Improving the Visual World for People with Alzheimer's Disease

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Performance vs. Competence

Performance is what you do.

Competence is what you CAN do.
With older adults we often make the mistake of defining their competence by their performance. Consequently, competence is underestimated. Interventions that may improve performance and quality of life are not implemented.

Perception is an act of Reconstruction.

Perception

- Perceiving is the act of acquiring information in the senses and using that data to **construct reality**.
- Perceiving is a process that takes time.
- Detection of a simple stimulus, such as the onset of a light, may take only 50 ms.
- Understanding that the light is the beam from a train barreling at you may take several seconds.
- If the quality or amount of data is weak, then the constructed reality will be correspondingly poor.
Major Themes

- Hidden visual deficits may masquerade as cognitive deficits.
  - Cognitive competence of older adults is underestimated.
- Vision deficits are associated with Alzheimer’s Disease.
  - Spatial Contrast Sensitivity
  - Motion Perception
- There are intervention strategies to remediate the perceptual deficits.
- Interventions may lead to the development of visually fair neuropsychological tests.

Alzheimer’s Disease

- Most common form of dementia. Estimated in 2013 to affect 44 million people worldwide.
- Prevalence
  - >65 years is 13% (5 million people)
  - >85 years is 32%.
- Memory problems are the hallmark of the disease.
- There is growing evidence that vision is affected by Alzheimer’s Disease.
  - However, the vision disorders are not commonly known by physicians.

Age-Related Vision Deficits

- Cataracts
  - Blurring of vision
- Glaucoma
  - Loss of vision in periphery
- Macular Degeneration
  - Loss of vision in central field
- Diabetic Retinopathy
  - Multiple blindspots
- Major reduction in contrast sensitivity associated with Alzheimer’s Disease
Normal Vision

Glaucoma

Macular Degeneration
Diabetic Retinopathy

Cataract

Alzheimer’s Disease
Terms

- **Contrast**  Difference between light and dark regions of light
- **Contrast Sensitivity**  Smallest difference that can be detected between light and dark areas
  - Reported as Log (1 / Threshold Contrast)
- **Spatial Frequency**  Number of changes from light to dark in a region
  - Reported in cycles per degree (cpd)
- **Spatial Contrast Sensitivity**  Contrast sensitivity for different spatial frequencies
Spatial Frequency Content

- Low spatial frequencies define large patterns and global characteristics.
- High spatial frequencies define edges and details in images.

Mona Lisa
Spatial Frequency Content

Low  | Original  | High
---|---|---
![Low Frequency](image1.png) | ![Original](image2.png) | ![High Frequency](image3.png)
Spatial Frequency Content

- Spatial frequency data becomes available over time.
  - Low frequencies have precedence.
Spatial Contrast Sensitivity

• Dictated by responses of two major classes of visual neural channels.
  – Magno Channels respond optimally to abruptly changing, low spatial frequencies.
  – Parvo Channels respond optimally to static, high spatial frequencies.

Spatial Contrast Sensitivity

• Assessed with wall charts
  – Vistech
  – Pelli-Robson
  – Functional Acuity Contrast Test
• Wall charts are best for assessing Parvo capability
• Magno channel capability must be evaluated with computer systems that display abruptly changing stimuli.

Spatial Frequency

Contrast

Low    High

Low    High
Illustration of change in line visibility as contrast changes

Contrast

Spatial Frequency

Contrast Sensitivity Functions

Spatial Frequency (cpd)

Contrast Threshold

.25% .5% 1% 2% 4% 10%

Young Adults
Elderly Adults
Alzheimer Patients

Contrast

Spatial Frequency

Illustration of change in line visibility as contrast changes

Contrast

Spatial Frequency

Contrast Sensitivity Functions

Spatial Frequency (cpd)

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Young Adults
Elderly Adults
Alzheimer Patients

Contrast

Spatial Frequency
Spatial Contrast Sensitivity
Longitudinal Study

- Group differences may be attributed to general cognitive deficits.
- If vision deficit is related to the progress of the disease, then contrast sensitivity should decline over time.
- Study evaluated healthy elderly adults and Alzheimer patients at 6 month intervals.
- Conditions permitted evaluation of both Magno and Parvo contributions to sensitivity.
Spatial Contrast Sensitivity
Longitudinal Study

Conclusions

• Alzheimer patients have major contrast sensitivity deficits at all spatial frequencies.
• Both Magno and Parvo channels are deficient in their responses.
• Changes in the Magno channels occur in as little as 6 months.
  – Magno neural channels may be deteriorating more rapidly.
Impact of Contrast Sensitivity Differences

Reduction in contrast sensitivity in both Normal Elderly Adults and Alzheimer’s disease patients will lead to a weaker stimulus signal in these groups relative to Young Adults.

Is there reason to believe that the improvement of the visual signal (contrast) will lead to better performance by the patient with Alzheimer’s Disease?

YES!

Selected Articles Demonstrating the Benefit of Stimulus Enhancement for Alzheimer’s Disease Patients


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Letter Identification

- It has been shown that the accuracy of stimulus acquisition is tied to the strength of the stimulus.

- Is Reaction Time also linked to stimulus strength?

- Can Alzheimer patients respond as quickly as healthy older adults, if given sufficiently strong stimuli?
Picture Naming

- Participants were presented with stimuli with adjusted contrast.
  - Enhanced
  - Normal
  - Degraded
- The amount of contrast change was determined by the differences in spatial contrast sensitivity between healthy elderly adults and Alzheimer’s patients.
### Picture Naming Accuracy (%)

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<th>Contrast Level</th>
<th>Degraded</th>
<th>Normal</th>
<th>Enhanced</th>
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<td>93</td>
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<td>Older Adults</td>
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<tr>
<td>Alzheimer Patients</td>
<td>--</td>
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### Conclusions

- Differences in confrontation naming may be strongly linked to the spatial contrast sensitivity deficits of the participants.
- When vision deficits are present, naming tasks are not pure measures of memory.

### Effects of Vision Deficits on Activities of Daily Living

- Eating
Effects of Vision Deficits on Activities of Daily Living

- Eating
  - High contrast place settings yield greater food consumption.

Improvements with Increased Contrast

- Letter Identification
- Word Reading
- Picture Identification
- Face Recognition
- Object Finding
- Eating
- Motion Perception
- Playing Bingo!

Perceptual Challenges in Alzheimer’s Disease

- Alzheimer’s patients experience significant deficits in spatial contrast sensitivity.
- These deficits may be an important contributor to higher-order cognitive disabilities.
- Enhancement of stimulus contrast can eliminate or ameliorate vision-based disabilities.
**Take Home Message #1**

Consider improving the visual environment of older adults

– Large print, high contrast reading material
– Use utensils and plates that contrast with tables and counters.
– Any object that is important to find, such as pill bottle, should contrast with background.
– Use Bingo cards with large, high contrast numbers!

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**What else can be done to improve the vision and quality of life of a person with Alzheimer’s Disease?**

• Consult an ophthalmologist for a full vision exam.
• Advocate for full vision care for patients with Alzheimer’s Disease.
• Patients with Alzheimer’s Disease may be denied some services!

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**Current Research**

• Examining the impact of cataract removal on the vision, cognition, and quality of life of patients with Alzheimer’s Disease
• Alzheimer’s Disease patients are often refused the opportunity for cataract surgery
  – In the absence of evidence that the surgery will benefit the patient, physicians opt to avoid potential risks.
• My research team expects, based on the evidence presented today, that the patients will benefit from the removal of their cataracts
Cataracts Common Vision Problem

- A cataract is a clouding that develops in the crystalline lens of the eye.
- Most persons over the age of 60 years have lens imperfections.
- In the United States, age-related cataracts are common –
  - 42% of those between the ages of 52 to 64
  - 60% of those between the ages 65 and 74
  - 91% of those between the ages of 75 and 85.
- Cataract surgery is a common, same-day procedure in the USA.

Effect of Cataract on Vision

Visual Problems of Cataracts May Include

- Cloudy, fuzzy, foggy, or filmy vision
- Loss of color intensity
- Double vision
- Difficulty seeing at night
- Problems seeing shapes against a background or the difference between shades of colors
- Seeing halos around lights
- Being sensitive to glare
- Frequent changes in eyeglass prescription
Problems of Cataracts

- Cataracts generally lead to decreased vision, even in daylight.
- Most people with cataracts have similar changes in both eyes, although one eye may be worse than the other.
- Many people with this condition have only mild vision changes.

Treatment for Cataracts

- The only treatment for cataract is surgery to remove it. Surgery is done if you cannot perform normal activities, even with glasses.
- If a cataract is not bothersome, then surgery is usually not necessary. However, some people may have additional eye problems, such as diabetic retinopathy, that cannot be treated without first having cataract surgery.
- For some people, changing glasses, getting stronger bifocals, or using a magnifying lens is helpful enough.

Prognosis and Treatment

- Vision may not improve to 20/20 after cataract surgery, if other eye diseases, such as macular degeneration are present.
  - Ophthalmologists can usually, but not always, determine this in advance.
- Early diagnosis and treatment are key to preventing permanent vision problems.
Alzheimer’s Disease and Cataracts

- An Alzheimer’s patient who has cataracts will have significant vision problems that may exacerbate their cognitive problems.
- Removal of the cataracts may improve both vision and cognition.
- Research study is now being conducted to assess the impact of cataract removal in patients with Alzheimer’s disease and other dementias.

Project

Therapeutic Effects of Cataract Removal in Alzheimer’s Disease

Principal Investigator: Grover C. Gilmore, Ph.D.
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Information on Research Study

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Free eye and neurological exams are available for persons who meet study inclusion criteria.

Take Home Message #2
- Vision problems may be unreported.
- Combination of dementia and vision problems can be devastating.
- Hidden vision deficits DO masquerade as cognitive deficits
  - Competence of person is underestimated
  - Persons are not given the opportunity to achieve their full potential
- Interventions can be created to permit healthy older adults and Alzheimer’s Disease patients to perform normally on simple cognitive tasks
- It is important to advocate for full assessment of a person’s vision and the use of interventions to help the person to achieve their full competence.

Social Work Leader for 99 Years
Countdown to Centennial