The Effect of Plausibility in Sentence Processing: Evidence from Sentence Comprehension

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Introduction

- It has long been noted that persons with aphasia (PWA) seem to rely more on semantics than syntax in their comprehension (Caramazza & Zurif, 1976).

Background

- **Noisy Channel Hypothesis** (Levy, 2008; Levy et al., 2009)
  - When meanings are uncertain, prior knowledge and the knowledge that speakers make errors come into play.
- **Gibson and Bergen (2012)**
  - Comprehenders of English integrate the likelihood of noise with prior knowledge and expectations.
  - 5 sentence types; 2 with major alternations, 3 with minor alternations (only applicable ones shown here).
  - Found that:
    1. More changes leads to a greater reliance on the syntax of the current structure.
    2. Deletions more accepted as mistakes than insertions.
    3. Exp2 vs. Exp1: When more syntactic errors are expected, reliance on syntax decreases.
    4. Exp3 vs. Exp1: When more implausible sentences are expected, reliance on syntax increases.
  - Materials
    - Major alternations
      - active → passive (2 insertions)

        The ball kicked the girl. →

        *The ball **was** kicked **by** the girl.*
      - passive → active (2 deletions)

        *The girl **was** kicked **by** the ball. →*

        The girl kicked the ball.
    - Minor alternations
      - prep.object (PO) → double object (DO) (1 deletion)

        *The nephew gave the niece **to** the bike. →*

        The nephew gave the niece the bike.
      - DO → PO (1 insertion)

        The nephew gave the bike the niece. →

        *The nephew gave the bike **to** the niece.*

Construction	Changes (from plausible)	Exp1: Baseline (N=300)	Exp2: ↑ syntax error (N=300)	Exp3: ↑ implausible (N=300)
Active implausible	2 deletions	98.6%	90.0%	94.8%
Passive implausible	2 insertions	96.8%	85.9%	92.0%
PO implausible	1 insertion	62.0%	58.2%	79.9%
DO implausible	1 deletion	47.8%	36.4%	69.0%

Aim and Hypothesis

- **Aim:** Determine the effect of plausibility on the comprehension of DO and PO constructions in persons with aphasia.
  - Neurologically healthy older and younger adults included as a comparison.
- **Hypothesis:** Plausibility will affect comprehension in persons with aphasia differently depending on sentence structure according to the noisy channel hypothesis.
  - If PWA assume more noise in the input, then they should rely less on syntax, especially in the minor change alternation.
    - Like normals, PWA should be less likely to follow syntax
      1. For implausible DO/PO (minor change) than implausible active/passive (major change)
      2. For implausible DO (deletion) than implausible PO (insertion)

Methods

- Participants
  - Persons with aphasia
    - N = 8 (5 male), aged 29-67 (*M* = 55.9)
  - Younger neurologically healthy adults
    - N = 11 (6 male), aged 19-40 (*M* = 27.2)
  - Older neurologically healthy adults
    - N = 7 (3 male), aged 56-69 (*M* = 62.1)

Persons with Aphasia

ID	Age	Sex	Months Post Onset	WAB AQ	Type
BUMA03	67	F	79	98	Anomic
BUMA05	54	M	119	75.4	Broca's
BUMA07	29	M	14	53.4	Broca's
BUMA08	62	F	60	74.4	Transcortical Motor
BUMA14	63	M	96	NA	NA
BUMA15	59	M	24	NA	NA
BUMA16	56	M	82	77.7	Conduction
BUMA50	57	F	44	99.2	Anomic

- Stimuli
  - 80 total experimental sentences (dative alternation)
  - 20 sentences per version (counterbalanced across participants)
    - 5 *plausible* double-object sentences

      The girl gave the boy the bike.
    - 5 *implausible* double-object sentences

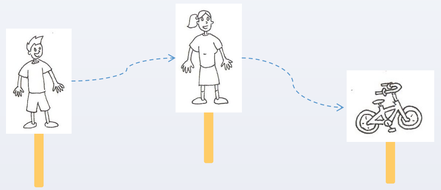
      The girl gave the bike the boy.
    - 5 *plausible* prepositional-object sentences

      The girl gave the bike to the boy.
    - 5 *implausible* prepositional-object sentences

      The girl gave the boy to the bike.
  - 20 filler sentences (active/passive)
    - 5 *plausible* / 5 *implausible* active
    - 5 *plausible* / 5 *implausible* passive

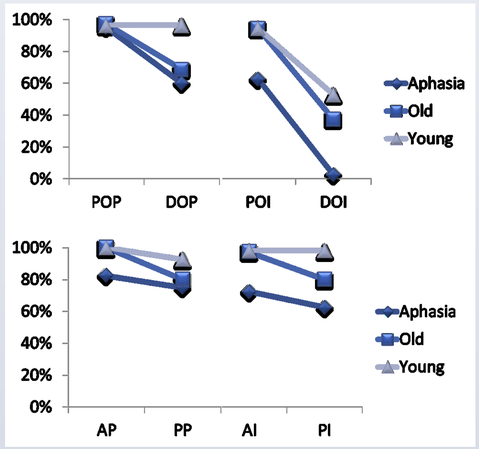
Results

Comprehension Performance



- Clinician reads sentence

  "The nephew gave the bike the niece."
- Participant shows comprehension through object manipulation



Note: POP=prepositional object plausible, DOP=double object plausible, POI=prepositional object implausible, DOI=double object implausible, AP=active plausible, PP=passive plausible, AI=active implausible, PI=passive implausible

- As expected, PWA follow syntax less for implausible than plausible for all structures.
  - For young normals, this is only true for DO structure
  - For older normals, this is true for both PO and DO

1. PWA follow syntax less for minor than major change
   - DOI/POI < AI/PI
   - For normals, only affects DO structure
2. PWA follow syntax less for deletion than insertion
   - DOI < POI

Discussion

- Hypothesis confirmed
- Within framework of noisy channel hypothesis:
  - Like normals, PWA integrate likelihood of noise with prior knowledge and expectations.
  - PWA show exaggeration of effects of noise compared with normals
    - Lesion may be an additional source of noise
  - Older adults show exaggeration of effects of noise compared with younger adults
    - Age may be an additional source of noise
    - DOP performance in older adults is lower than expected
      - most likely due to use of NP vs. usual pronoun; therefore cues point toward PO interpretation (Bresnan et al., 2004)
  - According to Gibson & Bergen (2012), increased implausible/plausible ratio creates higher expectation of implausibility which leads to increased reliance on syntax
    - Even with 50/50 ratio, PWA still relying less on syntax than normals (esp. for POI)
  - Current ERP study provides further evidence of the noisy channel explanation (Stearns, Fedorenko, Bergen, & Gibson, in progress)
    - N400 = semantic incongruity
    - P600 = error correction rather than syntactic incongruity
      - No P600 for jabberwocky incongruencies
      - P600 for plausible errors with correct syntax
        - » Alteration vs. altercation
- Future work
  - Explicitly test noisy channel hypothesis in PWA using Gibson & Bergen (2012) paradigm

References

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