Assessment and Treatment of Sentences in Aphasia: Evidence into Practice

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Overview
• Background, definitions, and theory
• Assessment of sentences

Break
• Treatment approaches
  - MT, TUF, VNeST
  - critical review

Aphasia
• Acquired
• Neurogenic
• Language disorder

Language disorder
• Impaired processing of linguistic rules and representations
  – Phonology
  – Morphology
  – Lexicon
  – Syntax

Grammaticality Judgment
• The man is fixing the car.
• The man is fixing.
• The girl is sleeping the bed.
• The girl is giving the teacher to the apple.
• Is melting the snowman.
• The dog is barking the man.
• The man is sending the letter to the woman.

Language Production Model

Bock & Levelt (1994); Garret (1988)

Grammatical Encoding: generation of semantic-syntactically specified sentence form
Grammatical Encoding

“who does what to whom”

Thematic (meaning) roles e.g., Agent (do-er)
Patient/Theme (do-ee)

Surface structure
active: det (N) aux (V) det (N)
passive: det (N) aux (V) by det (N)

VERB

Bock & Levelt (1994); Garret, 1988

Verb Argument Structure (VAS)

• Knowing a verb means knowing how many words are needed in the sentence and their thematic roles (e.g., agent, theme).

• Successful comprehension and production of sentences require correct assignment of thematic roles to the nouns (arguments) associated with the verb.

• e.g., sing [NPAGENT[V]]

• fix [NPAGENT[V NP THEME]]

Verb Argument Structure

• Systematic, rule-governed errors:
  – Verb argument structure complexity
  – Canonicity in the mapping between meaning and word order

Impaired Grammatical Encoding in Aphasia

• Pervasive
• Multiple underlying causes
• Systematic, rule-governed errors:
  – Verb argument structure complexity
  – Canonicity in the mapping between meaning and word order

Agrammatic Aphasia

• Often associated with Nonfluent/Broca’s aphasia
• Relatively preserved comprehension:
  – Comprehension of syntactically complex sentences is compromised.
• Impaired speech marked by reduced grammatical complexity

Make a sentence for each picture.

Verb Naming

A.

B.

C.

A.

B.

C.
VAS Complexity Effects

- Increased number of verb arguments, greater impairment in sentence production and verb naming (DeBlesser & Kauschke, 2003; Dragory & Bastiaanse, 2009; Kim & Thompson, 2000; Kiss, 2000; Luzzatti et al., 2002; Thompson et al., 1997 and others).

- The man is sleeping (1-argument)
- The man is pulling the woman (2-argument)
- The man is giving the flowers to the woman (3-argument)

Make a sentence for each picture.

Name each action.

- The man swam. (unergative)
- The glass, broke t. (unaccusative)

VAS complexity effects

- Non-direct mapping of VAS, greater impairment in both sentence and single verb production (Bastiaanse & van Zonneveld, 2004; Bastiaanse & Jonkers, 2005; Lee & Thompson, 2004; Lee & Thompson, 2011; Kegl, 1995; McAllister et al., 2009; Thompson, 2003)
Production of unaccusative vs. unergative sentences

Complex (Non-Canonical) sentences

- **Sentences with syntactic movement**, greater impairment (Bastiaanse & van Zonneveld, 2004; Bastiaanse & Jonkers, 2005; Lee & Thompson, 2004; Kegl, 1995; Schwartz et al., 1994; Rochon et al., 2005; Thompson et al., 2003 and others).

- Syntactic movement: the theme (do-ee) is displaced from its original position (after the verb) and appears in the subject position.

Canonical Sentence: Active

Non-canonical sentence: Passive

Complex (Non-Canonical) sentences

Simple sentences canonical order:
Active: the woman kissed the man.
Subject Wh-Q: Who kissed the man?
Subject Relative: I saw the woman who kissed the man.
Subject Cleft: It is the woman who kissed the man.

Complex sentences with object movement (non-canonical):
Passive: the man was kissed ____ by the woman.
Object Wh-Q: Who did the woman kiss ____?
Object Relative: I saw the man who the woman kissed____.
Object Cleft: It is the man who the woman kissed____.
Production of Canonical vs. Non-canonical sentences

![Graph showing production of canonical vs. non-canonical sentences](image)

Dick, Frederick, Mar, & Lee (under review)

> Early encoding of VAS

- May be crucial for successful sentence production (Lee, 2011; Lee & Thompson, 2011a; 2011b; accepted; Lee, Yoshida, & Thompson, 2015).

- ‘Eye-tracking while speaking’ studies to examine ‘when’ verb information is used during sentence production.

Production of verb arguments vs. adjuncts: Eyetracking while speaking

<table>
<thead>
<tr>
<th>Argument condition</th>
<th>Adjunct condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>is applying</td>
<td>is choosing</td>
</tr>
<tr>
<td>lotion</td>
<td>lotion</td>
</tr>
<tr>
<td>mother</td>
<td>baby</td>
</tr>
</tbody>
</table>

Goal argument       Beneficiary adjunct (modifier)

Lee & Thompson (2011b), Language and Cognitive Processes

Summary

- GE is impaired in many IWA, characterized by systematic errors
- Two important factors in predicting errors are the VAS complexity and (Non) canonicity of the sentences
- Early encoding of VAS may be critical for successful sentence production and more beneficial for IWA with greater syntactic impairments.
- The existing research evidence suggests that assessment and treatment of sentence production should take these linguistic variables into consideration.
Assessment of Syntax

Rationale

- Many persons with aphasia (PWA) have ‘syntax’ problem, affecting processing of words, sentences, and conversation in general.
- Research support dissociated impairments among different verbs and sentence types in IWA, which in turn inform intervention strategies for these deficits.
- Take care in selecting assessment tools for verbs and sentences
  - The stimuli should be controlled for verb types and sentence types at least.

Standardized Tests

- Boston Diagnostic Aphasia Examination (BDAE, Goodglass, Kaplan, & Barresi, 2001)
- Comprehensive Aphasia Test (CAT; Swinburn, Porter, & Howard, 2004)
- Object & Action Naming Battery (OANB; Druks & Masterson, 2000)
- Verb and Sentence Test (VAST; Bastiaanse, Edwards, & Rispens, 2002)
- Northwestern Assessment of Verbs and Sentences (NAVS, Thompson, 2011)
- Northwestern Anagram Test (NAT; Thompson, Weintraub, & Mesulum, 2012)

Northwestern Assessment of Verbs and Sentences (NAVS)

The NAVS was designed to examine comprehension and production of action verbs, production of verb argument structure in sentence contexts, and comprehension and production of canonical and non-canonical sentences in individuals with language disorders resulting from neurological disease.

Summary of tests for examining verbs, verb argument structure and/or sentences in aphasia

<table>
<thead>
<tr>
<th>Test</th>
<th>Naming</th>
<th>Comprehension</th>
<th>Argument Structure</th>
<th>Production</th>
<th>Comprehension</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDAE</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAT</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PCBA</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>SOAP</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>OANB</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>VAST</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

WAB = Western Aphasia Battery, BDAE = Boston Diagnostic Aphasia Examination, CAT = Comprehensive Aphasia Test, PCBA = Philadelphia Comprehension Battery for Aphasia, SOAP = Subject-relative, Object-relative, Active, Passive syntactic battery, OANB = Object and Action Naming Battery, VAST = Verb and Sentence Test.

NAVS

- Strengths:
  - A good test for syntax: selected portions can be used
  - Good research support
  - Controlled for word-retrieval difficulty for sentence-level tests by providing written nouns and verbs, and using the same nouns (man, woman, dog, cat) repeatedly.
  - Affordable
- Limitations:
  - Can be lengthy for administering the entire test (~40 min or more)
  - Not appropriate for severe patients.
NAVS subtests

- Verb Naming Test
- Verb Comprehension Test
- Argument Structure Production Test
- Sentence Priming Production Test
- Sentence Comprehension Test

Sample stimuli for the Verb Naming Test (VNT) by verb type

(a) one-argument verb (target verb: laugh)
(b) two-argument verb (target verb: stir)
(c) three-argument verb (target verb: read)

Sample stimuli for the Verb Comprehension Test (VCT)

(from top left to bottom right, different verb distractor: push and move, target: roll, same verb distractor: roll)

Sample stimuli for the Argument Structure Production Test (ASPT)

(a) Optional two-argument verb with two arguments (target: The dog is biting the cat)
(b) Optional two-argument verb with one argument (target: The cat is biting)

Sample stimuli used in the Sentence Production Priming Test (SPPT) and Sentence Comprehension Test (SCT)

(a) Sample stimulus for testing active, passive, and subject and object who questions (Subject Wh-Question target: Who is pulling the boy? Object Wh-Question target: Who is the girl pulling?)
(b) Sample stimulus for testing Subjunct Relative and Object Relative (SRL target: Five use the girl who is pulling the boy; OR target: Five use the boy who is pulling)

Practice:
NAVS administration and scoring
Argument Structure Production Test (ASPT)
Sentence Production Priming Test (SPPT)
Northwestern Anagram Test

Sample Stimulus Picture

Target: The dog is biting the cat.

Mapping Therapy (MT)

- Mapping Deficit Hypothesis (Schwartz et al., 1987): Agrammatic deficits arise from impaired mapping between the functional (thematic roles, e.g., agent/theme) and positional processes (surface word order, e.g., subject/object).

- To strengthen mapping between the functional (underlying semantic) and positional (surface syntactic) processes.
- Focus: identifying thematic roles of the nouns in relation to the verb.
- Utilized for both sentence comprehension and production deficits across various canonical and non-canonical sentences.

MT Protocol - Comprehension (Schwartz et al., 1994)

- Pt is presented with a written sentence and asked to read it aloud.
- Pt is trained to identify the verb and the thematic roles of each noun in a varying order.
- Immediate feedback is provided for each trial.

Treatments

- Mapping Therapy (MT)
- Treatment of Underlying Forms (TUF)
- Verb Network Strengthening Training (VNeST)

Byng, 1988; Byng et al., 1994; Rochon, Lund, Bose, & Scofield, 2005; Schwartz, Saffran, Pink, & Meyers, 1994; Marshall, 1995; and others
### MT protocol – Comprehension
(Schwartz et al., 1994)

The woman is kissing the man.

Clinician prompts:
- a. Read this sentence aloud.
- b. Show me the verb (action word) in this sentence.
- c. Who is doing the kissing?
- d. Who is being kissed?
- e. Client color codes the verb and different thematic roles for each step.

The order of c and d is varied across trials.

### MT protocol - Comprehension
(Schwartz et al., 1994)

- **3 Phases:**
  - Phase A: Canonical sentences with action verbs (e.g., call, hug)
  - Phase B: Canonical sentences with ‘state of mind’ verbs (e.g., like, love)
  - Phase C: Noncanonical sentences with action verbs

### MT protocol – Production
(Rochon et al., 2005)

**Target sentence:** "The woman is kissing the man."

Clinician says:
- This is a picture about kissing.
- The verb in this sentence is ‘kisses’.
- In this picture the one doing the kissing is the woman (Agent).
- The one who is being kissed is the man (Patient).
- Please make a sentence starting with the woman.

### MT protocol – Production
(Rochon, Laird, Bose, & Scofield (2005))

**Target sentence:** "The man is kissed by the woman."

Clinician says:
- This is a picture about kissing.
- The verb in this sentence is ‘kisses’.
- In this picture the one doing the kissing is the woman (Agent).
- The one who is being kissed is the man (Patient).
- Please make a sentence starting with the man.

### MT results
(Rochon et al., 2005)

<table>
<thead>
<tr>
<th>Action</th>
<th>Subject role</th>
<th>Passive</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Male</td>
<td>92</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td>Female</td>
<td>92</td>
<td>86</td>
<td>100</td>
</tr>
</tbody>
</table>

- When collapsed across sentence types, changes in performance were significant for MT trained participants, but not for control participants.
- Treatment gains were generally maintained four weeks after tx.

### MT protocol – Production
(Wierenga et al., 2006)

- Color coded mapping template used to train active and passive sentences.
Neural changes following MT
(Wierenga et al., 2006)
- Increased activity in Broca's area
- Reduced activity in lateral frontal regions

Treatment of Underlying Forms (TUF)
- Linguistically-motivated Tx for training sentences with syntactic movement (non-canonical)
- Complexity Account of Treatment Efficacy (CATE): “Training more complex structure results in recovery of untrained less complex, linguistically related, structures”
  (Thompson et al., 2003)

WH-movement structures
- Object wh-Q: Who did the dog chase ___?
- Object-cleft: It is the boy [who the dog chased ___].
- Object Relative: John saw the boy [who the dog chased ___].

TUF protocol
- Identify verb and thematic roles of the verb arguments (nouns) in active form of target sentence (underlying functional structure)
- Move constituents to form the target sentence (surface structure).

TUF Protocol
- Demo for Object Relative Tx
- See Thompson et al. (2003, Appendix B) for the treatment protocols for different sentence types.
- TUF can be purchased:
  http://anr.northwestern.edu/research/diagnostic-tests/#TUF

Step 1: comprehension probe
"Point to Pete saw the woman who the man kissed." Incorrect response is corrected by clinician.
Step 2: Sentence production priming probe

- An object relative construction is elicited using the sentence production priming task.
- When pt fails to produce the target sentence, steps 3-7 are followed.

For this picture, I could say “Pete saw the man who the woman kissed.” For this picture (pointing to the target picture), you could say…?

Step 3: Verb and verb argument comprehension

1. "Point to the action word"
2. “point to the person who saw/kissed”
3. “point to the person who was seen/kissed”

Pete saw the woman the man kissed the woman

Step 4: Verb and verb argument production

1. Pointing to the verb of each clause: “name the action”
3. “Who was seen? Who was kissed”

Pete saw the woman the man kissed the woman

Step 5: Object-relative clause formation (a)

“Now we want to make a new sentence, one that combines these two sentences.”
“The woman is the one who was kissed” (Clinician replaces ‘the woman’ with ‘who’)

“Now you read the sentence for me.”

Pete saw the woman the man kissed the woman

Step 6: Object-relative clause formation (a)

“Now we want to make a new sentence, one that combines these two sentences.”
“The woman is the one who was kissed.” (Clinician replaces ‘the woman’ with ‘who’)

“Read/repeat the sentence for me.”

Pete saw the woman the man kissed who
Step 6: Object-relative clause formation (b)

(Referring to the first clause) “the woman that Pete saw and the woman the man kissed are the same person. So, we are going to move them next to each other”. “Read the sentence for me”

Pete saw the woman the man kissed

Step 7. Patient practices steps 4-6

- Sentence constituents are rearranged in their active sentence form for each clause, together with the [who] card (as in Step 3).
- Steps 4-6 are repeated, with the pt replacing/selecting/moving the cards to form a correct target construction.
- Assistance is provided if needed.

Participant (DL):
Generalization to untrained structures (OC, WH?) following OR-Tx

Participant (HR):
No generalization to untrained structures.

Thompson et al. (2003)

Generalization to simpler structures
(Thompson & Shapiro, 2007)

More than 20 individuals with agrammatic aphasia trained:

85% of those who trained to produce complex who-movement structures successfully generalized to simpler who-movement structures.

Only 17% of individuals who trained to produce who-questions showed generalization to more complex who-movement structures.

Verb Network Strengthening Training (VNeST)

- Aims to increase activation of a verb and its thematic roles (agent-theme pairs) in order to facilitate correct production of the words in sentences.
- Generalization to untrained semantically related verbs and their thematic roles is expected via spreading activation in the lexical network:
Verb Network Activation
(Edmonds & Babb, 2011)

VNeST protocol
(Edwards et al., 2009)

• Step 1-2: Generate 3 agent-patient pairs for verb.
  
  Tell me who can measure.

  Tell me what can be measured.

• If pt cannot verbally provide the pairs, cards (including foils) are provided from which the pt chooses plausible agents and patients.

VNeST Protocol

• Step 3: Answer wh-questions about patient chosen agent-patient pair.

  "In the morning"
  "correct amount"
  "kitchen"

• Step 4: Semantic judgment of sentences
  • Cards removed from table
  • Clinician reads 16 sentences containing the target verb:
    • 4 correct
    • 4 with an inappropriate agent
      (e.g., the dentist measures the door)
    • 4 with an inappropriate patient
    • 4 with the agent and patient switched
  • Client judges whether the sentences make sense or not.

VNeST Protocol

• Step 5: Generation of 3 agent-patient pairs (repeat steps 1–2)
  • No cards used during Step 5, feedback is general

VNeST Results
Edmonds et al. (2009)
A Systematic Review of Verb-Centered Treatments: Acquisition, Generalization, & Maintenance

Man, Dick & Lee (2015)
ASHA Convention

Review of Treatment Efficacy Data

• To systematically review treatment efficacy data of MT, TUF, and VNeST
  – Acquisition of trained sentences
  – Generalization to untrained sentences
  – Generalization to connected speech
  – Maintenance of tx gains
• 25 peer-reviewed published studies located (9 TUF, 13 MT, and 5 VNeST)
• 4 MT and 1 VNeST studies excluded: no sentence production probes for acquisition
• A total of 22 studies were included.

Review of Treatment Efficacy Data

<table>
<thead>
<tr>
<th></th>
<th>TUF</th>
<th>MT</th>
<th>VNeST</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>30</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>Aphasia type</td>
<td>28 nonfluent, 2 mixed</td>
<td>21 nonfluent, 1 fluent</td>
<td>8 nonfluent, 11 fluent</td>
</tr>
<tr>
<td>Severity</td>
<td>25 mild-to-moderate, 5 severe</td>
<td>2 mild, 20 moderate-to-severe</td>
<td>1 mild, 16 moderate, 2 severe</td>
</tr>
</tbody>
</table>

Acquisition

• Production of trained sentences pre- vs. post-tx
• All three treatments showed high levels of success.

Generalization to untrained sentences

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Generalization to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUF</td>
<td>untrained linguistically related simpler structures (e.g., Object Relative &gt; object cleft, object wh-Q’s)</td>
</tr>
<tr>
<td>MT</td>
<td>untrained simpler structures untrained verbs and arguments in trained structures untrained more complex structures</td>
</tr>
<tr>
<td>VNeST</td>
<td>untrained semantically similar verbs and their agent-patient pairs in sentence production (e.g., measure → weigh)</td>
</tr>
</tbody>
</table>

Generalization to untrained sentences

<table>
<thead>
<tr>
<th></th>
<th>Generalization to Untrained Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of participants</td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>59%</td>
</tr>
<tr>
<td>TUF</td>
<td>71%</td>
</tr>
<tr>
<td>VNeST</td>
<td>74%</td>
</tr>
</tbody>
</table>

10/17                      20/28                    14/19
71% 59% 74%
Generalization to connected speech

- Narrative tasks: Cinderella, Cookie Theft, Nicholas & Brookshire (1993)
- Successful generalization was judged as documented improvement in one of the following:
  - Informativeness (e.g., % CIU)
  - Utterance length (e.g., MLU)
  - Utterance complexity (e.g., % of complete utterances, % of correctly produced complex sentences, % of sentences with correct VAS)

Maintenance

- Retention of the acquisition effects made in therapy
- Measured at 1 to 5 months post-tx across studies
- Not all studies measured maintenance.

Summary

- Relatively successful acquisition effects for all Tx’s.
- Tx gains maintained when assessed.
- Variable generalization to untrained stimuli and tasks.

Critical variables/limitations

- Limited treatment/generalization effects in participants with severe aphasia (WAB AQ < 50).
- Not appropriate for patients with significantly impaired comprehension or cognitive skills (Dickey & Yoo, 2010; Murray et al., 2004)
  - Auditory comprehension was a significant predictor for TUF outcomes, but not aphasia severity and complex sentence comprehension scores (Dickey & Yoo, 2010).
- No more than moderate-to-mild apraxia of speech.
- Little application for fluent aphasic patients.
- Tx-induced changes in quality of life rarely assessed.
MT studies included in our view:


VNeST studies included in our review:


TUF studies included in our review:


Conclusions:

- Within a staged model of sentence production, grammatical encoding processes are impaired in individuals with (agrammatic) aphasia.
- Research evidence suggests that impaired processing of VAS and non-canonical word order underlie these deficits.
- It is crucial to assess how these linguistic factors affect sentence processing in IWA.
- A review of selected SP treatments show:
  - Relatively successful acquisition and maintenance effects (when assessed).
  - Somewhat variable generalization to untrained stimuli and tasks across treatments.

Thank you!

Questions/Comments?