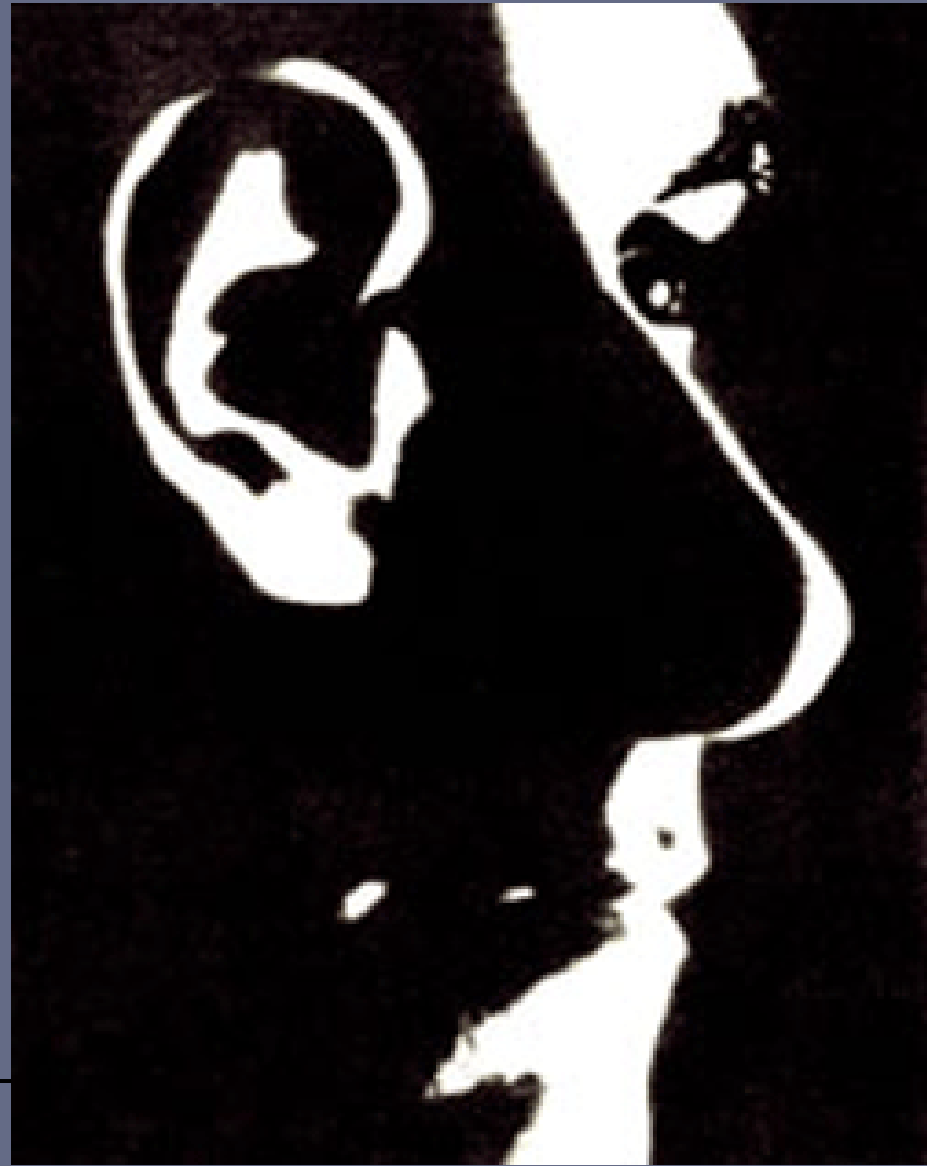


# Visual impairment and AV speech understanding in older adults with acquired hearing loss



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# Vision an important component of speech communication

*'The profession of audiology has not been consistent in acknowledging the visual component of everyday communication.*

*For example, most hearing assessment and hearing aid selection/ adjustment/programming techniques exclude the visual component completely, and appear to treat the person with impaired hearing as they were totally blind.'*

# Vision and speech communication

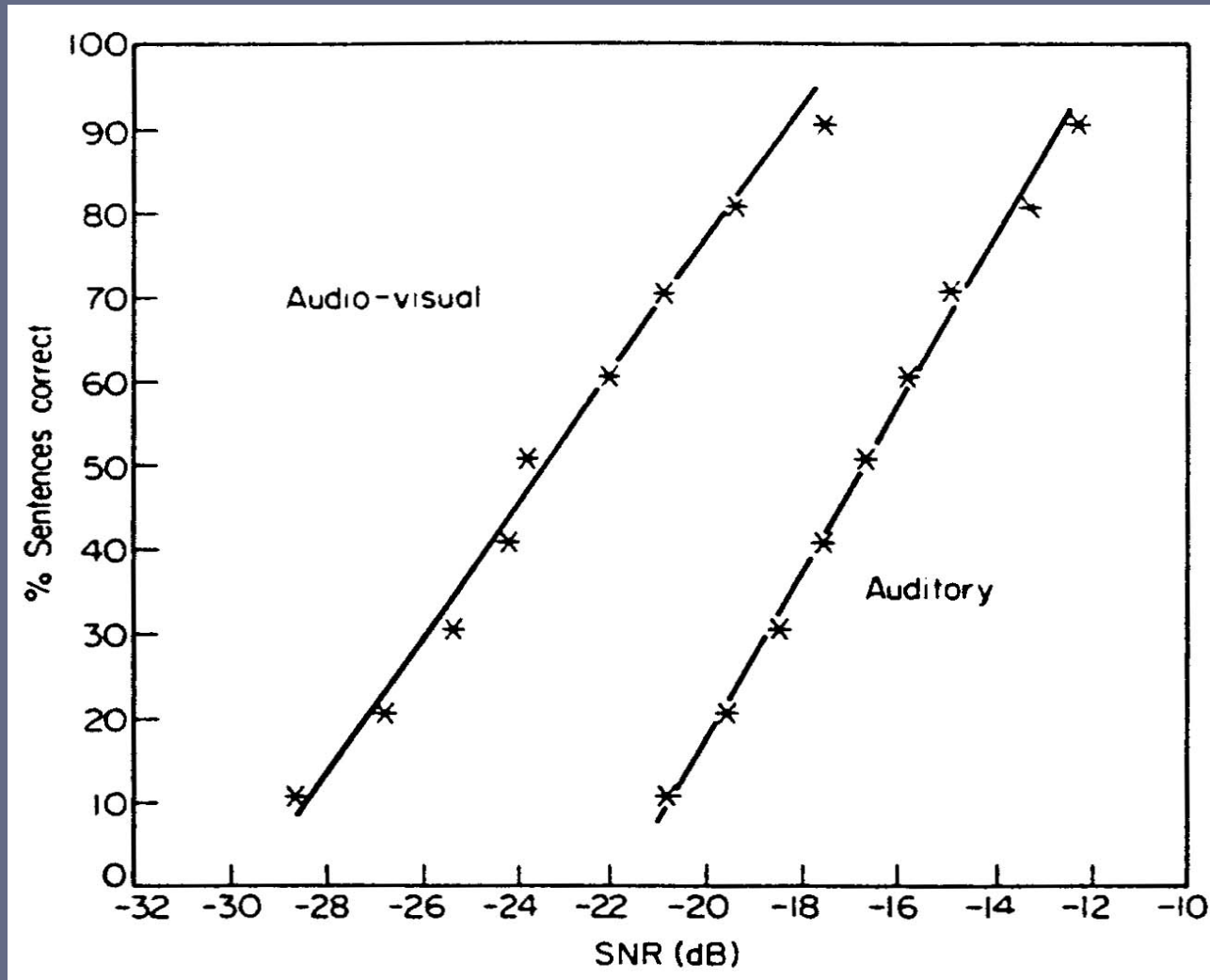
*Given that much daily interaction occurs face-to-face, the visual component of communication must be seriously considered in the overall rehabilitation process*

Erber, 2003, p. 2523

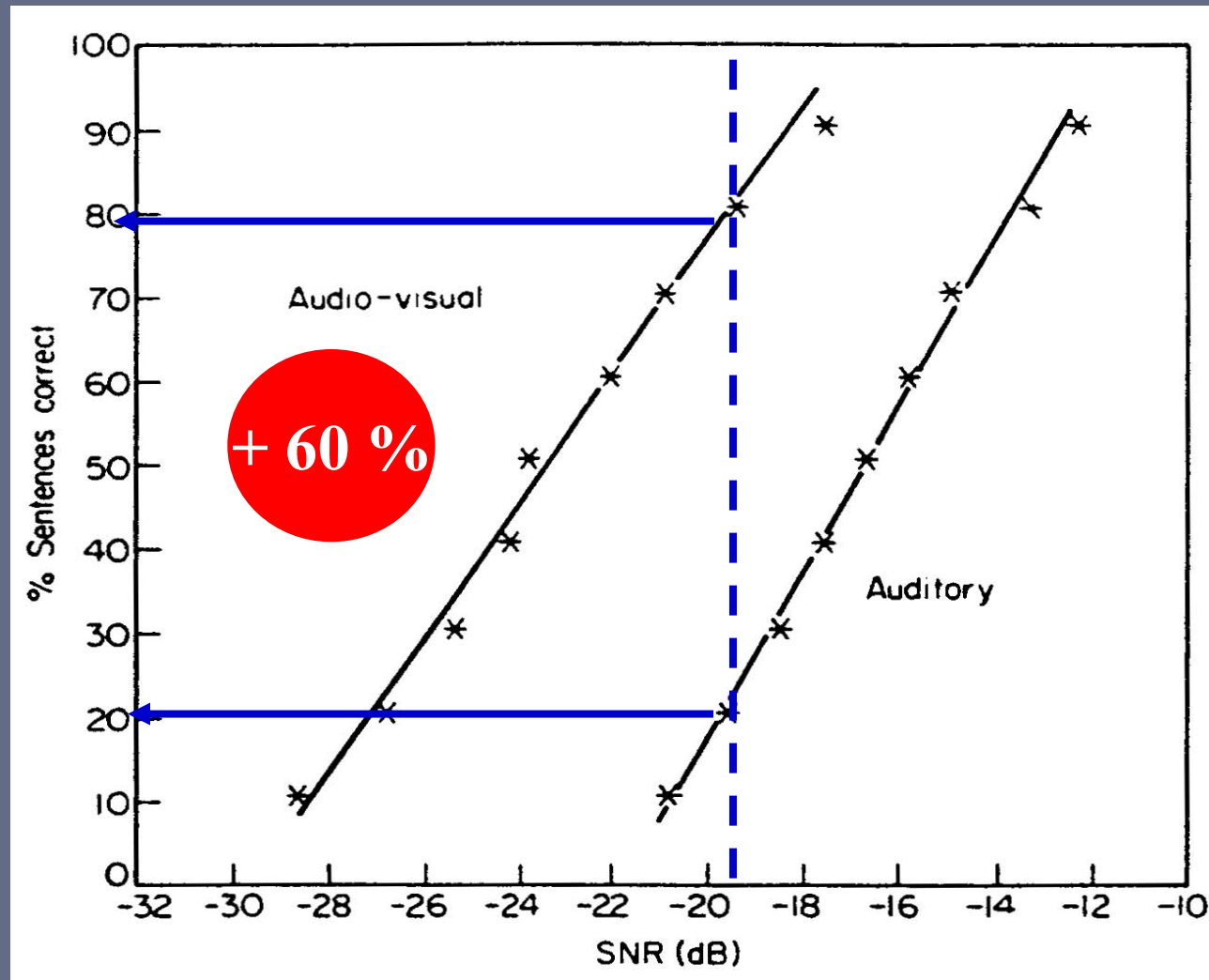
There is more and more evidence to suggest that speech-perception is an audiovisual phenomenon.

Except in some specific situations (e.g., telephone) the interlocutor has access to the visual-speech cues produced by the talker.

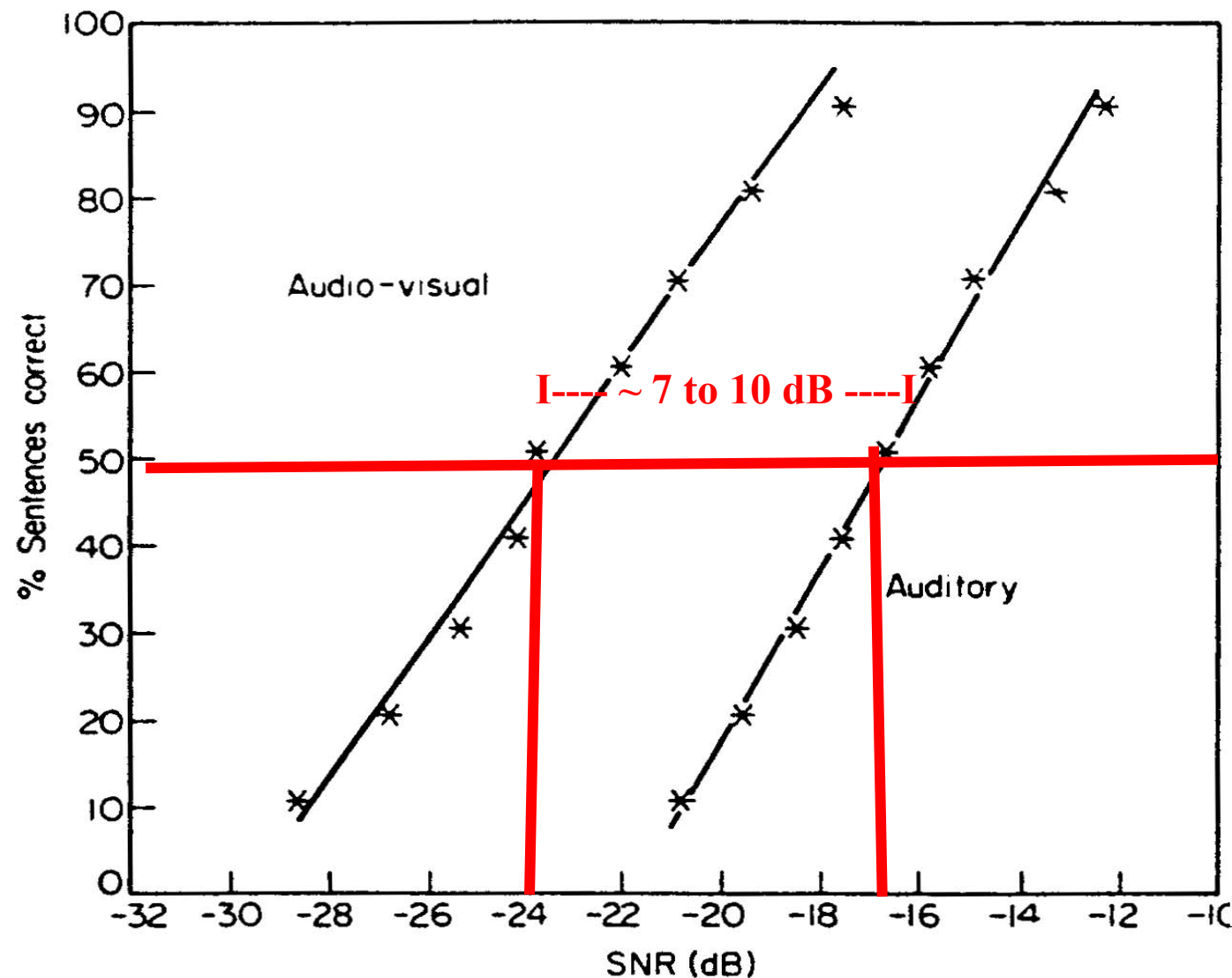
# Benefits of providing visual speech cues



# Benefits of providing visual speech cues



# Benefits of providing visual speech cues



Summy & Pollack, 1954 showed improvements in SNR ranging from 5 to 18 dB

# Benefits of providing visual speech cues

Using a divided attention task (a dual task paradigm), with normal-hearing young adults we have shown that, relative to A-alone performance, providing visual-speech cues significantly:

**Improves Performance**

**Improves Response time**

**Decreases Effort**

...on a sentence recognition task

# Speechreading (V-alone) in OA with normal (or corrected normal visual acuity)

There is an effect of age for words and sentences

Performance decreases as a function of age:  
likely beginning as early as the 5th decade  
certainly by the 7th decade

Dancer et al., 1994; Shoop & Binnie, 1979; Campbell et al., 2007;  
Spehar et al., 2004; Sommers et al. 2005, Tye-Murray et al., 2007  
Walden et al., 1993



# Speechreading (V-alone) in OA with normal (or corrected normal visual acuity)

There is an effect of age for words and sentences

Speechreading for words better in OA with hearing loss than OA with typical hearing

Tye-Murray et al., 2007

Despite speechreading differences in performance observed between OA and YA there are no differences in the patterns of confusion made between the 2 groups

Walden et al. 1993

# AV-Speech-perception in OA with normal (or corrected normal) visual acuity

Sommers et al., 2005

Adjusted speech-babble to fix performance in A-alone modality

Measured: VCVs, words, and sentences in A, V, and AV.

Participants were YA and OA normal hearing and vision

# AV-Speech-perception in OA with normal (or corrected normal) visual acuity

Results:

A-alone same for YA and OA

V-alone poorer for OA

AV scores : poorer for OA

AV-integration: No age difference in A-enhancement or V-enhancement when v-alone performance was taken into account.

***Conclusion:***

***Poorer AV scores for OA due to poorer V-scores***

***No age difference in ability to integrate AV information***

# AV-Speech-perception in OA with normal (or corrected normal) visual acuity

Walden et al. 1993, compared middle-aged adults (MAA) with HL and OA with similar HL

He concluded:

- OA with moderately severe hearing loss, but without other specific pathology or disease, benefit as much from the provision of visual cues to supplement their impaired auditory speech recognition performances as do middle-aged adults with impaired hearing
- OA are similar to YA in their ability to integrate audio and visual speech cues

# AV-Speech-perception in OA with normal (or corrected normal) visual acuity

- Helfer (1998) found that age was not related to AV benefit (i.e., OA and YA similar benefits)
- Cienkowski and colleagues (2002, 2004) there are no age related declines in AV integration

# AV-Speech-perception in OA with normal (or corrected normal) visual acuity

## Take home message:

Older adults :

Poorer A-alone than YA;

Poorer V-alone than YA

AV-integration: OA appear to Integrate as well as YA but  
verdict not definitive

**However, there is no doubt that in OA with good vision, AV-  
performance is better than A-alone or V-alone**

## Conclusion:

**In AR, promote the use of vision to enhance auditory speech  
understanding.**

What about the effects of visual  
impairment on AV-speech  
understanding

# Dual (hearing and vision) impairments in older adults

Generally estimated that between 9 and 18% of older adults (< 65 yrs) have a visual impairment

Brennan, Horowitz and Sue (2005) who found that 20% of seniors over the age of 70 presented with dual sensory impairment.

Up to 1 in every 5 OA (above age 70) that consults a hearing care professional because they have hearing problems also have significant (uncorrectable) vision problem!



# Visual impairments

# Vision impairment

Four major eye diseases that occur in OA:

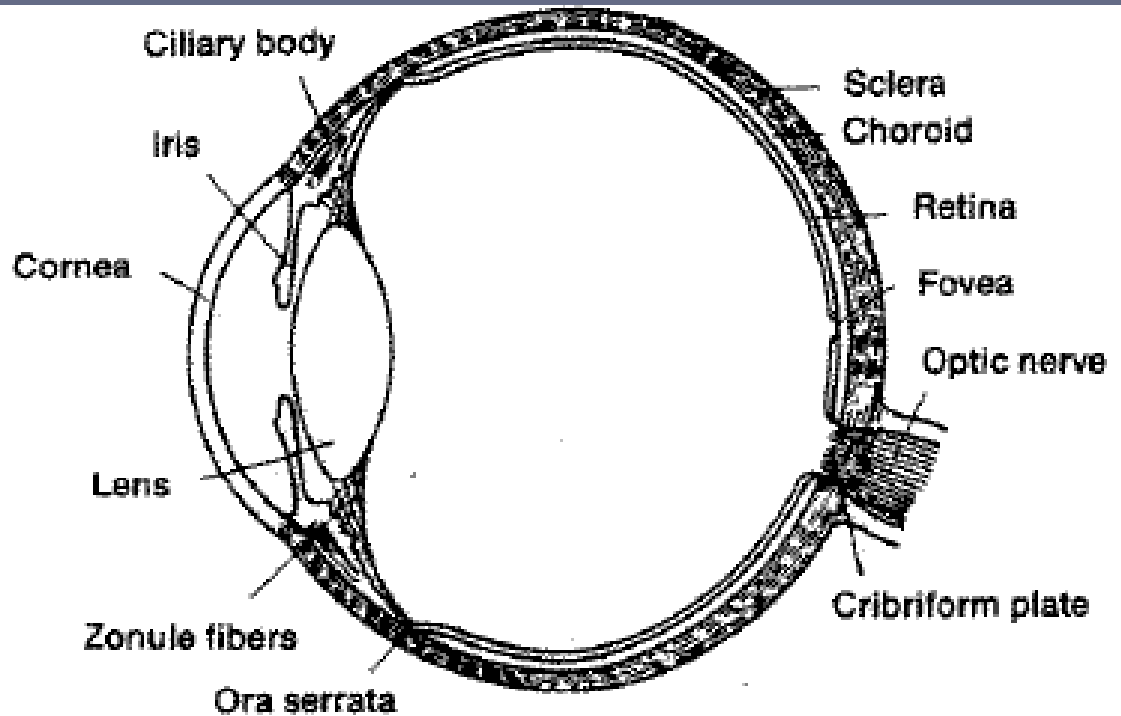


Figure 2-11 Section through the globe.

- Cataracts
- Macular degeneration
- Diabetic Retinopathy
- Glaucoma

# Normal visual perception



# Visual impairments in OA

## Cataracts:

Most common in OA

Clouding of the lens

Scattering of incoming light

Can be treated by surgery – lens replacement)



Cataract

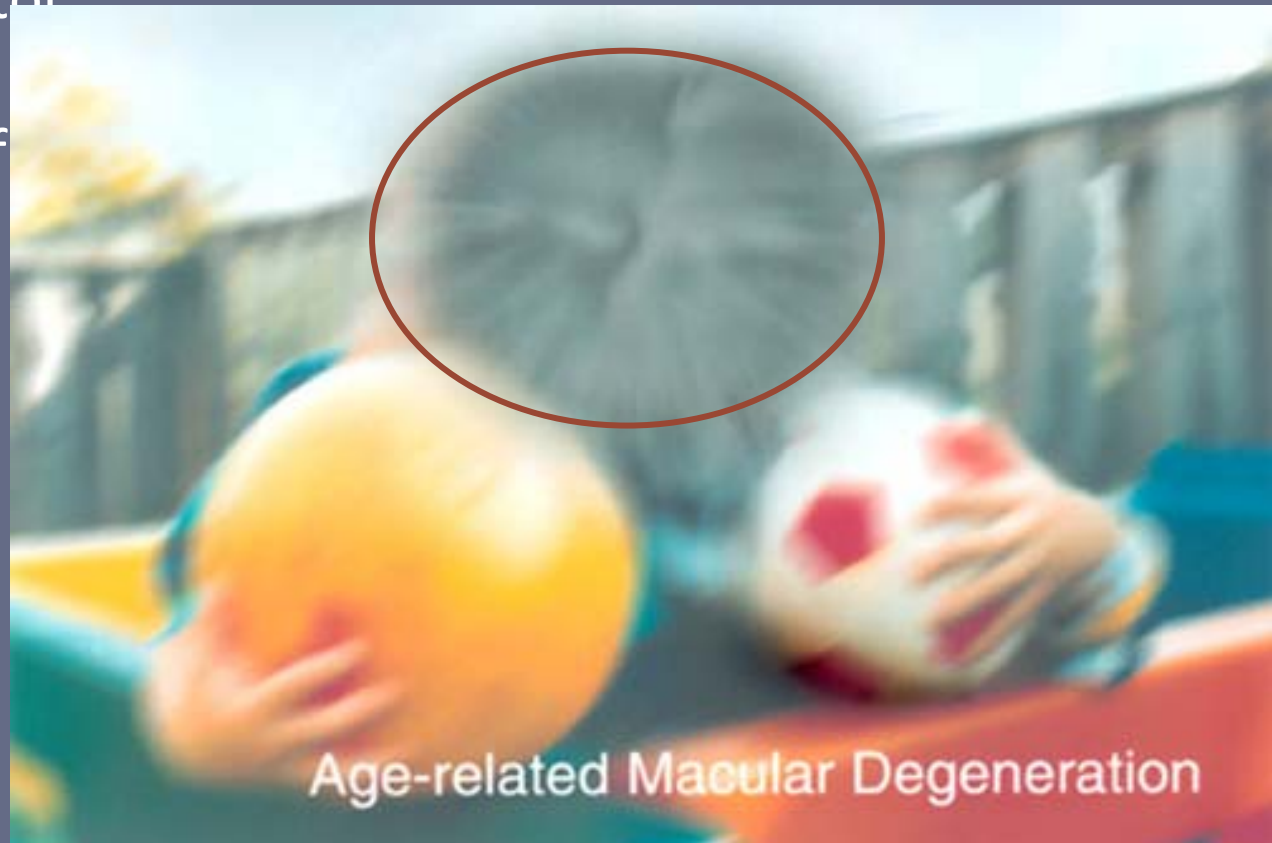
# Visual impairments in OA

## Age-related Macular degeneration (AMD):

Progressive photoreceptor loss in the central visual field (the central part of the retina – the macula)

Loss of vision (partial or complete) in the central part of the visual field

For most this disorder cannot be resolved medically or surgically.



# Visual impairments in OA

## Glaucoma:

High fluid pressure  
within the eye

Apoptosis (death of  
cells) of retinal  
ganglion cells

Can damage optic  
Nerve and reduce  
Vision mainly in the  
Peripheral visual field



Glaucoma

# Visual impairments in OA

## Diabetic Retinopathy:

Growth of unstable blood vessels that can bleed and scar the retina

Obscures incoming light

Damage of sensory cells

Causes patchy vision



# Visual impairments

Visual acuity:

A very basic (simplistic) measure of visual ability

The ability to identify symbols (often letters) of different sizes from a predetermined distance. Using an eye-chart

Normal visual acuity:

The ability that people with normal vision have to identify a visual symbol of a standardized size that is located at a distance of 20 feet from the participant

Normal visual acuity is: 20/20



# Visual impairments

Visual acuity:

Moderately/severe visual impairment loss: e.g., 20/100

The person can identify at a distance of 20 feet what people with normal visual acuity can identify at 100 feet

Severe/profound vision loss: e.g., 20/200

The person needs to be at 20 feet to identify what people with normal visual acuity can identify at 200 feet

Often the criteria used to define 'legal blindness'

# Visual impairments and Speech perception

Effects of poor visual acuity on Visual-only speech-perception. Hardick, Oyer, & Irion (1970)

Conclusion:

Even a minor deviation in distance visual acuity in either or both eyes can cause speechreading performance to be significantly reduced

Johnson & Caccamise (1983): 'It is imperative that all hearing-impaired persons receive visual screening and corrective follow-up, if needed, prior to conducting speechreading training and research in which an intact visual channel is essential.'

# Visual impairments in OA

## Visual acuity and visual speech-perception

Johnson and Snell (1986)

Speechreading and distance visual acuity in a group of 786 deaf college aged students (NTID)

Stimuli: CID sentences

### Conclusions

The effect of impaired binocular vision will be reflected in speechreading performance, especially when the vision in both eyes is 20/60 or poorer

Speechreading performance will be deleteriously affected if visual acuity worse than 20/40, in the better eye.

# Visual impairments in OA

Visual acuity and audiovisual speech-perception

# Erber 1979: (the shower study)

Investigated the effects of reduced visual acuity on AV speech-perception

Used translucent plexiglas (like the doors that are sometimes used in showers) to blur vision (simulate degrees visual acuity impairments)

The image seen by the observer becomes more and more blurred as the distance from the talker and the plexiglas increases

Simulated visual acuity impairments from 20/20 to 20/400

# Erber 197: the shower study

## Participants:

2 YA (normal visual acuity and normal hearing)

14 young adolescents with severe or profound hearing loss

## Test conditions:

Used words presented visually-only and AV

# Erber 1979: the shower study

## Results:

If visual acuity is worse than 20/200; the provision of visual speech cues does not improve auditory speech perception visual

## Conclusion:

under poorer shower-door (optical) experimental conditions it seems that speechreading can serve only as a minimal aid to listening.

# Visual impairments in OA

Visual acuity and audiovisual speech-perception



# Hickson et al 2004

## Study objectives

- Does providing visual speech cues (in addition to auditory cues, improve speech-perception performance in OA?
- Is there a relationship between visual acuity and benefit provided by the addition of visual-speech cues

# Hickson et al 2004

Participants 77 OA

hearing:

36% had normal hearing

40% had a mild hearing loss

23% had moderate or greater loss

Vision:

66% had normal (normal corrected) visual acuity

34% had distance vision impairment

9 % had both near and distance vision impairments

# Hickson et al 2004

Experiment:

Sentence recognition in A-alone (noise set to approx. 50%)

AV in noise

# Hickson et al 2004

## Results:

The provision of visual-speech cues results in an average improvement of 28%

Only 1 participant did not show any improvements

The correlation between visual acuity and benefit from visual speech cues was not significant (but there was a trend)

This likely due to the fact that most of the OA who took part in this study had normal or only a mild visual impairment

# Visual impairments in OA

Visual acuity and audiovisual speech-perception

Legault , Gagné, Rhoualem, Jodouin, Anderson 2009

# Legault et al., (underway)

Investigate the effects of blurred vision (poor visual acuity) on AV-speech perception in YA and OA

Participants:

16 YA and 16 OA

-normal hearing (to at least 3KHz)

-normal or corrected normal visual acuity

# Legault et al., (underway)

## Task:

Close set sentence recognition in noise  
noise set to yield  $\approx$  50% in YA

## Conditions:

A-alone in noise (yield approx. 50% in YA)

AV – 20/20 in noise

AV 20/100 in noise

AV 20/200 in noise

## Legault et al., (underway)

Optical lenses used by opticians were used to blur vision (to simulate visual acuity)

The lenses were individually adjusted so that, on the eye-chart test, the participant performed at the level expected from someone with a visual acuity impairment equal to the experimental condition tested (e.g., the minimum blurring required to read the corresponding line on the eye chart)

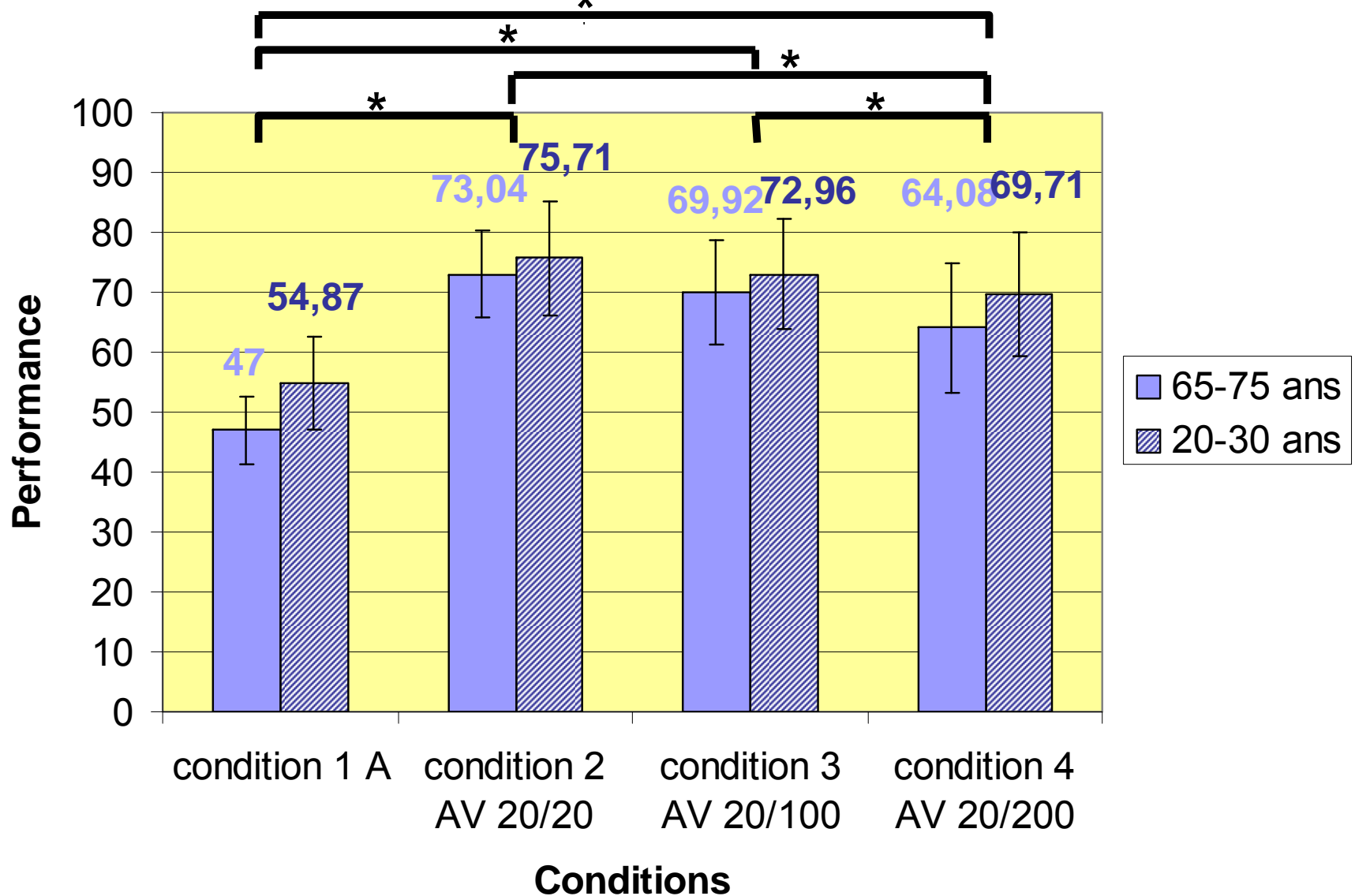


# Experimental lenses we used (and the type of participants we recruited)



# Legault et al., (underway)

## Performance en fonction des conditions



# Legault et al., (underway)

- Show video

Effet de  
l'embrouillement de la  
vision sur la perception  
auditive

# Legault et al., (underway)

## Conclusions:

1. There is a significant group difference in the AV benefit provided by the provision of visual cues. This difference is mainly explained by the group differences in the A-alone condition.
2. Provision of visual-speech cues improves auditory perception for both YA and OA
3. AV speech-perception performance is significantly better than A-alone performance even when the level of blurring is set to simulate a visual acuity of 20/200.

# Take home message

- ❑ The provision of visual-speech cues greatly improves auditory-speech perception in YA and OA
- ❑ Many OA with hearing loss also have some form of (correctable or non correctable) visual impairment
- ❑ In AR it is important to investigate/question OA about any possible visual impairment
- ❑ It is important for OA to maintain appropriate vision health care

# Take home message

- ❑ Even OA with severe visual impairments are likely to benefit from visual speech cues to improve their speech understanding performance (and to reduce the effort required)
- ❑ It is important to include visual- and AV- speech-perception in rehabilitative services provided to OA with hearing loss

# Take home message

AR services may be provided in the form of:

- information counseling
- training to optimize AV speech perception
- use of communication strategies that incorporate the optimal integration of auditory and visual speech cues.

Thank You  
for your  
attention  
and ...  
your interest





# Sentences list

- PILOT
- BABY
- POLICE
- TEACHER
- CAPTAIN
- STUDENT
- BUTCHER
- SLEPT
- ATE
- RAN
- JUMPED
- WALKED
- SAT
- READ
- BOAT
- TABLE
- CAR
- BENCH
- CHAIR
- PLANE
- BUS

# AUDITORY ONLY CONDITION

- The baby sat on the bench
- The butcher jumped on the boat
- The pilot ran on the plane
- The teacher slept on the chair
- The student read on the table
- The police walked on the car
- The captain ate on the bus
- The baby slept on the plane
- The teacher walked on the boat
- The pilot jumped on the bench

# AUDIOVISUAL CONDITION

- The pilot slept on the boat
- The baby ate on the table
- The butcher read on the car
- The captain ran on the bench
- The police jumped on the plane
- The student sat on the bus
- The teacher walked on the boat
- The baby ate on the chair
- The captain slept on the car
- The police sat on the table

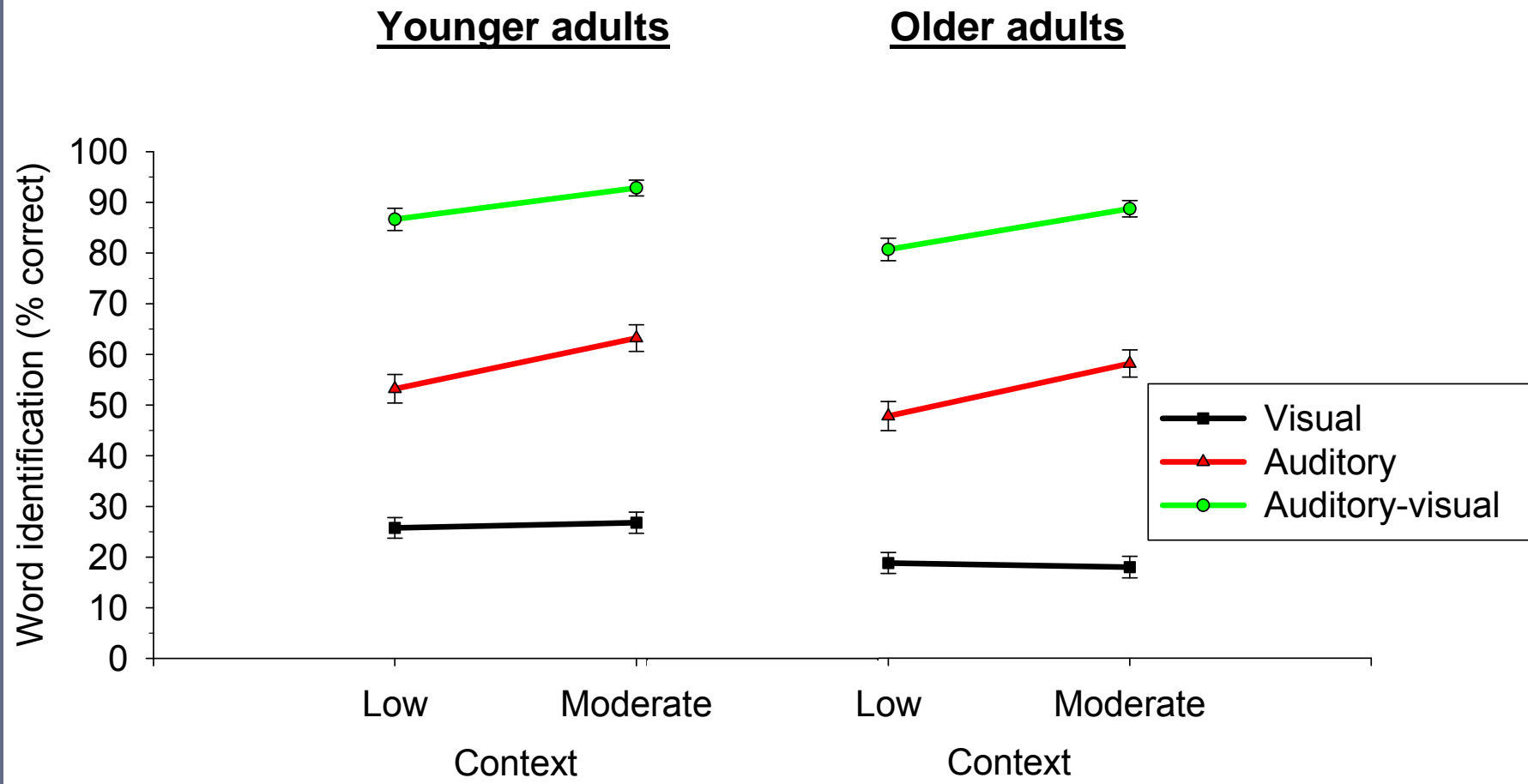
# AV 20/100 CONDITION

- The pilot slept on the boat
- The baby ate on the table
- The butcher read on the car
- The butcher ran on the bench
- The police jumped on the plane
- The student sat on the bus
- The teacher walked on the bus
- The baby ate on the chair
- The captain slept on the car
- The police sat on the table

# AV 20/200 CONDITION

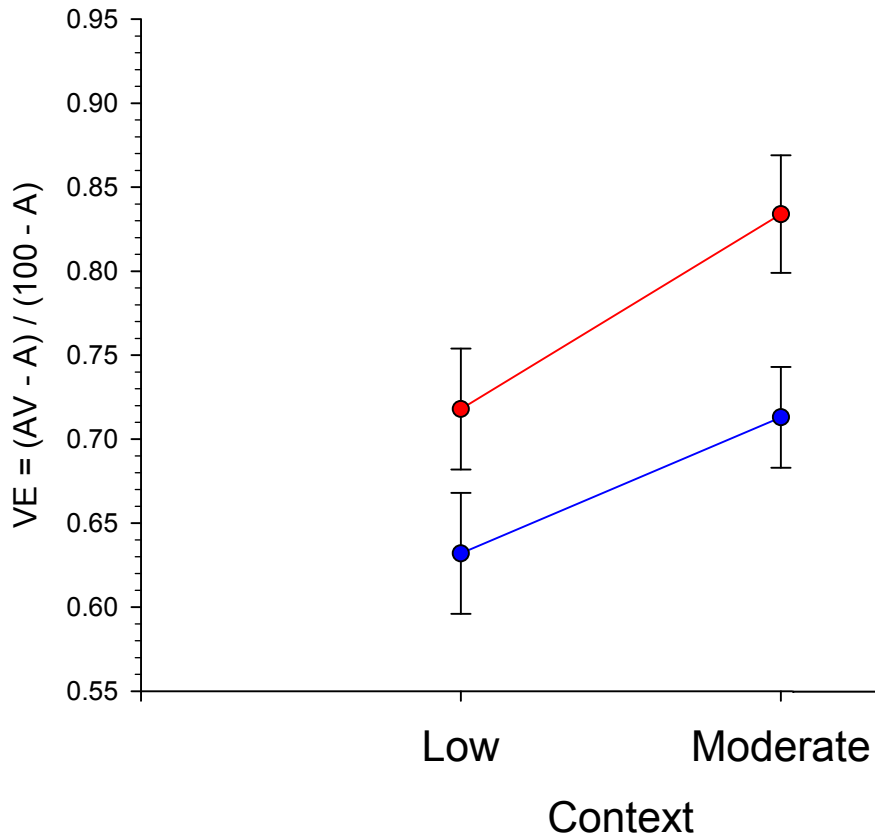
- The student ran on the boat
- The teacher sat on the chair
- The baby slept on the table
- The butcher read on the table
- The police ate on the bench
- The captain ran on the bus
- The pilot walked on the car
- The butcher ate on the boat
- The teacher jumped on the bus
- The student slept on the bench

# Sentence Word Identification Rate as a Function of Modality and Context

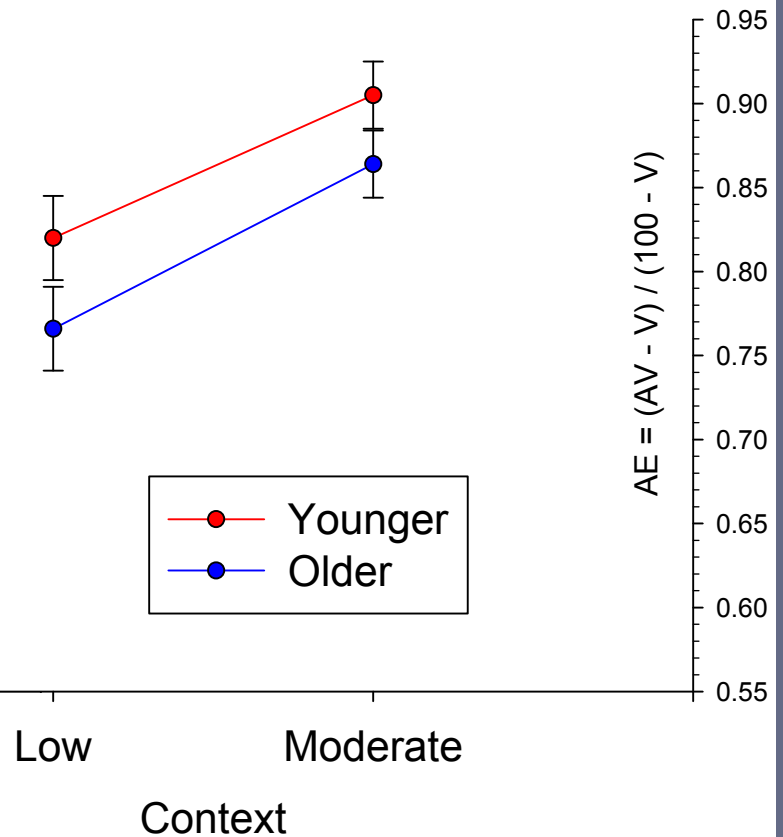


# Sentence Perception Enhancement Scores

Visual enhancement



Auditory enhancement



# Benefits of providing visual speech cues

