Understanding Language Problems in the Elderly

Linguistic and Cognitive Dissociations in Dementia

Daniel Kempler

Outline

• Language in healthy aging & dementia
  • Words
  • Sentences
  • Discourse
• The cognitive context
• A few basics about dementia
• Further questions & potential uses for a shared database

Cognitive Aging
Seattle Longitudinal Study

Theories of Cognitive Aging

| Neurochemical | ↓ Dopamine |
| Focal structures | ↓ Frontal lobe efficiency |
| Cognitive processes | ↓ Executive functions |
| Information processing | ↓ Rate of processing |
| Perceptual | ↓ Hearing & vision |

February 24, 2012
Executive Functions

• Self-regulation of goal-directed behavior
• Organization and use of large amounts of information
• Strategic processes for planning, inhibition of irrelevant information, shifting sets, etc.
• Working memory (WM): component that allows simultaneous storage and manipulation of information (contrast: STM)
• WM decrements >> decreased attentional control & inhibition >> vulnerability to interference
• Neurological substrate: Prefrontal cortex

Language in Healthy Aging

• Words
• Sentences
• Discourse

Language in Typical Aging

<table>
<thead>
<tr>
<th>Words</th>
<th>Sentences</th>
<th>Discourse</th>
</tr>
</thead>
<tbody>
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</tbody>
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Language in Healthy Aging

• Words
• Sentences
• Discourse

First, the good news.....

“Your vocabulary is enlarged”

Word Knowledge

Figure 4: Differential effects of normal aging on processing language abilities. Adapted with permission from Park et al. (1994).
Word Production
Spontaneous Speech
Average Tip of Tongue Occurrence in 1 M

<table>
<thead>
<tr>
<th>Age</th>
<th>Young</th>
<th>Middle Age</th>
<th>Old</th>
</tr>
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<tbody>
<tr>
<td>4</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

(Baier et al., 1991)

Word Production
Picture Naming

Language in Typical Aging

<table>
<thead>
<tr>
<th>Variable</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words</td>
<td>Stable or improved</td>
</tr>
<tr>
<td>Sentences</td>
<td>Improved</td>
</tr>
<tr>
<td>Discourse</td>
<td>Improved</td>
</tr>
</tbody>
</table>

Language in Healthy Aging

- Words
- Sentences
- Discourse

Sentence Production
Diary Study

<table>
<thead>
<tr>
<th>Decade</th>
<th># Clauses</th>
<th># Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>20's</td>
<td>3.0</td>
<td>9.8</td>
</tr>
<tr>
<td>70's</td>
<td>1.4</td>
<td>9.2</td>
</tr>
</tbody>
</table>

(Kempler & colleagues)
Sentence Production

Sentence Comprehension

Language in Typical Aging

<table>
<thead>
<tr>
<th></th>
<th>Words</th>
<th>Sentence</th>
<th>Discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOT: verbal fluency</td>
<td>grammatical complexity</td>
<td>Comprehension</td>
</tr>
<tr>
<td></td>
<td>age related</td>
<td>working memory (WM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>stable or improved</td>
<td>working memory (WM)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>WM due to poor attention control and inhibition</td>
<td></td>
</tr>
</tbody>
</table>

Language in Healthy Aging

- Words
- Sentences
- Discourse

Discourse

- Narrative structure, i.e., “story telling” - (e.g., into, complication, resolution)
- Topic relevance (e.g., Grice’s maxims)
- Coherence (e.g., linking with pronouns)

Discourse: Narrative Structure

Telling a Good Story

Compared to stories told by young adults, older adults' stories are:

- more interesting
- more informative
- better story quality
- remembered better

(e.g., James et al., 1998)
Discourse: Topic Relevance

"Off-topic verbosity"

I started in grammar school in Porterville, Ohio and, uh, we lived about a block about 8 blocks and I use to go home for lunch. One of the things I remember so vividly was a fire across the street and they pulled a lady out on a stretcher and I was very, very upset. And upset for a long, long time. I remember my second-grade teacher. Her name was Lucy Keller and she had buck teeth and when I looked up she scared the daylights out of me. As an adult, as I knew her better, why she probably was one of the most wonderful people I’d ever met but uh as a child…I’ve thought of that with my own children. If they ran into something I kind of check what uh what’s cooking because it could be something simple like a very tall person with uh buck teeth.

Discourse: Coherence

Older adults use more ambiguous pronouns (he, she, they) than younger adults.

Discourse Coherence (Comprehension)

1. Henry spoke at a meeting while John drove to the beach.
2. He lectured on administration.

Language in Typical Aging

<table>
<thead>
<tr>
<th></th>
<th>Words</th>
<th>Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>commands</strong></td>
<td>↑ verbal fluency</td>
<td>↑ phonological memory, working memory (WM)</td>
</tr>
<tr>
<td><strong>shortened</strong></td>
<td>↑ semantic complexity</td>
<td>↑ working memory (WM)</td>
</tr>
<tr>
<td><strong>unstated</strong></td>
<td>↑ with sentence complexity or task difficulty</td>
<td>↑ WM due to poor-organized control and inhibition</td>
</tr>
<tr>
<td><strong>omitted</strong></td>
<td>↑ structure is significantly off task (longer sentences)</td>
<td>↑ criticism of others; poor sentence coherence</td>
</tr>
<tr>
<td><strong>replaced</strong></td>
<td>↑ tracking reference to longer sentences</td>
<td>↑ working memory (WM)</td>
</tr>
</tbody>
</table>

When is it no longer normal?

Dementia

- Acquired, persistent intellectual impairment in at least three (3) of the following domains: language, memory, visuospatial skills, emotion/personality, executive functions
- Cognitive deficits are severe enough to cause impairment in occupational or social function
Dementia (cont.)

- Deficits are not due to delirium
- Onset is typically gradual
- Course is typically progressive (although can seem abrupt or stable)
- Due to diffuse or multi-focal brain dysfunction

Estimated Prevalence of Dementia in North America

Projected Dementia Prevalence in North America

Causes of Dementia

CORTICAL
- Alzheimer’s Disease (50%)
- Frontotemporal dementia

SUBCORTICAL
- Parkinson’s disease
- Progressive supranuclear palsy
- Huntington’s disease
- Idiopathic basal ganglia calcification (Fahr’s disease)
- Thalamic dementia
- Lewy body dementia (15-35%)

VASCULAR (10-30%)
- Large cortical occlusions
- Lacunar state (subcortical)
- Binswanger’s (subcortical white matter ischemia)
- Mixed cortical & subcortical
- METABOLIC
- Vitamin deficiency states
- TOXIC
- Medication toxicity
- OTHER
- Neoplasms, psychiatric dementias

Neuropathology

- Cortical atrophy (esp. temporo-parietal, anterior frontal, and hippocampal regions)
- Amyloid plaques
- Neurofibrillary tangles

Alois Alzheimer (1864-1915)

In 1907 Alzheimer described a 51 y.o. woman who frequently used “perplexing phrases…some paraphrastic expressions” (milk pourer instead of cup) and suffered from a significant language comprehension deficit.
Frontotemporal Dementia

Language in Dementia

- Words
- Sentences
- Discourse

Words

“If I have anything to do, I get something that has something doing, or I have some reason for being.”

What’s wrong with the words?

Tip-of-the-tongue (“access”) vs. Disruption or loss of semantic representations

Naming Error Patterns

Other evidence of impaired semantic representations

- Consistency of naming errors over time
- Word comprehension errors
- Other semantic probes (e.g., similarity judgments, sorting, definitions)

Words: Tip-of-the-tongue (“access”) vs. Disruption or loss of semantic representations

Naming Error Patterns

Other evidence of impaired semantic representations

- Consistency of naming errors over time
- Word comprehension errors
- Other semantic probes (e.g., similarity judgments, sorting, definitions)
Semantic Categories

Semantic Features

What do patterns of deterioration tell us about semantic representations?
- Living things vs. Artifacts
- Nouns vs. verbs

Category Specific Deficits: Nouns

- Artifacts
- Living Things

Group Data

- 15 mild-moderate AD subjects
- 3 tasks
  - Picture naming
  - Word-picture matching
  - Superordinate comprehension
- 36 black and white line drawings
  - Natural kinds (e.g., fruits & vegetables)
  - Artifacts (e.g., vehicles & furniture)

Double Dissociation of Semantic Categories

Intercorrelations

- Connections between frequently co-occurring features
- Examples
  - has-fur & has-claws
  - has-a-handle & made-of-metal
- More in natural kinds

Cross-sectional data
#### Longitudinal Data
3 Semantic Deficit Patterns

- Initial artifacts deficit
- Natural kinds deficit
- Crossover pattern

#### Beyond Nouns
Nouns and Verbs

- Living things
- Manner verbs
- Non-living things
- Instrumental verbs

#### Noun and Verb Naming

- Accuracy
- Reaction Time

#### Nouns & Verbs in the Brain

- Vigliocco et al., 2011
- Crepaldi et al., 2011

#### Language in Dementia (AD)

<table>
<thead>
<tr>
<th>Category</th>
<th>Healthy</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words Comprehension</td>
<td>Stable or improved</td>
<td>Declined</td>
</tr>
<tr>
<td>Words Production</td>
<td>Unaffected or mildly impaired</td>
<td>Severe</td>
</tr>
<tr>
<td>Sentences Comprehension</td>
<td>Unaffected</td>
<td>Severe</td>
</tr>
<tr>
<td>Sentences Production</td>
<td>Unaffected</td>
<td>Moderate</td>
</tr>
<tr>
<td>Discourse</td>
<td>Unaffected</td>
<td>Severe</td>
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#### Sentence Structure/Grammar

“If I have anything to do, I get something that has something doing, or I have some reason for being.”
Is grammatical knowledge preserved?

YES

Spontaneous Speech
- Errors
- Type & frequency of grammatical constructions

Experiments
- Use of grammatical cues in writing to dictation
- Sensitivity to grammatical violations in cross-modal naming
- Grammaticality judgments

Writing to Dictation:
Use of syntactic vs. semantic cues

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>mouth-nose</td>
<td>my nose</td>
</tr>
<tr>
<td>thinks-knows</td>
<td>she knows</td>
</tr>
</tbody>
</table>

73% correct 92% correct

Grammatical Processing
Cross-Modal Naming

“Some people always lose their keys. The old lady -

Grammatical Processing
Cross-Modal Naming

“Some people always lose their keys. The old lady -

Grammatical Processing
Cross-Modal Naming

(long condition)

“Some people always lose their keys. The old lady, who searched very carefully through every one of those old trash cans behind the stores -

Grammatical Processing
Cross-Modal Naming

Almor et al., 2001
Preservation of Verb-Argument Structure

Production of verbs in narratives

Grammaticality judgments
• “‘Good’ vs. ‘Bad grammar’”
• Violations of verb argument structure
  - The dog is barking the girl.
  - The man is carrying the boy a box.
  - The man is putting the dollar.
• 94% correct

(Kim & Thompson, 2004)

Language in Dementia (AD)

<table>
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<th>Words</th>
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<th>Semantic knowledge</th>
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<tbody>
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<td>Stable or improved</td>
<td>↓</td>
<td>↓</td>
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<table>
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<tr>
<th>Sentences</th>
<th>Grammatical complexity</th>
<th>Sentence complexity or task difficulty</th>
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<tbody>
<tr>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discourse</th>
<th>Tracking reference in longer sentences</th>
</tr>
</thead>
<tbody>
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<td>↓</td>
<td>↓</td>
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</tbody>
</table>

The problem of pronouns

• Presume antecedents (“the boy....he....”)
• Too few or too many disrupt discourse
• Requires adequate:
  1. knowledge of discourse rules (pragmatics)
  2. semantic activation of antecedents
  3. working memory to track them

Pronoun Production

Spontaneous Speech
AD patients use significantly more pronouns

Correlation between working memory and pronoun preference
\( r = -0.4, p < 0.05 \):
higher WM, fewer pronouns

Pronoun Processing

• Cross-modal naming
• Sensitivity to inappropriate pronouns in sentence processing

* Patients less sensitive to pronoun appropriateness than controls
* Sensitivity to pronoun appropriateness correlated with WM (\( r = -0.3, p < 0.02 \)) but not picture naming

(Almor et al., 1999)
Pronoun Data 3

- Sensitivity to inappropriate full NPs in comprehension
- Cross-modal naming experiment

The housewife watched the clumsy plumber working under the sink. The housewife showed the plumber where the leak was. The housewife could not believe the plumber was so clumsy (Almor et al., 1999).

- AD participants faster with full NPs
- NCA faster with pronouns
- Pronoun advantage correlated with WM (r = .68, P < .001)

Pronoun Data

- Overuse in production
- Representations of referents in WM is degraded (loss of some distinguishing features)
- More general expression likely to be used
- Linked to WM
- Processing impaired
- Overall decrease in activation of referents makes full NPs more functional
- Linked to WM

Language in Dementia (AD)

<table>
<thead>
<tr>
<th>Words</th>
<th>Non-AD</th>
<th>TOT</th>
<th>Verbal fluency</th>
<th>Semantic knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>normal or impaired</td>
<td>verbal fluency</td>
<td>semantic knowledge</td>
<td></td>
</tr>
</tbody>
</table>

Sentence

- Grammatical complexity
- Syntactic complexity and word difficulty
- Overall decrease in activation of referents makes full NPs more functional

Discourse

- Interpreting less accurately off-topic (tangential)
- Maintaining reference in longer sentences
- Understanding and clarity

The Future

- Biomarkers
- Treatments
- Behavioral
- Pharmacological
- Prevention/protective factors

DementiaBank

Potential questions to address via shared data

- Neuro-cognitive-linguistic questions
  - Structure of lexical/semantic categories
  - Roles of word frequency, genre, etc. on language impairment
  - Relationships between language and cognitive abilities
  - The “where” question
- Diagnostic questions
  - Distinguishing dementia syndromes from one another
  - Progressive Aphasias vs. AD vs. Lewy Body Dementia
  - Evolution of dementia (longitudinal data)
  - Progressive aphasia > Alzheimer’s
  - Mild Cognitive Impairment > Alzheimer’s
  - Comparison of dementias and other clinical populations (e.g., aphasia)
- Treatment efficacy
  - Therapeutic effectiveness