Spoken language processing across the adult life span

Esther Janse

Radboud University Nijmegen, The Netherlands

Why study aging?

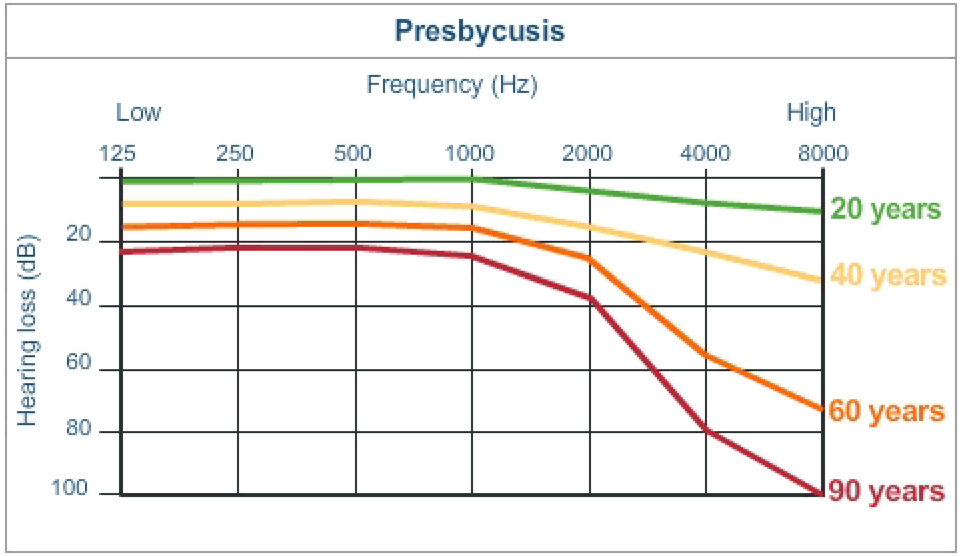
Demographic changes (> 20% above 65 yrs in Europe)

Diversity and individual differences

Baseline for clinical studies

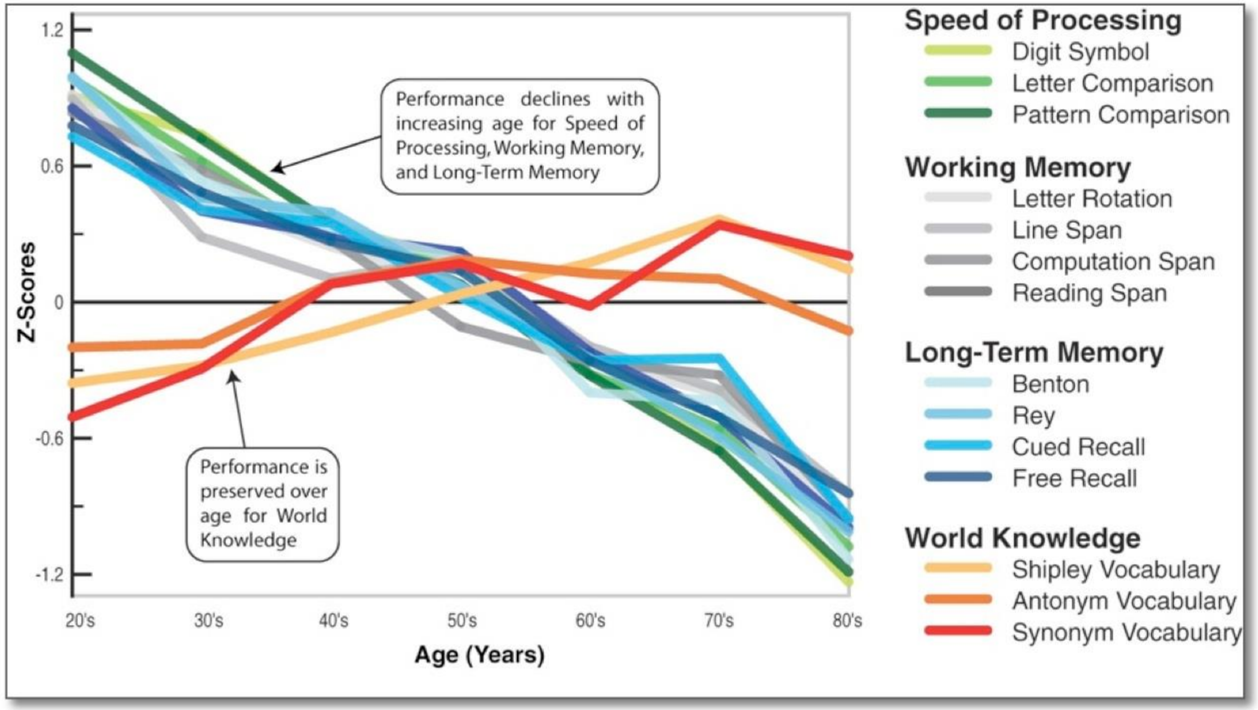
Advancing adult age

- Sensory decline



Advancing adult age

- Sensory decline
- Cognitive decline
  - Brain structure
  - White matter integrity

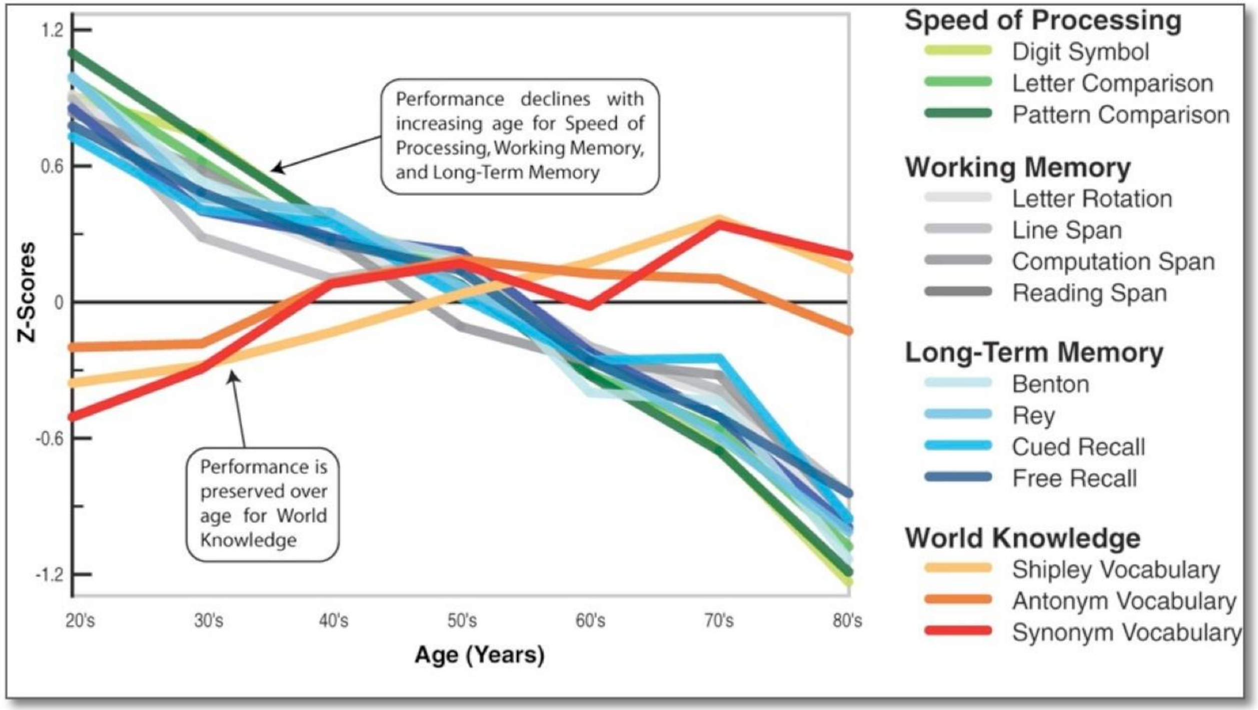


Advancing adult age

- Sensory decline

- Cognitive decline

- Crystallized knowledge increases



'Scaffolding Theory' of aging and cognition
(Park & Reuter-Lorenz, 2009)

- To face sensory and cognitive decline

Or communicative

- And to achieve a particular cognitive goals
  - use and development of complementary / alternative neural circuits

- Cognitive system responding *dynamically* and *adaptively*

Consequences of aging for spoken communication

- Perceptual adaptation for speech comprehension
- Statistical learning from auditory input for comprehension
- Probabilistic reduction in speech production

Thordis Neger

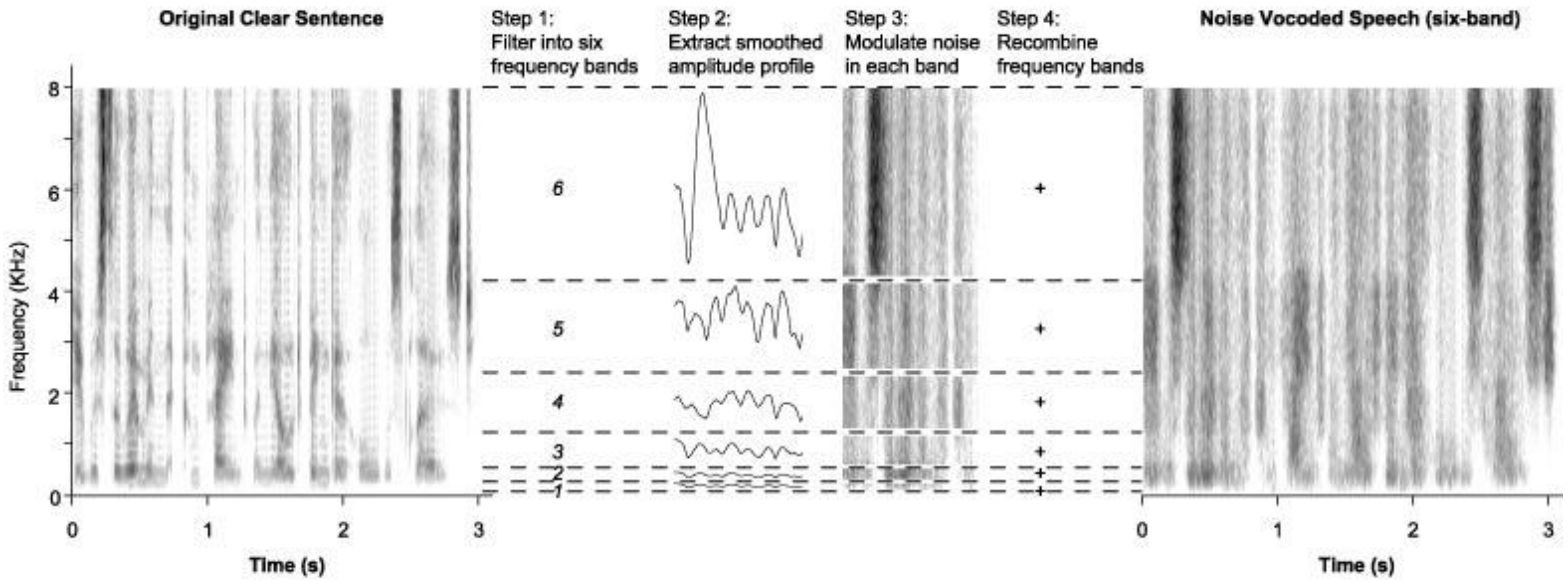
Conny Moers

Perceptual adaptation (Neger, Rietveld & Janse, 2014)

- "relatively long-lasting *changes* to an organism's perceptual system that improve its ability to respond to its environment"(Goldstone, 1998)
- Implicit learning stable across adult life span?
- Noise-vocoded speech
- Age group differences in perceptual adaptation?

Task and participant sample

- Sentence identification (# keywords correct)
- Improvement over (blocks of) trials (no feedback)
- 5 band vocoding for older adults; 4 bands for younger adults



Task and participant sample

- Sentence identification (# keywords correct)
- Improvement over (blocks of) trials
- 5 band vocoding for older adults; 4 bands for younger adults

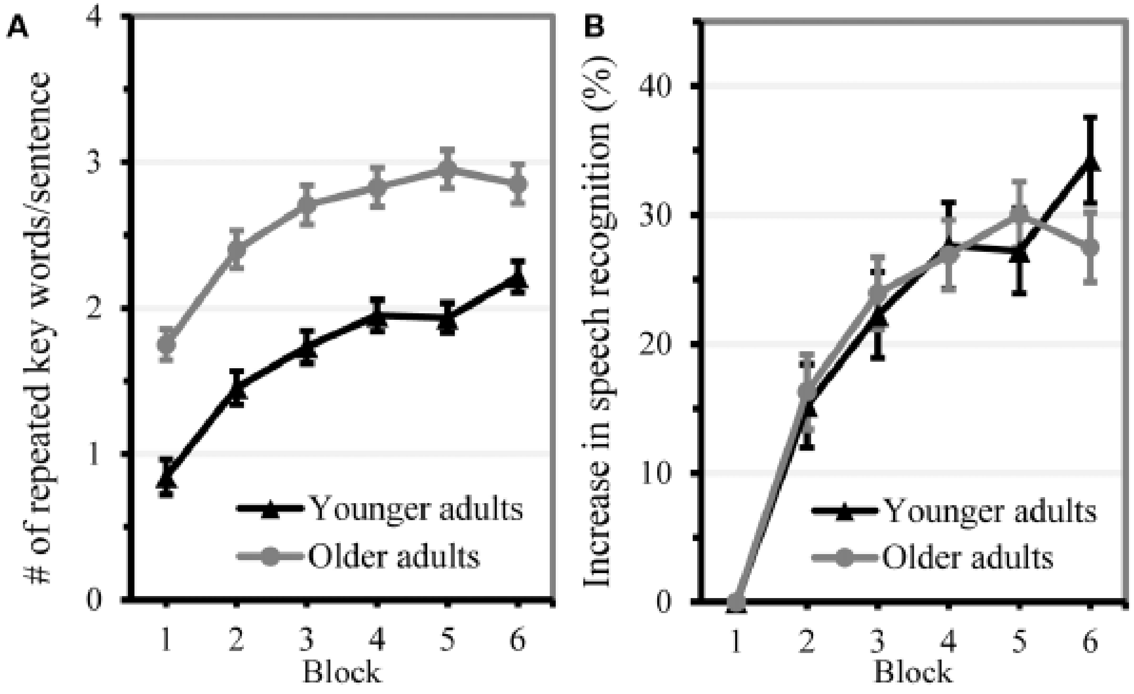
60 younger adults (18-29 yrs)	73 older adults (60 – 84 yrs)

Working memory	YA >> OA
Processing speed	YA >> OA
Hearing	YA >> OA
Vocab	YA << OA

Perceptual adaptation results

- Sentence identification (# keywords correct; 4 keywords per sentence)

Performance *Increase in performance*



Perceptual adaptation results

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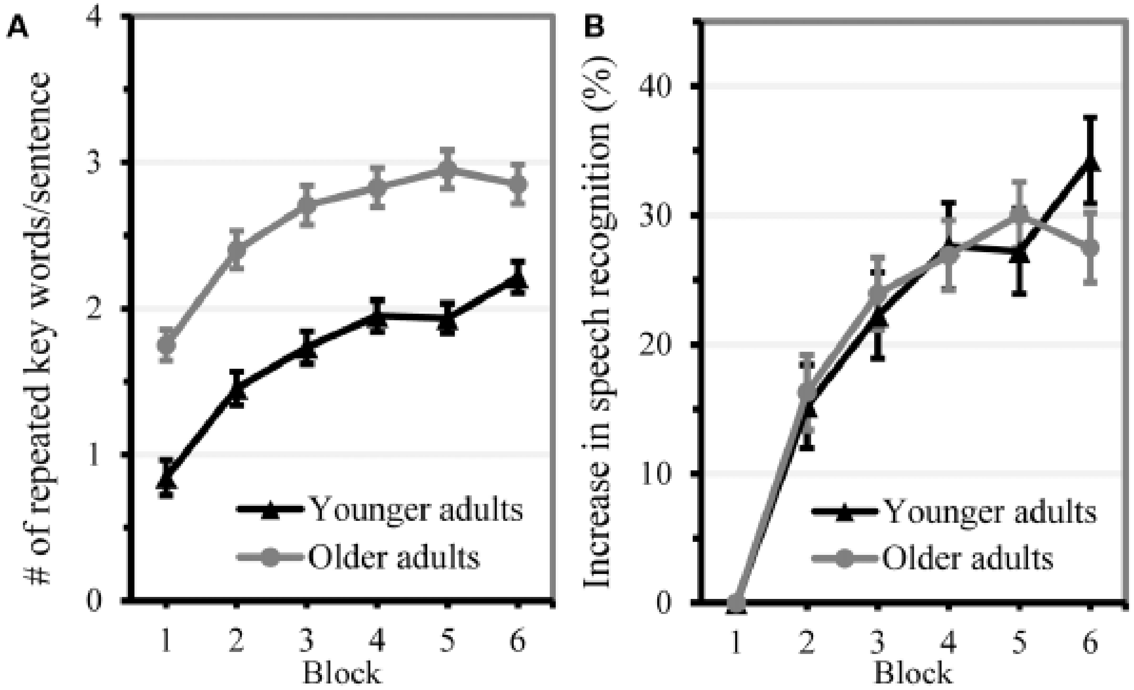

- Same amount of learning for OA given better starting level intelligibility

Perceptual adaptation (Neger, Rietveld & Janse, 2014)

- Age group differences in perceptual adaptation?

- *Not really*
- In line with earlier findings of equal adaptation across age groups

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- *BUT...*
- OA had higher starting level than YA
- Among OA: less adaptation with older age

- Vocabulary knowledge differences
- Statistical learning differences

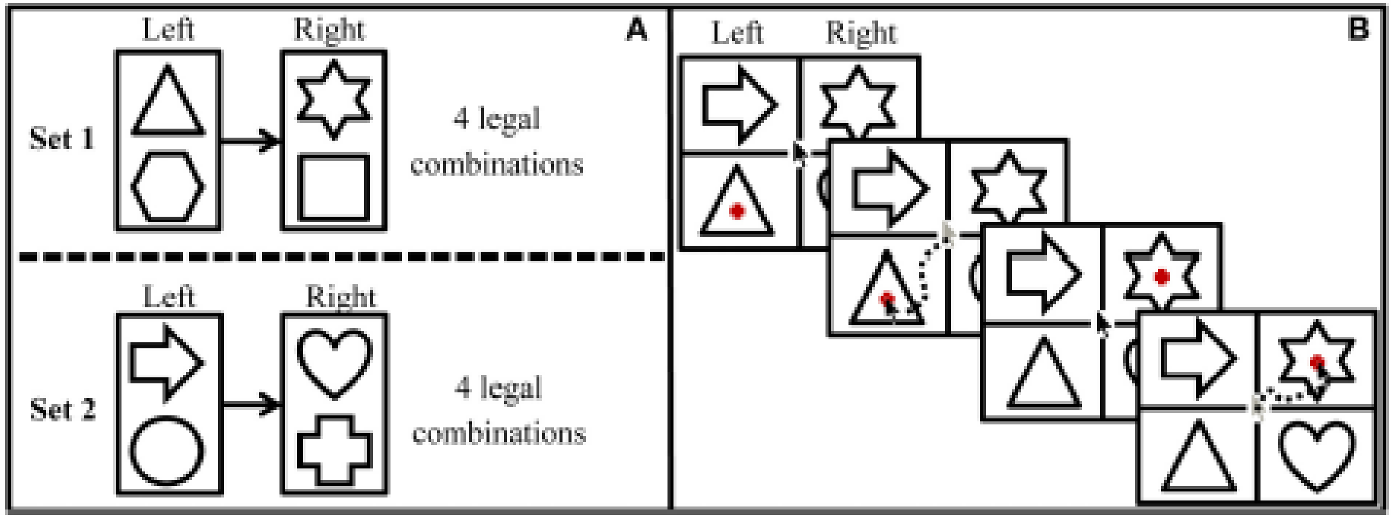
} Perceptual adaptation

Statistical learning

- Age group differences in statistical learning?

Noise-vocoding study

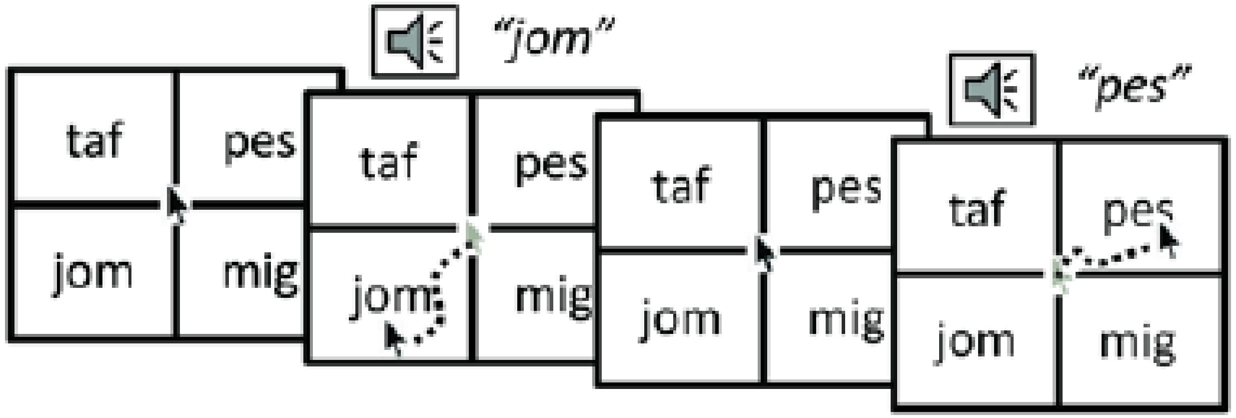
- Visual artificial language learning paradigm
- Statistical learning for YA, but not for OA



Statistical learning (Neger et al., 2015)

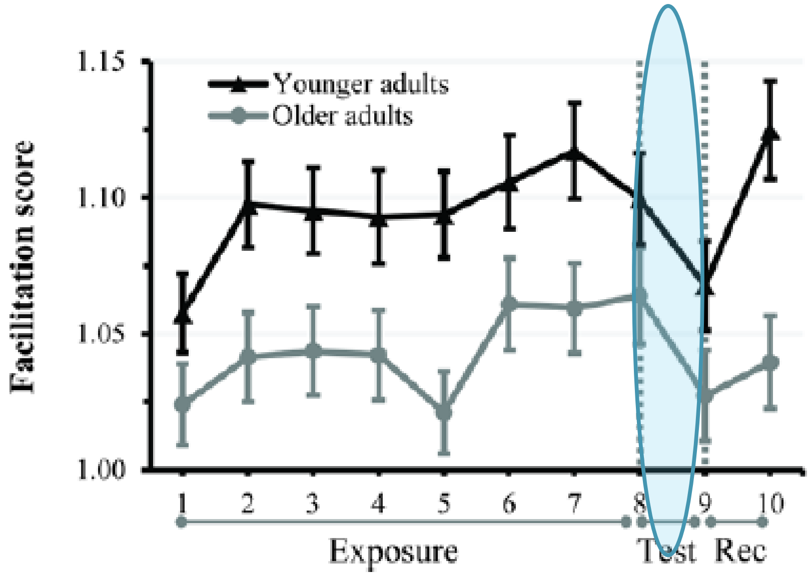
- Sensitivity to co-occurrence statistics *generally* impaired in OA?

- Artificial language learning paradigm
- Auditory nonword combinations (e.g., “jom-pes” / “jom-vun”)



Statistical learning (Neger et al., 2015)

- Age differences in auditory statistical learning?
- Statistical learning predicted by hearing and attentional ability?



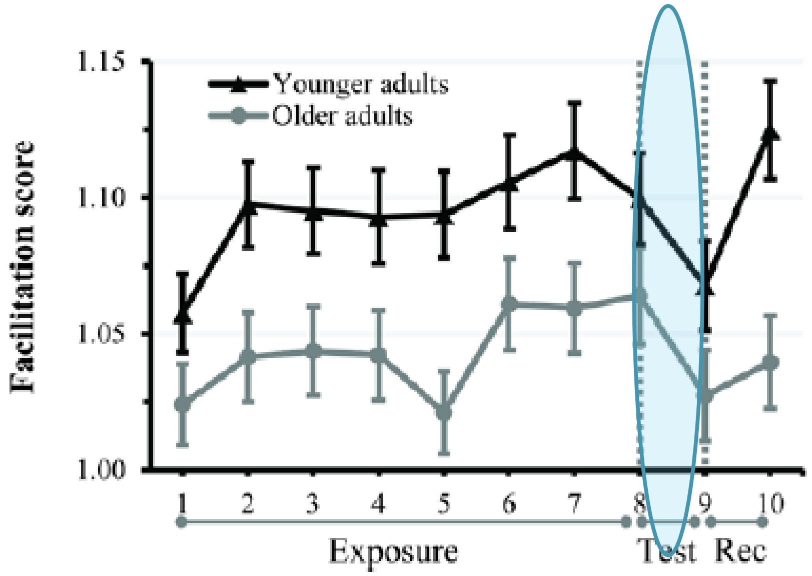
Statistical learning (Neger et al., 2015)

- Age differences in auditory statistical learning?
- Statistical learning predicted by hearing and attentional ability?

Age groups show

- similar improvement over exposu
- similar drop in performance at te
- similar recovery

No role for hearing/attention



Different pattern of results due to modality (not syllable vs. symbol)

Age group differences or not?

Perceptual adaptation to NV speech	Y / N
Temporal regularities in visual input	Y
Temporal regularities in auditory input	N

Age group differences or not?

Perceptual adaptation to NV speech Y / N

Temporal regularities in visual input Y

Temporal regularities in auditory input N

Modality-specific deficit in aging

Auditory modality temporal regularities

Visual modality spatial regularities (Conway & Christiansen,2005)

OA experience deficit in modality less specialised for sequential info

Ideal adapter framework (Kleinschmidt & Jaeger, 2015)

- Sensitivity to statistical distributions indispensible for accommodating to novel speech input
- Update beliefs / representations → better prediction

- Age group differences in prediction?

  Age-related declines in WM may account for age differences in prediction (Janse & Jesse, 2014; Janse & Huettig, 2016)

- Probabilistic reduction in speech production

Probabilistic Reduction

- More probable items (e.g., words, phrases, and syntactic constructions) are acoustically reduced

- Probability quantified as Transitional Probability (word pairs):
- Increase/decrease over the adult life span?

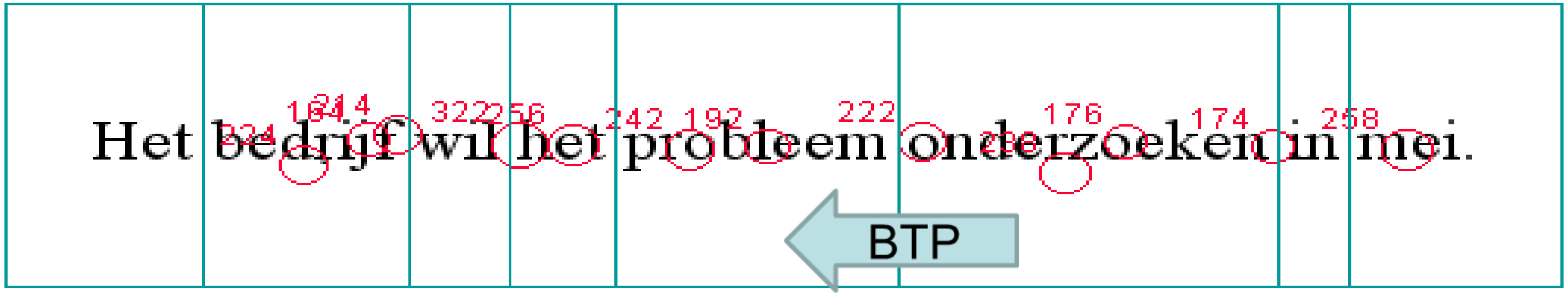
TP: likelihood of a word given preceding/following word

Probabilistic Effects on Reading

- Eye-tracking while subjects read full sentences
- Two conditions: silent reading & reading aloud

Dataset:

- 1) 240 noun-verb combinations varying in TP (Fw & Bw)
- 2) Lexical statistics based on SUBTLEX



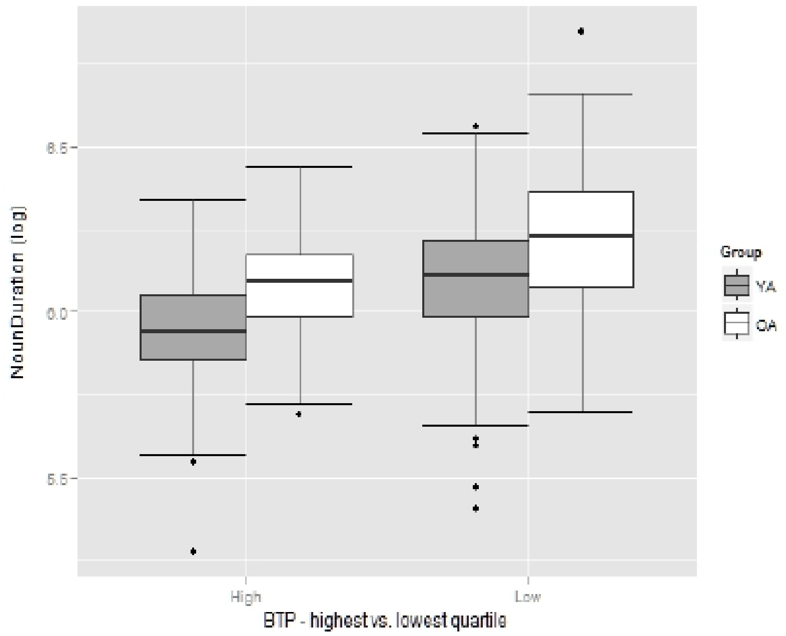
Results of spoken word durations

<u>Speech rate (sentence reading)</u>

YA: 5.9 syll/sec   OA: 5.1 syll/sec

<u>Noun duration predicted by</u>

- Speech rate
- Noun frequency
- Bw-TP (from upcoming verb)
- Age



But no interactions of frequency/TP with Age

Same story for eye-tracking data (silent and oral reading)

Probabilistic reduction

Frequency and TP effects on speech production

- coordination mechanism linking lexical access to articulation
- progress of lexical retrieval is synchronized with speed of articulation

This coordination is well maintained in older adulthood

Age group differences or not?

Perceptual adaptation to NV speech	Y / N
Temporal regularities in visual input	Y
Temporal regularities in auditory input	N
TP effects on reading (aloud)	N
(Rapid semantic prediction in comprehension)	Y

Age group differences or not?

Perceptual adaptation to NV speech Y / N

Temporal regula[illegible]nput Y

Temporal regula[illegible]y input N

TP effects on re[illegible] N

(Rapid semantic [illegible]omprehension) Y

...

....

Depending on task, modality, time pressure .....

Dynamic changes over the life span

- Stability with older age across many (not all) communicative tasks
- Susceptibility to aging effects depends on multiple factors
- Language experience (vocab) as ‘protective’ factor