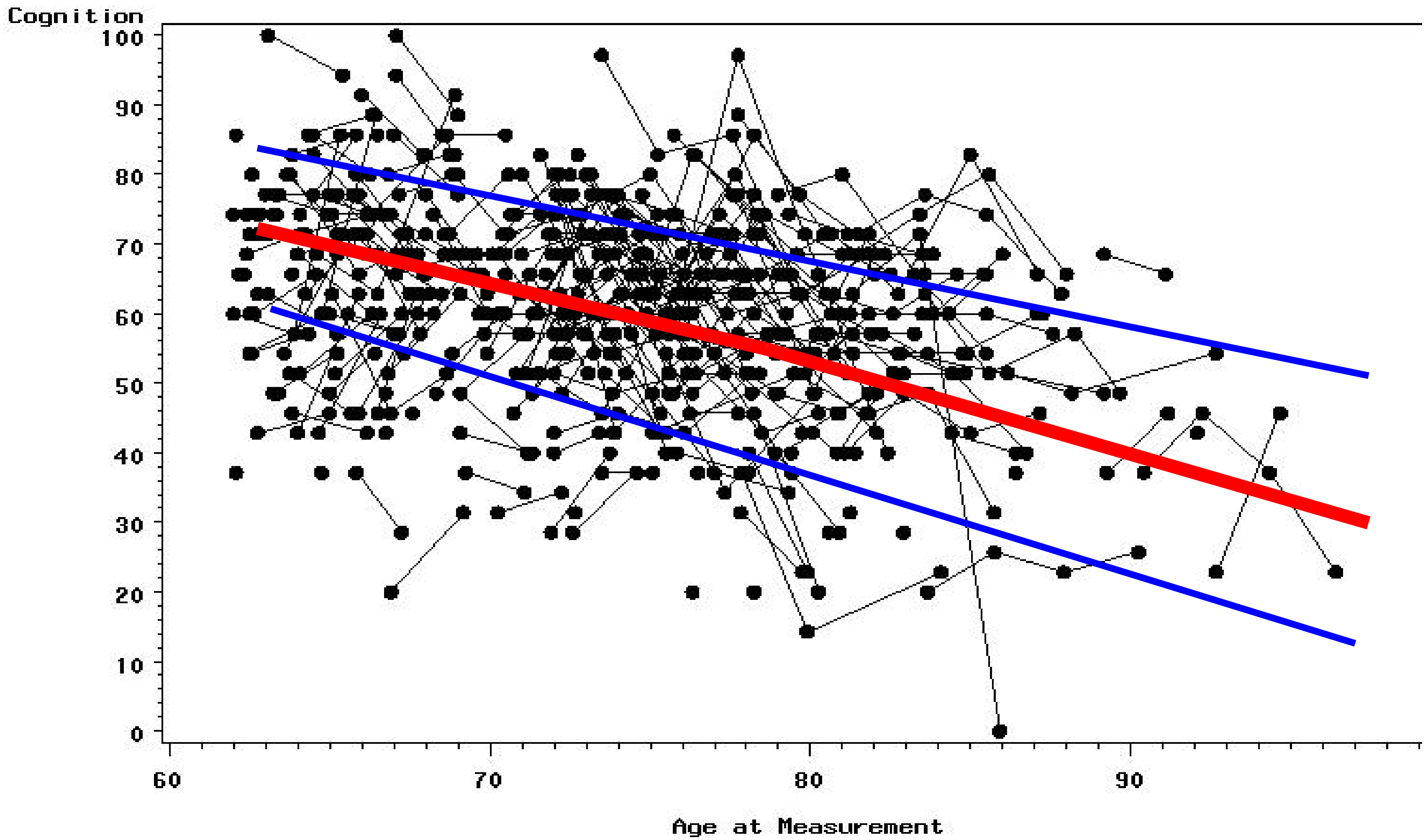
Figure [2b]: HRS Cognitive Data over DATE



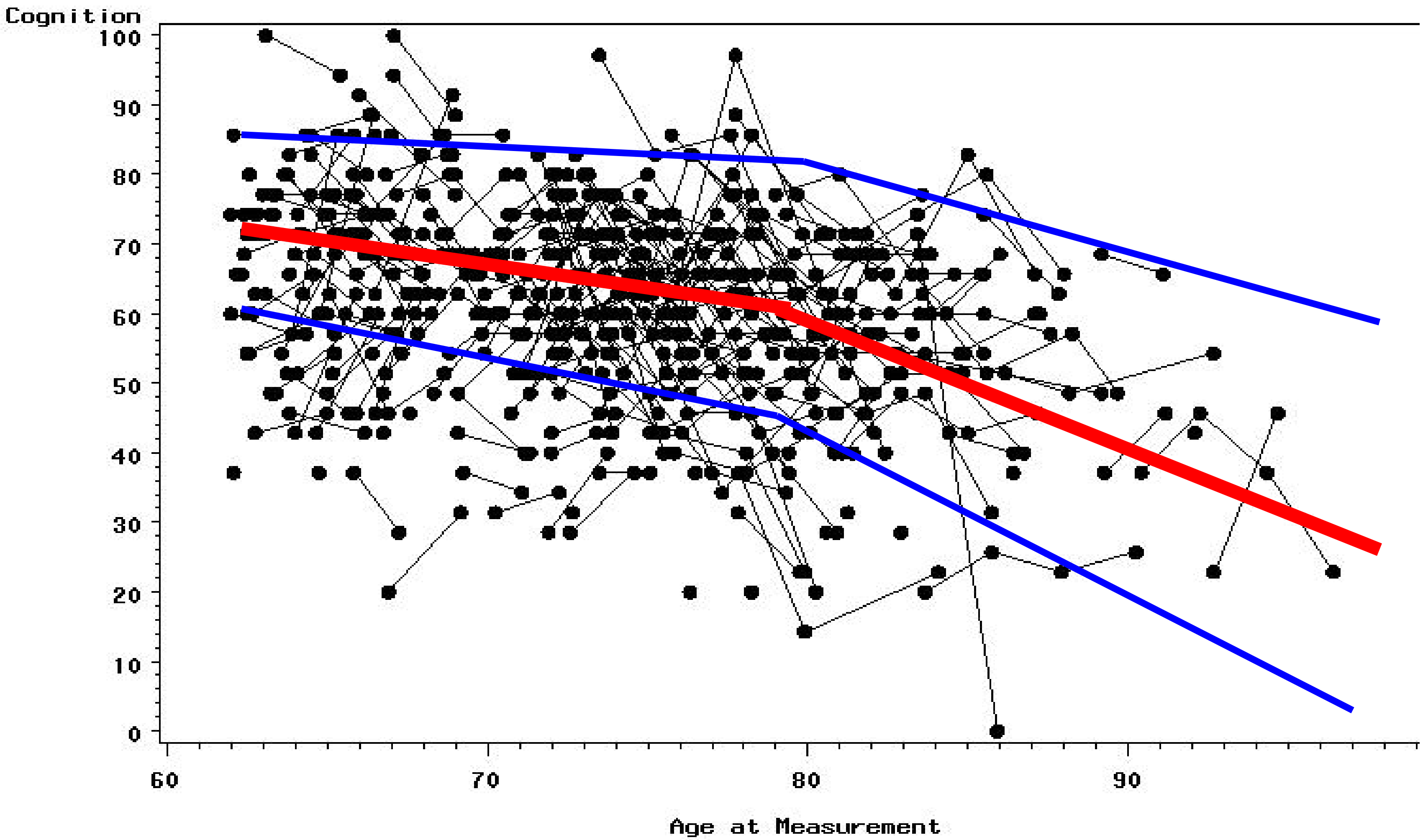
HRS Cognition Scores given AGE of Measurement (N=14,250; D=32,665; T=1-4; Only a sample of data are drawn here, and outliers were excluded)



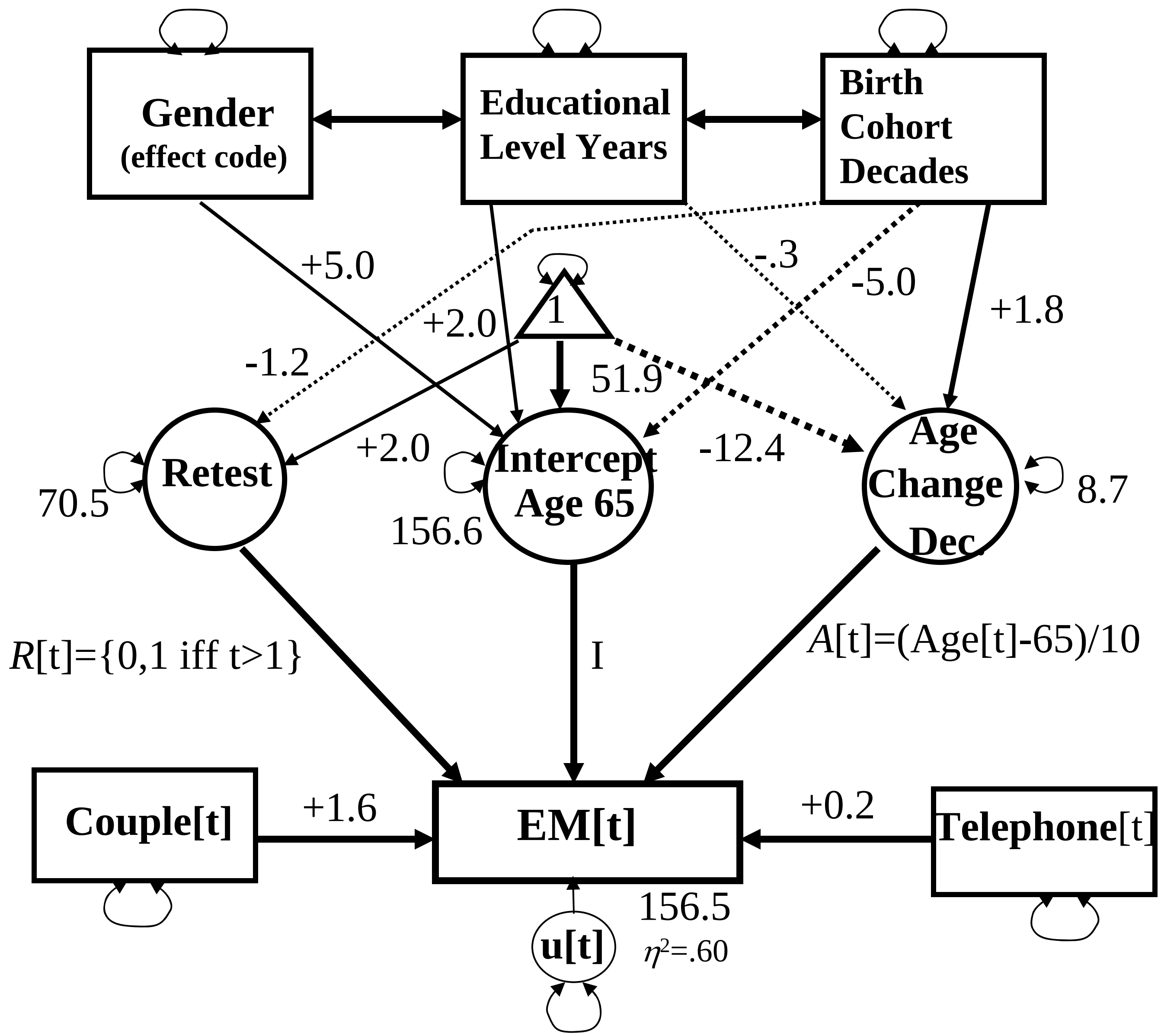
Expected HRS Cognition Scores given AGE of Measurement (N=14,250; D=32,665; T=1-4; Only a sample of data are drawn here, and outliers were excluded)



Nonlinear Changes in HRS Cognition Scores given AGE of Measurement (N=14,250; D=32,665; McArdle et al, 2007)



Longitudinal changes in Episodic Memory (EM[t]) related to demographic indices (McArdle et al, 2007)



Need 4: Death in Survival-Growth Modeling

- One of the major threats to the validity of aging studies is the analysis of heterogeneous sub-groups following different age trajectories. Some reasonable groupings may be related to differences in health, so a focus on "age-at-death" is a potentially important way to reconsider Δy[t].
- A new set of statistical models based on the concept of "shared-parameters" has led to a natural mixture of "survival and growth curve" analysis. These models can be used to: (a) evaluate any "early indicators" of the later problems from the longitudinal components – "cognitive epidemiology," OR (b) separate out the growth differences in mortality – "normal" versus "pathological" trajectories.
- Our recent analysis of Age-at-Death the HRS, and in the Berlin Aging study, and Age-at-AD diagnosis in the Kungsholmen aging study provide concrete examples.

Figure [1b]: Kungsholmen Cognitive Data over AGE

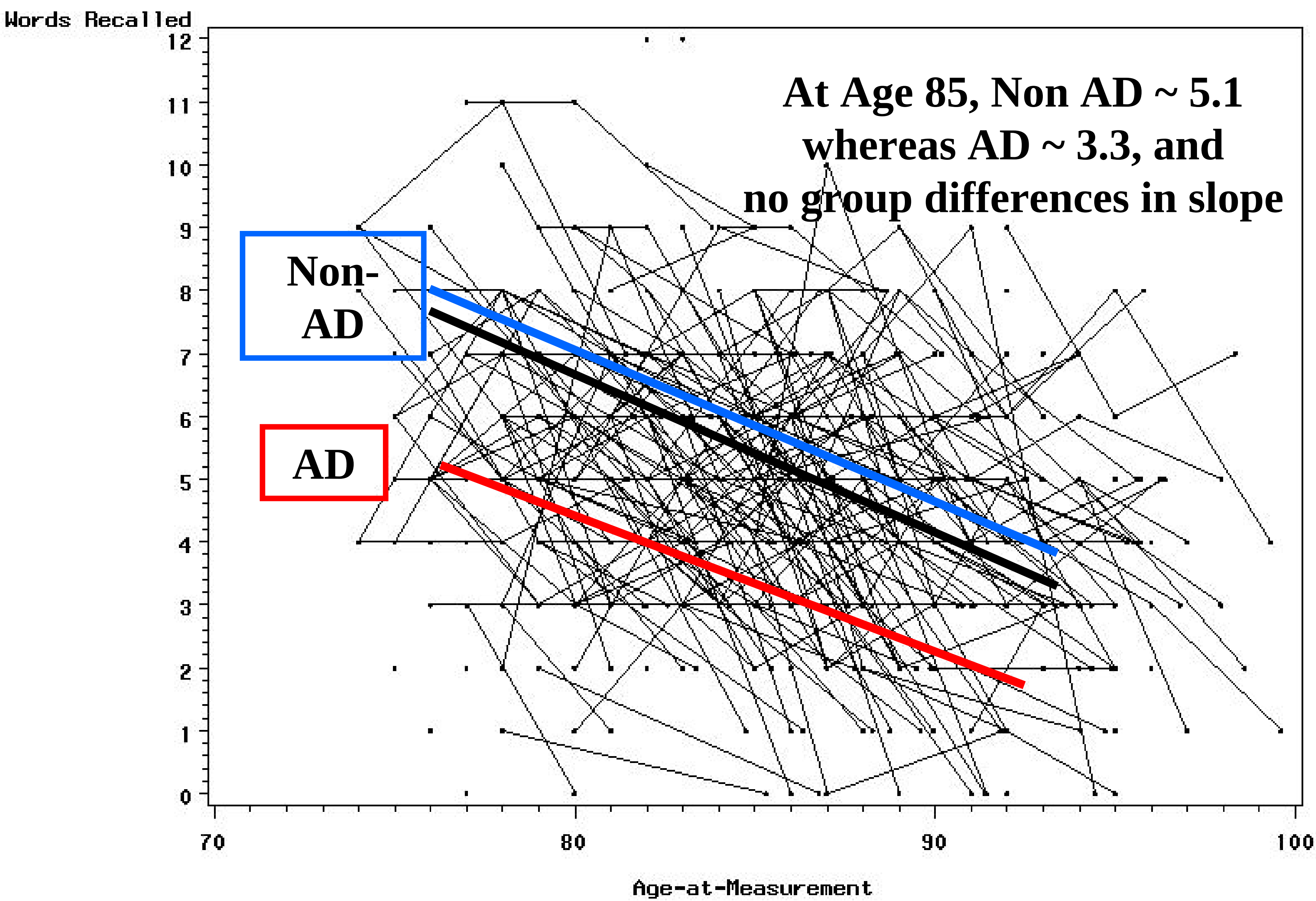
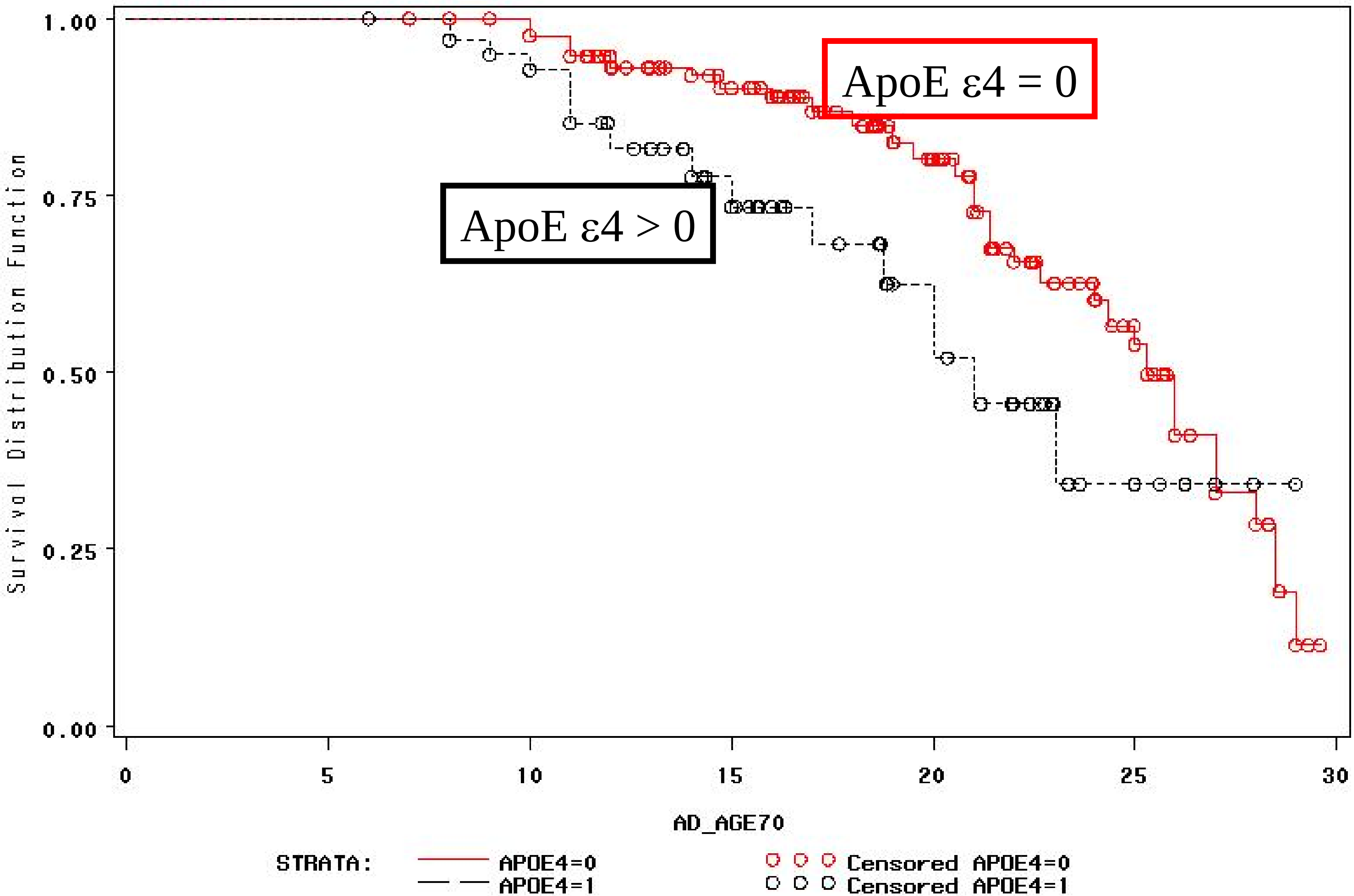


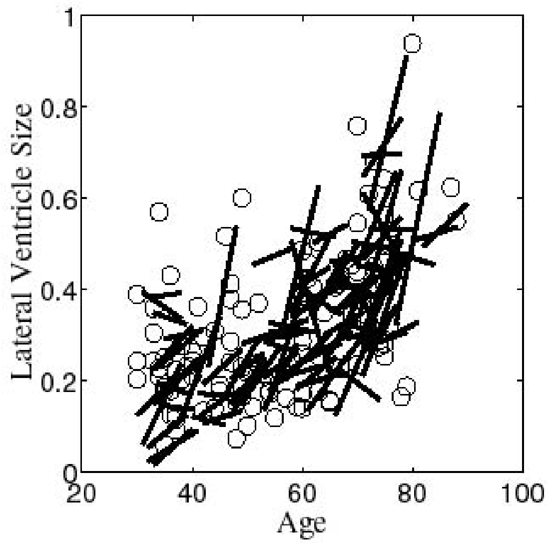
Fig. [2a]: ApoE e4 differences in AD Survivor Functions



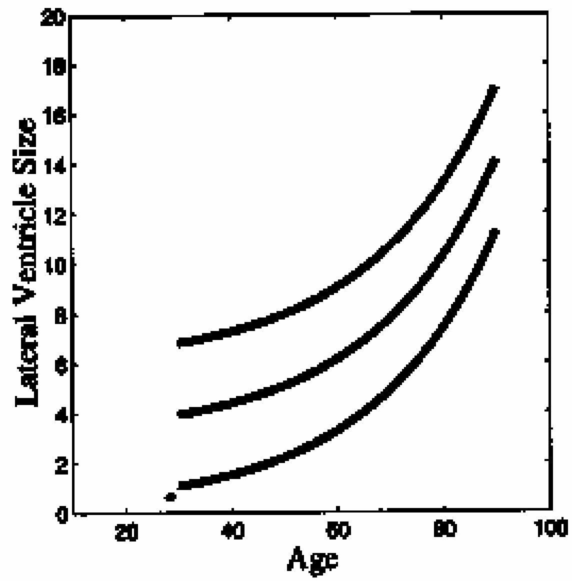
Need 5: Measuring Dynamics of Aging

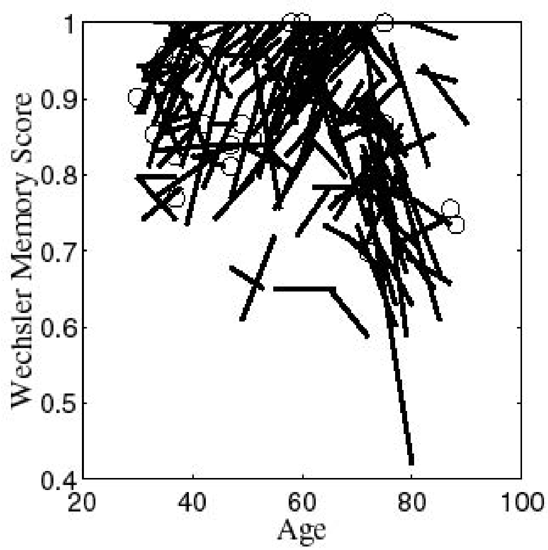
- One of the major threats to the usefulness of aging studies is the lack of clear analysis of dynamic sources of different age trajectories. If the focus is on $\Delta y[t]$, then we need to create studies designed to investigate its determinants.
- A new set of statistical models based on the concept of *multivariate dynamics* ($\Delta x[t]$, $\Delta y[t]$, $\Delta z[t]$, etc.) permits a natural mixture of "dynamics and growth curve" analysis.
- These models can be used to evaluate any "lead and lag" or "leading indicators" of the age-based variation of the longitudinal growth/decline. The separation of groups with differences in dynamic systems is essential.
- Our recent analysis of this kind of dynamic analysis was fit using the NAS/MGH data on Brain Physiology and Memory losses (McArdle,… Albert et al, 2005).

Results for latent curves of LVS +WMS

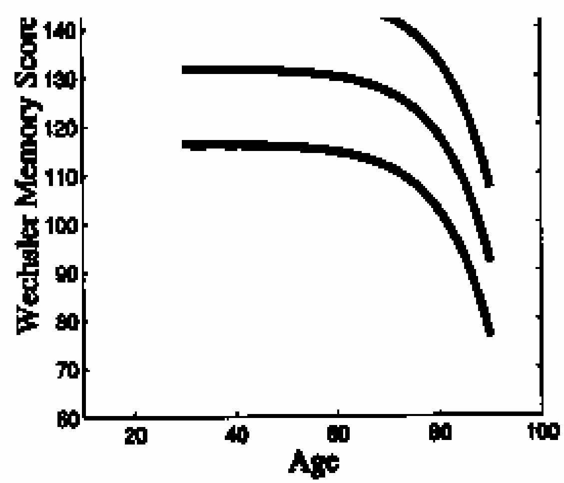


LVS Brain Size

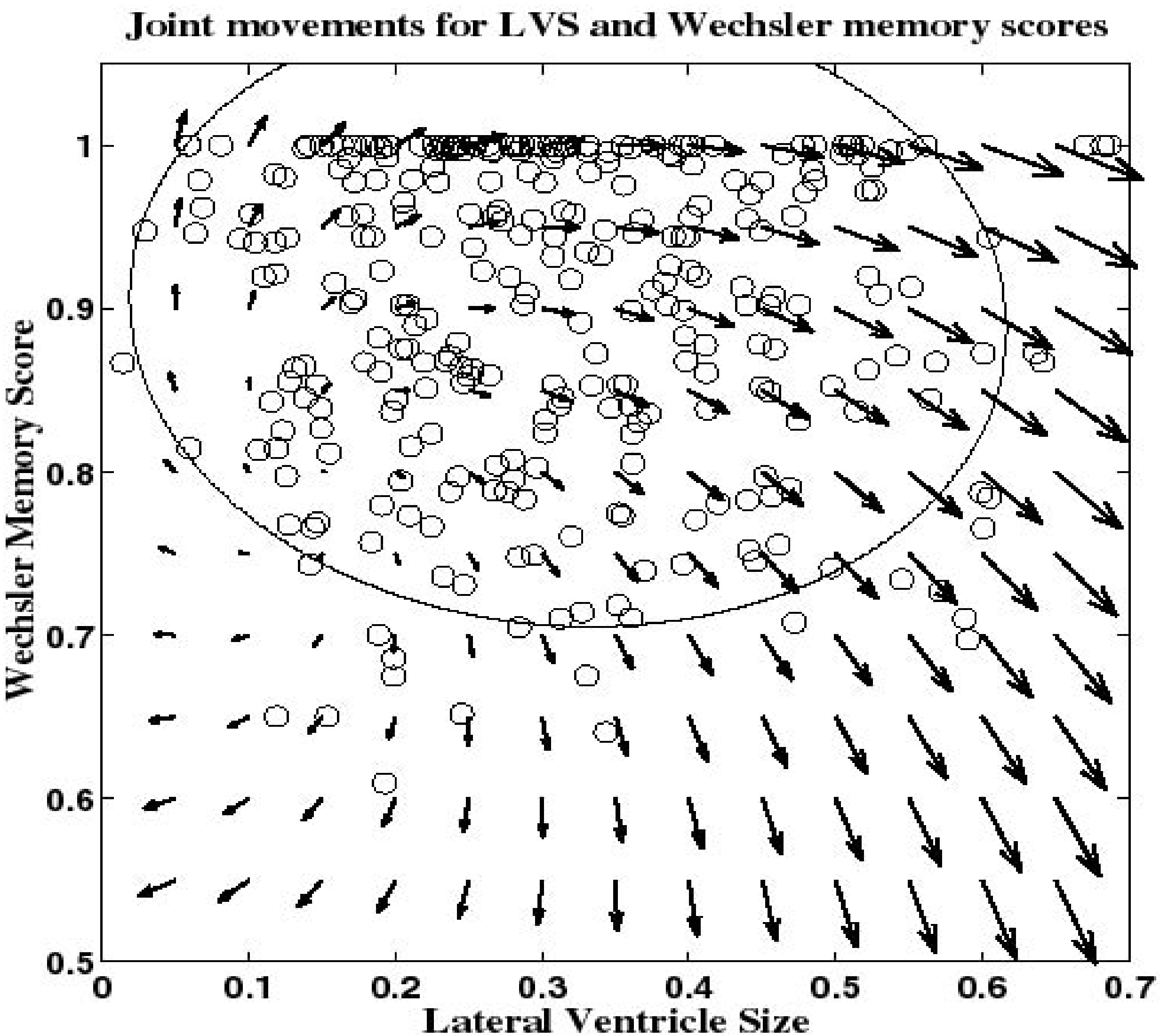




WMS Memory Score



The dynamic field showing increases in Lateral Ventricle Size leads directly to losses in Memory



Separate dynamic vector fields by gender