Beyond naming:
Assessing near and far transfer effects in bilingual aphasia following semantic feature-based treatment

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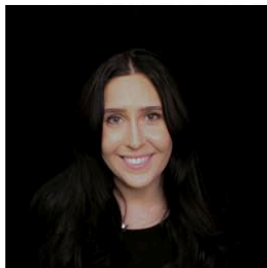
62nd Annual Meeting of the Academy of Aphasia
October 18-20th, 2024
Nara, Japan

Predicting Rehabilitation Outcomes for bilinguals with aphasia using Computational Modeling (PROCoM) Team

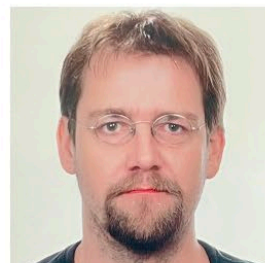Swathi Kiran

Erin Carpenter

Manuel J. Marte

Michael Scimeca

Claudia Peñaloza

Risto Miikkulainen

Uli Grasemann

Disclosures

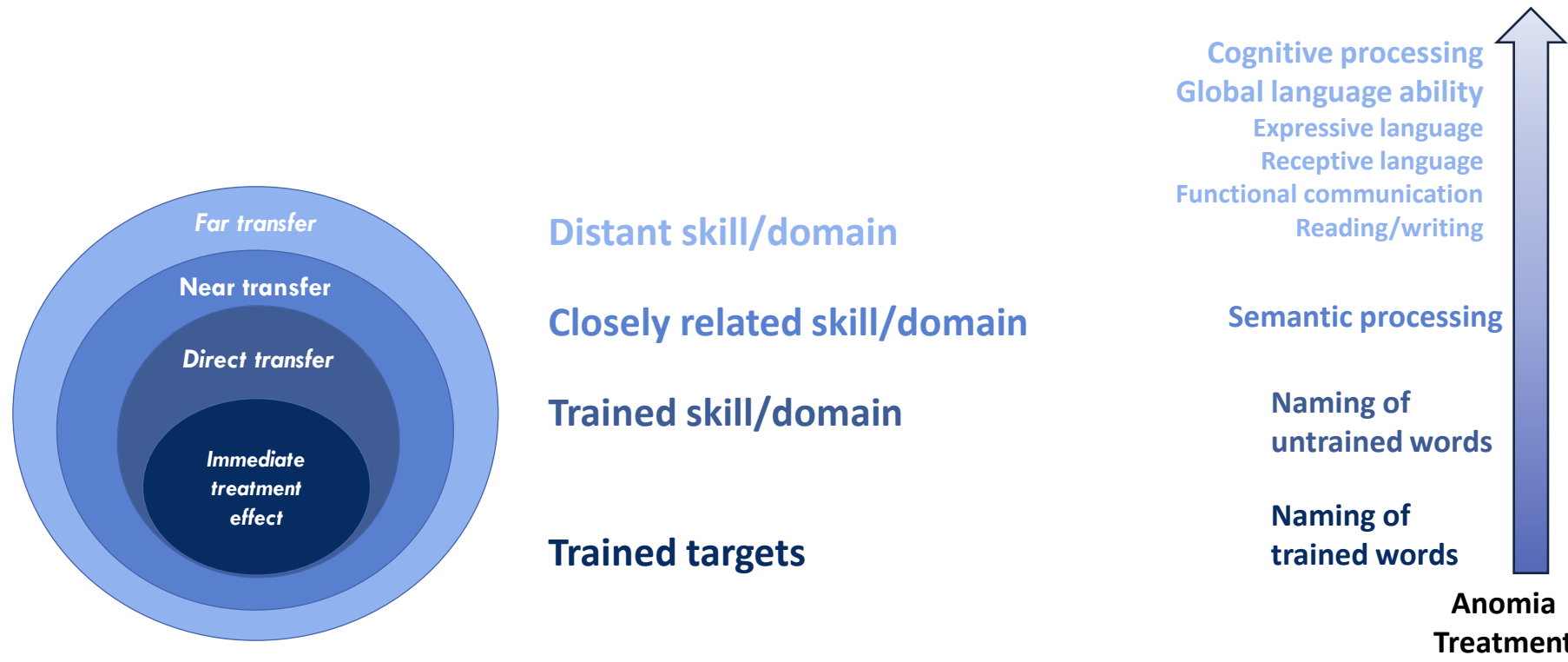This study is registered at www.ClinicalTrials.gov, identifier: NCT02916524

Background

Treatment-induced change following aphasia therapy

- Anomia is a hallmark deficit of aphasia

- Generalization → optimal aphasia therapy[1]
    - Bilinguals have the potential for *cross-language generalization*[2-5]

1. Webster et al., 2015; 2. Faroqi-Shah et al., 2010; 3. Goral et al., 2023; 4. Lee & Faroqi, 2024; 5. Scimeca et al., 2023

Treatment-induced change following aphasia therapy

Far transfer

Near transfer

Direct transfer

Immediate treatment effect

Distant skill/domain

Closely related skill/domain

Trained skill/domain

Trained targets

Cognitive processing
Global language ability
Expressive language
Receptive language
Functional communication
Reading/writing

Semantic processing

Naming of untrained words

Naming of trained words

Anomia Treatment

1. Webster et al., 2015; 2. Faroqi-Shah et al., 2010; 3. Goral et al., 2023; 4. Lee & Faroqi, 2024; 5. Scimeca et al., 2023
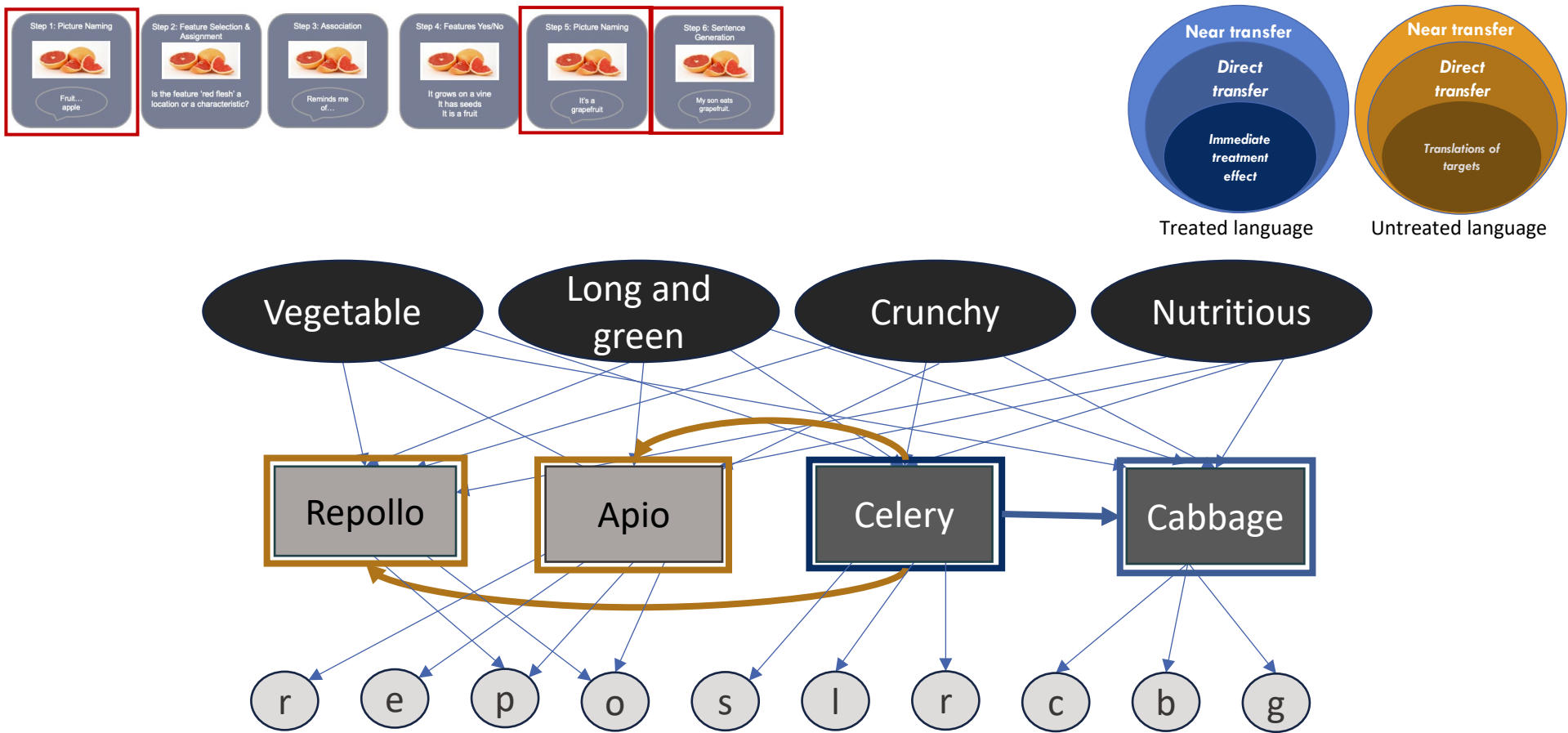
Current work:
Measurement of cross-language and cross-domain generalization following semantic feature-based anomia therapy in bilingual aphasia

Treated language

Untreated language
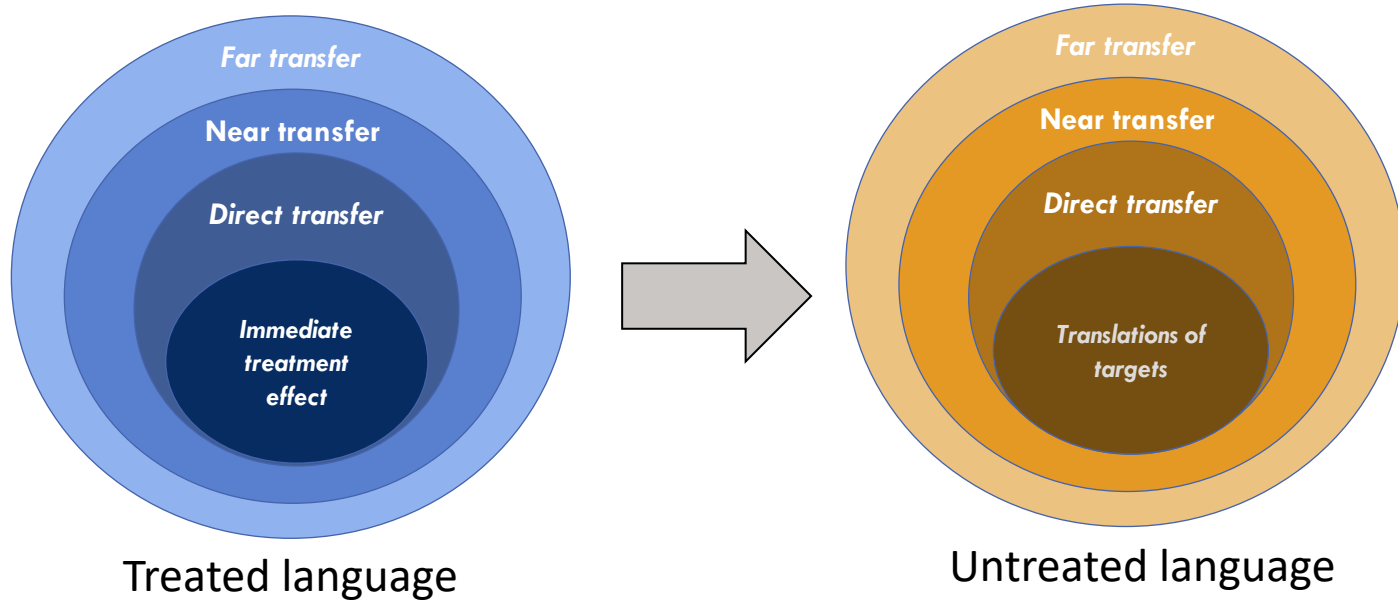
# Semantic feature-based treatments (SFT) and patterns of transfer
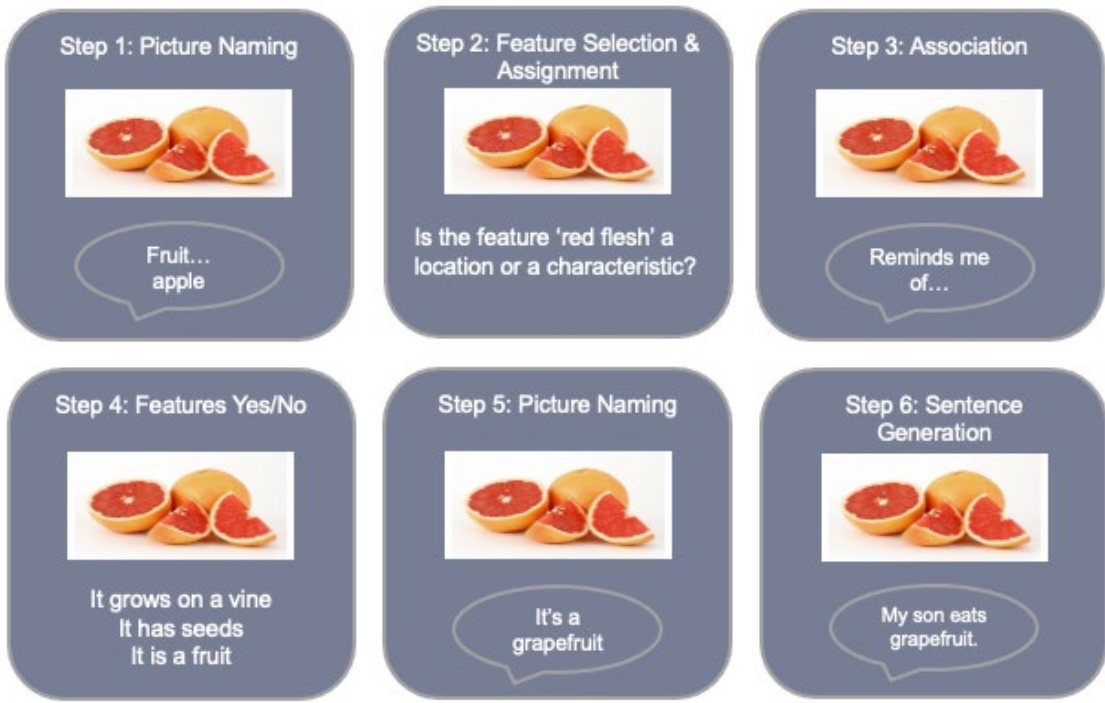
Adapted from Costa, La Heij, & Navarrete (2006), framework of bilingual lexical access; Kiran et al., 2013

Semantic feature-based treatments (SFT) and patterns of transfer

- Sustained attention to therapy tasks
- Executive functioning demands
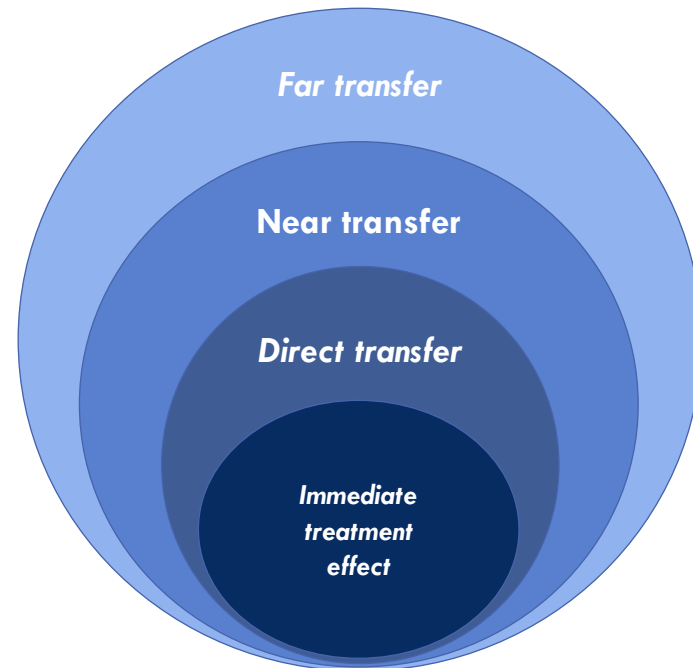- Auditory comprehension of instructions
- Sentence production

FAR TRANSFER
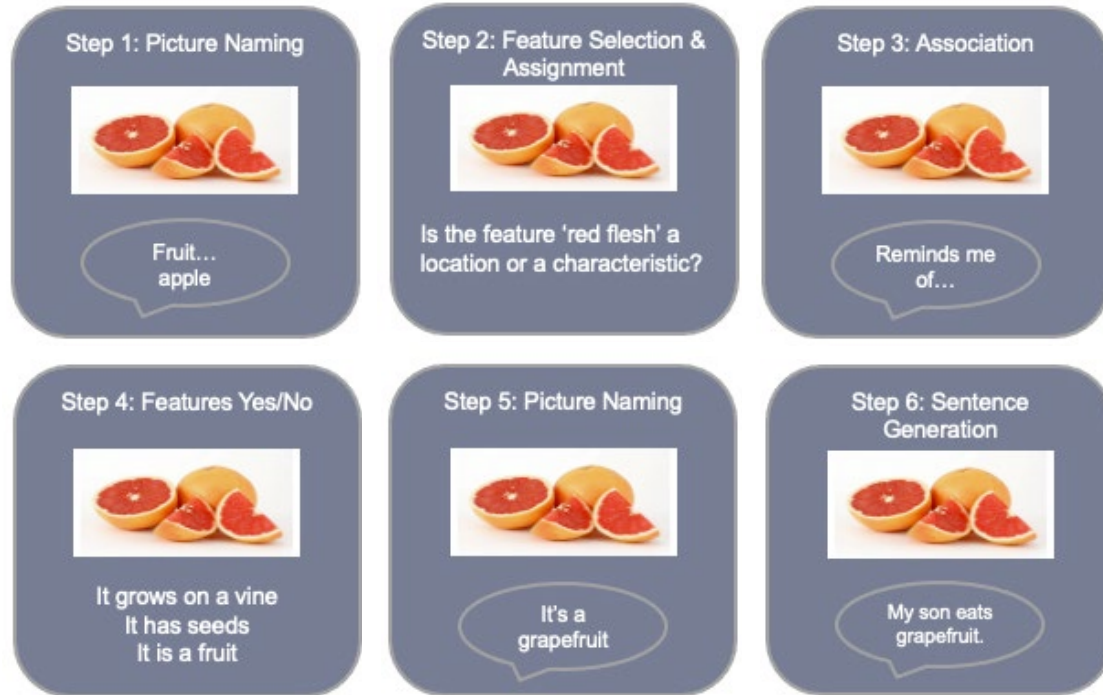
? Hypotheses

Following SFT, BWA will show:

1) <u>Direct transfer</u> effects to untrained naming items

2) <u>Near transfer</u> effects to untrained semantic processing tasks

3) <u>Far transfer</u> effects to broader linguistic and non-linguistic tasks

? Hypotheses

Following SFT, BWA will show:
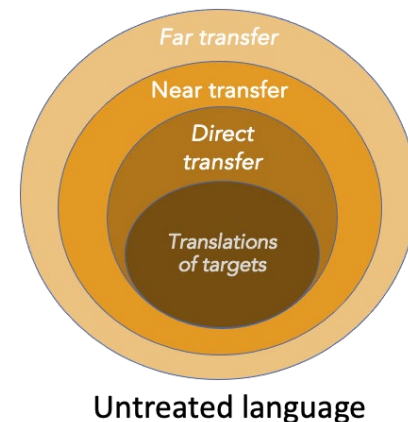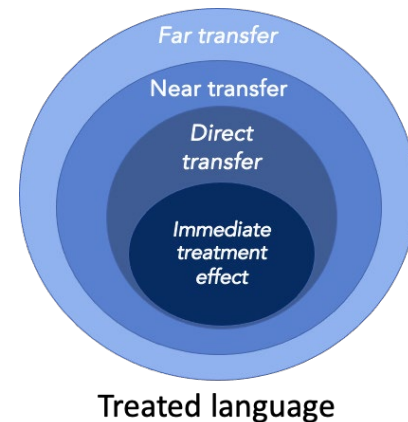
1) <u>Direct transfer</u> effects to untrained naming items

2) <u>Near transfer</u> effects to untrained semantic processing tasks

3) <u>Far transfer</u> effects to broader linguistic and non-linguistic tasks

Treated language

Untreated language

Methods

Participants

- 48 Spanish-English BWA

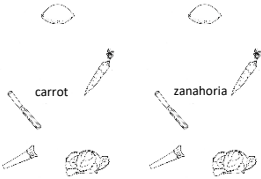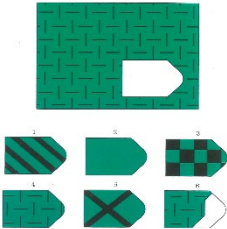- Received 40 hours of SFT in either Spanish or English

Participant demographics, language background, and treatment assignment

	Sex	Age	MPO	Education (years)	L1	L2 Age of Acquisition	Treatment language
n = 48	F = 19	53.84	47.35	13.98	Sp = 40	13.21	Sp = 28
	M = 29	(15.86)	(82.7)	(3.39)	Eng = 8	(11.09)	Eng = 20

Note. Values are presented as Mean (SD). MPO = *Months post-onset*; L1 = *first acquired language*; L2 = *second acquired language*; Sp = *Spanish*, Eng = *English*

Peñaloza, C., Dekhtyar, M., Scimeca, M., Carpenter, E., Mukadam, N., & Kiran, S. (2020). Predicting treatment outcomes for bilinguals with aphasia using computational modeling: Study protocol for the PROCoM randomised controlled trial. *BMJ open*, *10*(11), e040495.

Assessments

Immediate effect	Direct transfer (untrained naming)	Near transfer (semantic processing)	Far transfer (broader language & cognitive skills)
1. Trained words (e.g., *celery*)	2. Untrained, related words (e.g., *cabbage*) 3. Untrained, unrelated words (e.g., *dog*) Untrained translations of 1-3 (e.g., *apio, repollo, perro*) **Boston Naming Test (BNT)**	• **Spoken/written word-picture matching** carrot zanahoria • **Auditory/written synonym judgment** ocean sea océano mar • **Word semantic association** **comb** door brush gate tweezers **peine** puerta cepillo entrada pinzas • **Pyramids and Palm Trees Test (PAPT)**	• **Western Aphasia Battery Aphasia Quotient (WAB-AQ)** • **Raven's Coloured Progressive Matrices (RCPM)**

Statistical Analyses

Data cleaning/organization

- Compiled pre and post treatment assessment scores

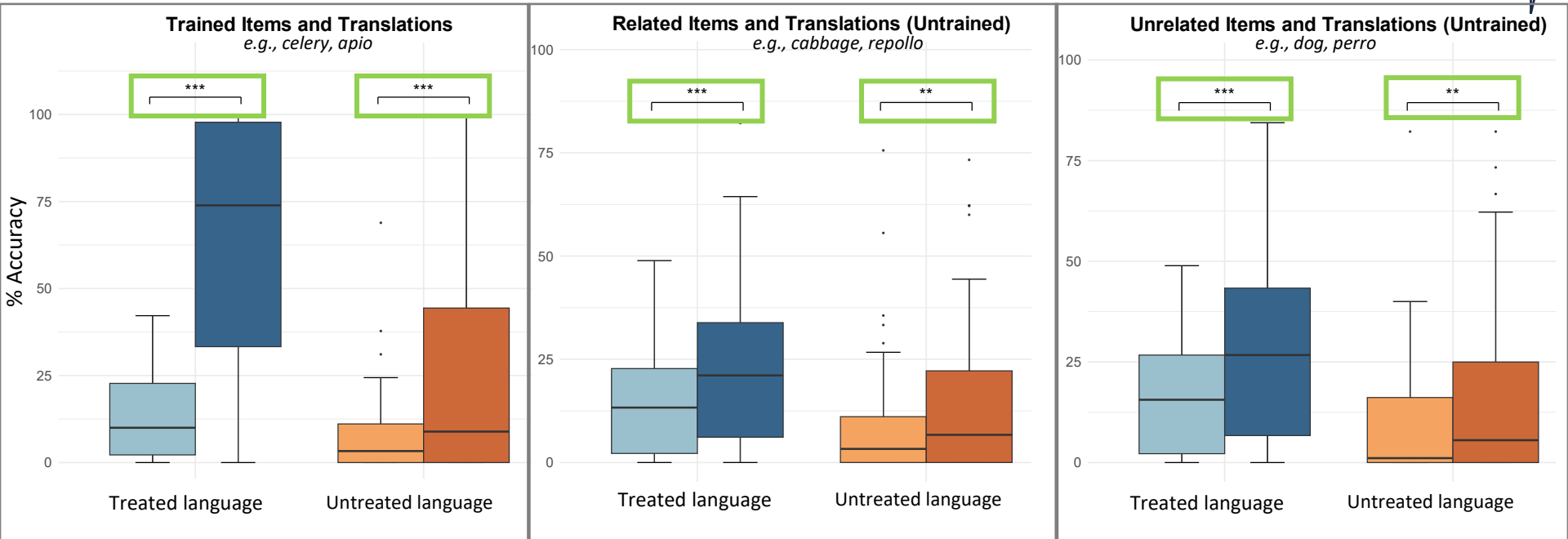- Imputed < 10% of missing data (primarily post-treatment) using *mice* package in R[1]

Linear mixed-effects models

- Score ~ timepoint + (1|participant)

- 16 models:
    - treated language assessments (7)
    - untreated language assessments (7)
    - nonverbal assessments (2)
    - Benjamini-Hochberg correction

1. Zhang, Z. (2016). Multiple imputation with multivariate imputation by chained equation (MICE) package. *Annals of translational medicine*, *4*(2).
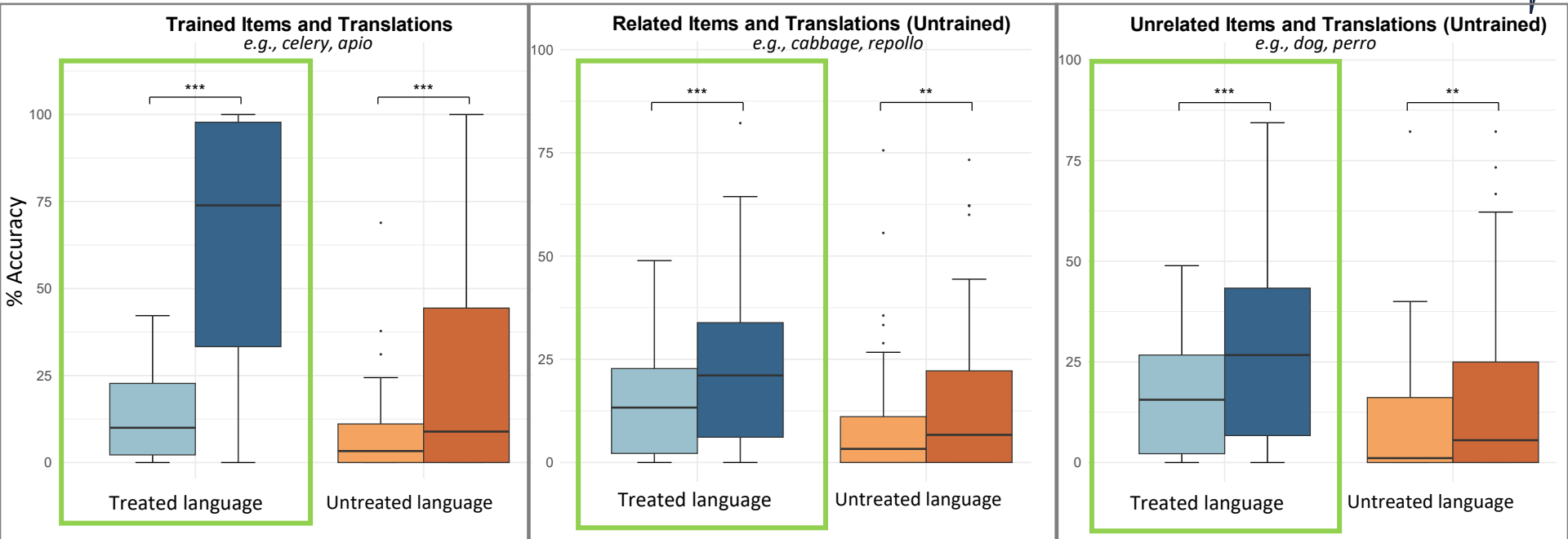
Results

Immediate effect | Direct transfer (untrained naming)

Trained Items and Translations
e.g., celery, apio

Related Items and Translations (Untrained)
e.g., cabbage, repollo

Unrelated Items and Translations (Untrained)
e.g., dog, perro

Timepoint
Pre-treatment
Post-treatment

Significant improvement across all word sets

Immediate effect | Direct transfer (untrained naming)

Trained Items and Translations
e.g., celery, apio

Related Items and Translations (Untrained)
e.g., cabbage, repollo
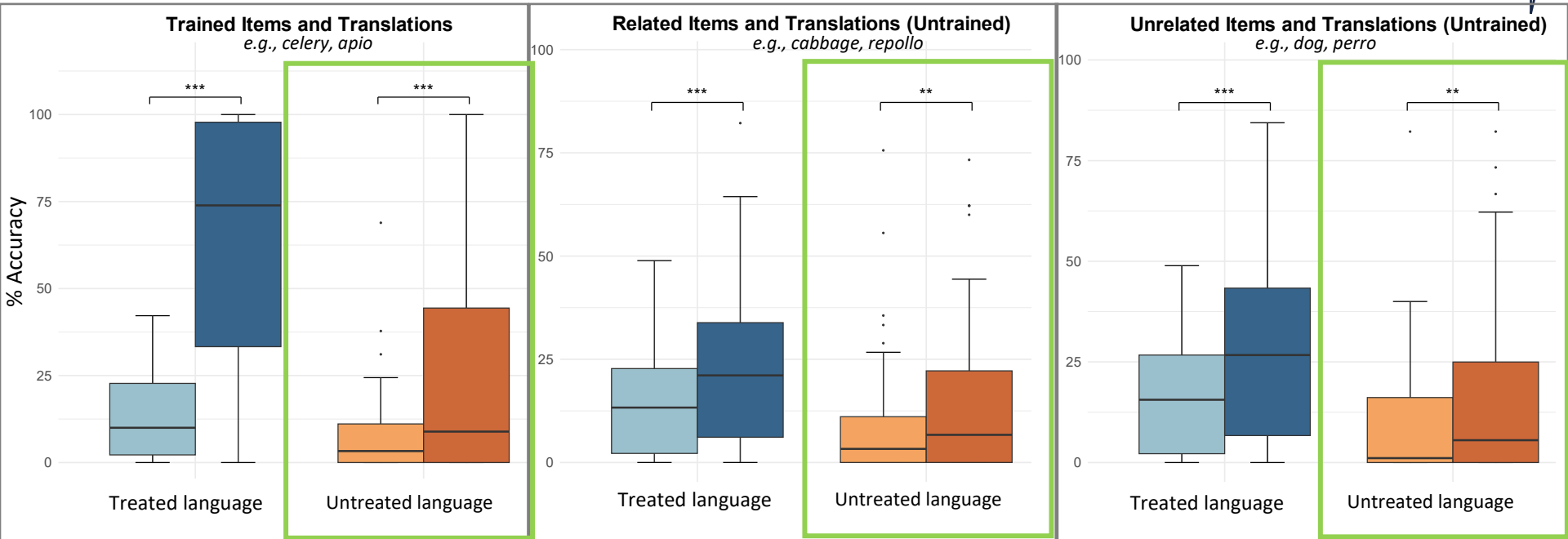
Unrelated Items and Translations (Untrained)
e.g., dog, perro

Timepoint
Pre-treatment
Post-treatment

Directly trained words → semantically unrelated words → semantically related words

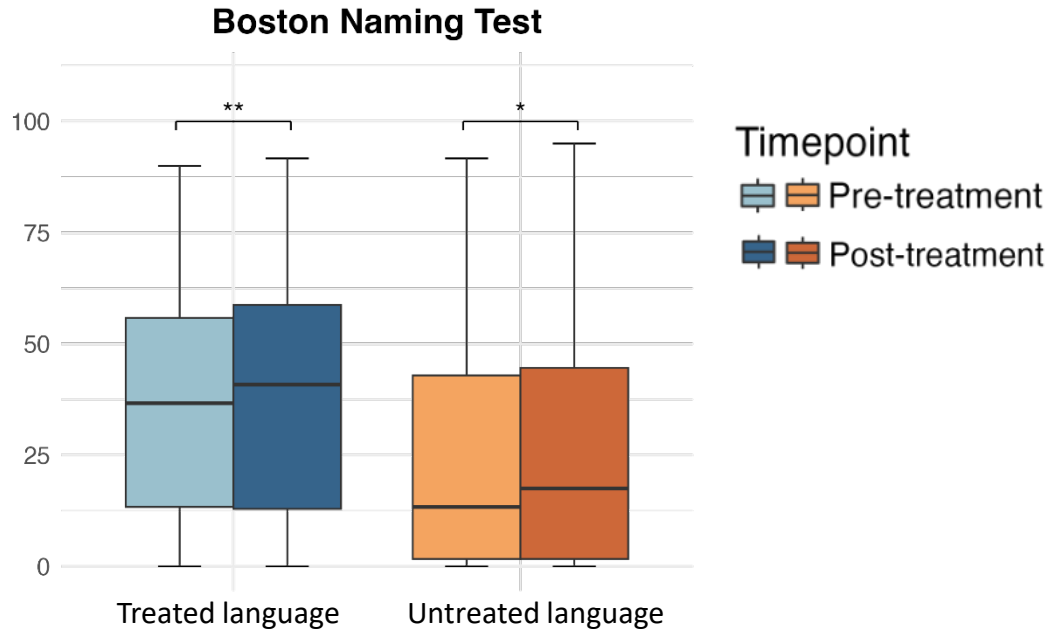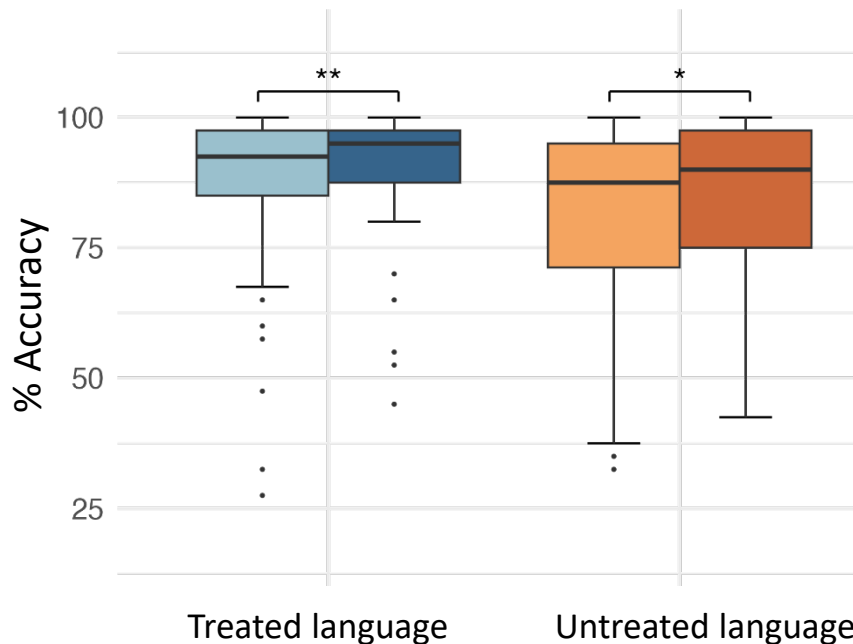Immediate effect | Direct transfer (untrained naming)

Trained Items and Translations
e.g., celery, apio

Related Items and Translations (Untrained)
e.g., cabbage, repollo

Unrelated Items and Translations (Untrained)
e.g., dog, perro

Treated language   Untreated language   Treated language   Untreated language   Treated language   Untreated language

Timepoint
Pre-treatment
Post-treatment

Cross-language generalization

Immediate effect | **Direct transfer (untrained naming)**

Boston Naming Test

BNT: Significant improvement in both languages

Near transfer (semantic processing)

Spoken Word Picture Matching

Written Word Picture Matching

Improvements in both languages:
- Spoken word-picture matching
- Written word-picture matching

Near transfer (semantic processing)

Word Semantic Association
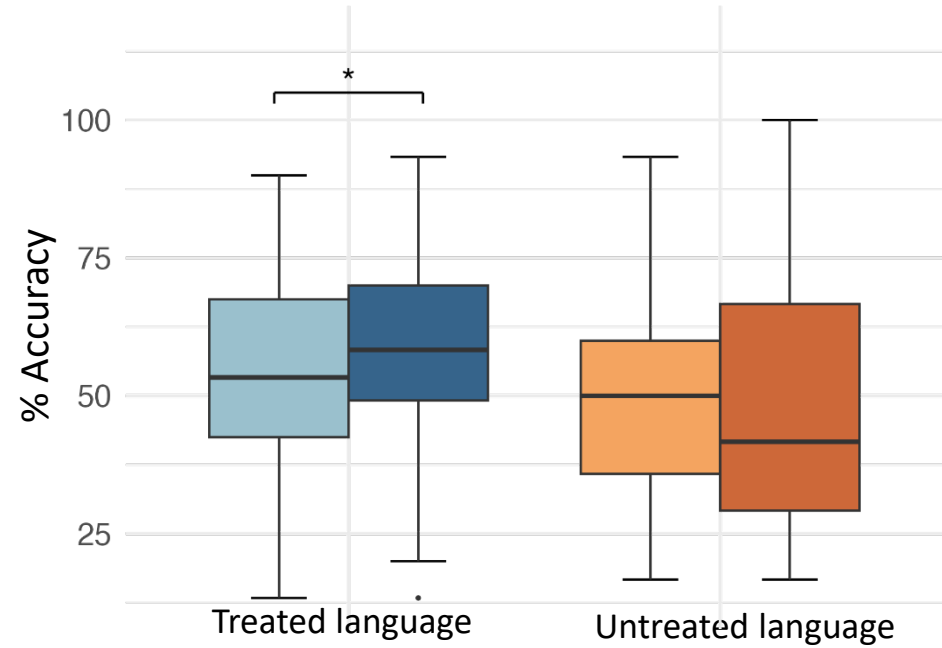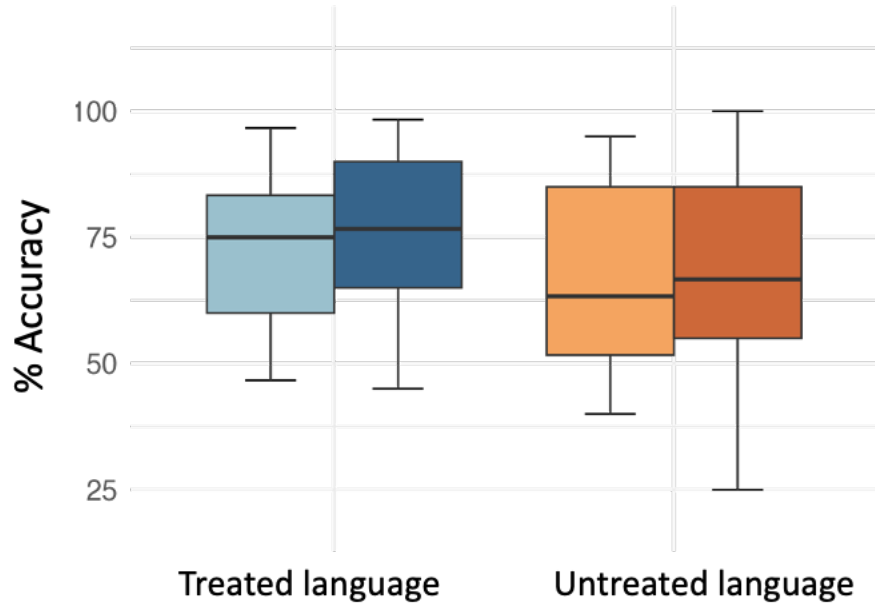

Timepoint
- Pre-treatment
- Post-treatment

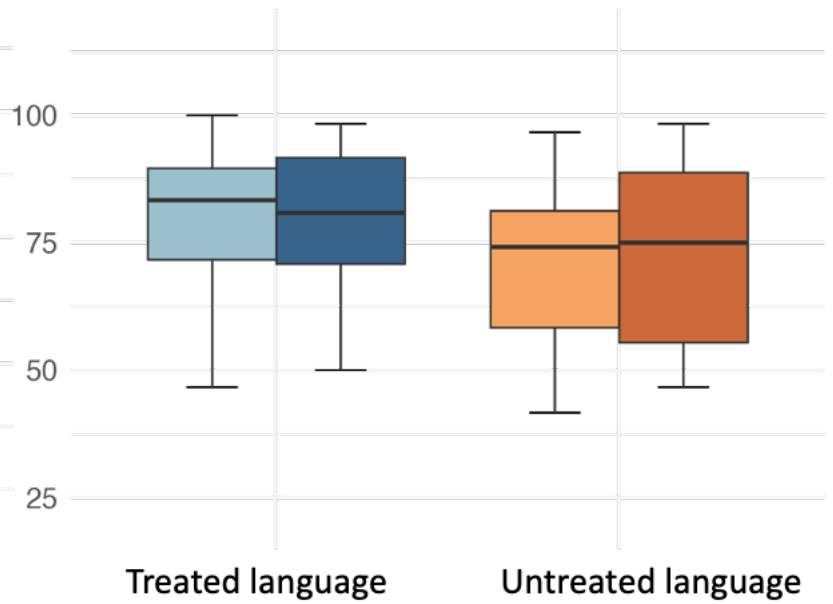**Improvement in treated language only:**
- Word semantic association

comb
door brush gate tweezers

peine
puerta cepillo entrada pinzas

Near transfer (semantic processing)

Auditory Synonym Judgments

Written Synonym Judgments

Timepoint
Pre-treatment
Post-treatment

No significant improvement:
- Auditory synonym judgments
- Written synonym judgments

ocean   sea

océano   mar
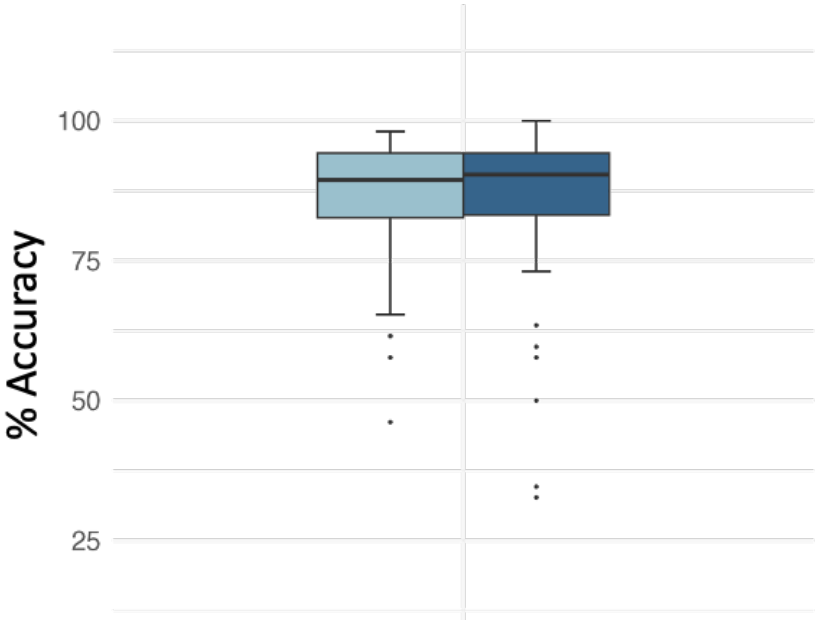
Near transfer (semantic processing)
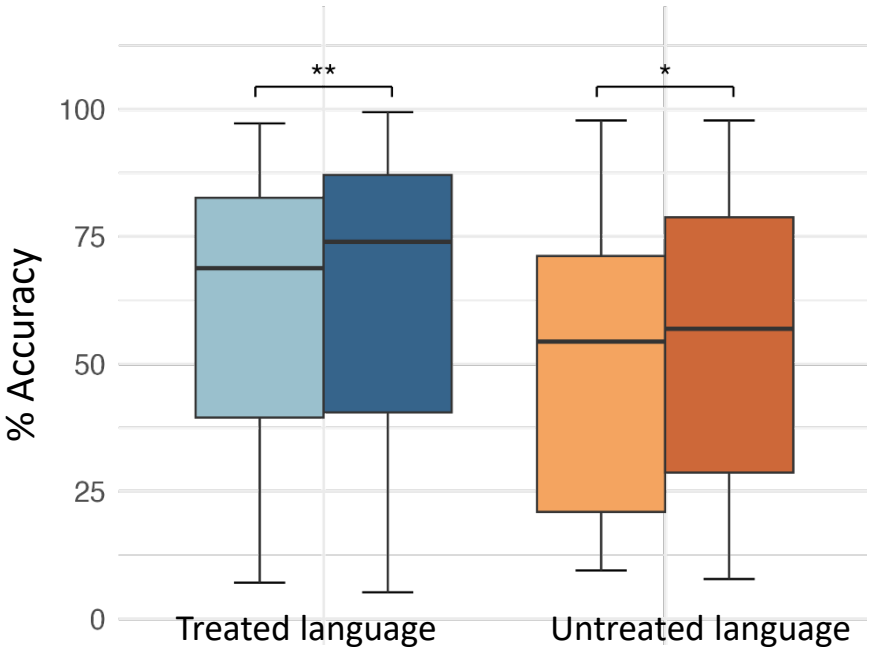
Pyramids and Palm Trees

% Accuracy

100

75

50

25

Timepoint
Pre-treatment
Post-treatment

No significant improvement:
- Auditory synonym judgments
- Written synonym judgments
- PAPT

**Far transfer
(broader language & cognitive skills)**

WAB-AQ

Raven's Progressive Matrices
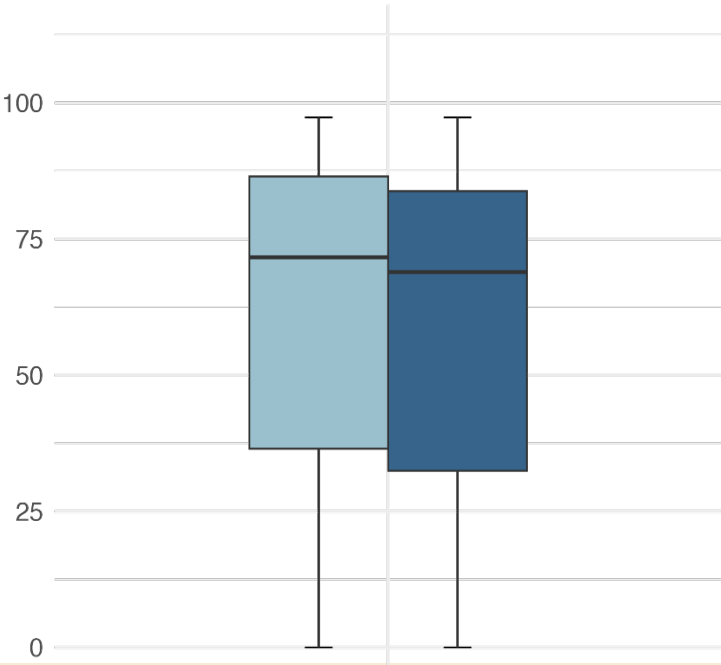
WAB-AQ
- Significant changes in both languages

RCPM:
- No significant change

Timepoint
- Pre-treatment
- Post-treatment

Discussion

Significant in both languages

Significant in one language

Not significant

Immediate effect	Direct transfer (untrained naming)

1. Trained words (e.g., *celery*)	2. Untrained, related words (e.g., *cabbage*) 3. Untrained, unrelated words (e.g., *dog*) Untrained translations of 1-3 (e.g., *apio, repollo, perro*) **Boston Naming Test (BNT)**

- Significant gains in all word sets & BNT[1,2], aligns with **spreading activation theory**

- Improvement in semantically unrelated words > semantically related

1. Li & Kiran 2023; 2. Gilmore et al., 2020; 3. Collins & Loftus, 1975; 4. Dell, 1986; 5. Jeffries & Lambon Ralph, 2006; 6. Bihovsky et al., 2023
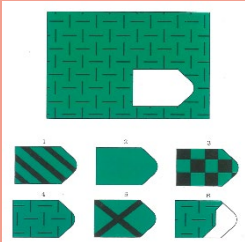
Discussion

- Significant in both languages
- Significant in one language
- Not significant

Immediate effect

Direct transfer (untrained naming)

Near transfer (semantic processing)

- **Spoken/written word-picture matching**

carrot / zanahoria

- **Auditory/written synonym judgment**

ocean   sea

océano   mar

- **Word semantic association**

comb
door brush gate tweezers

peine
puerta cepillo entrada pinzas

- **Pyramids and Palm Trees Test (PAPT)**

- Improvement in tasks involving mapping lexical forms to visual semantic referents (e.g., word-picture matching)

- No improvement in tasks demanding greater cognitive resources (e.g., synonym judgments, PAPT[5])

1. Li & Kiran 2023; 2. Gilmore et al., 2020; 3. Collins & Loftus, 1975; 4. Dell, 1986; 5. Jeffries & Lambon Ralph, 2006; 6. Bihovsky et al., 2023

Discussion

Significant in both languages

Significant in one language

Not significant

Immediate effect	Direct transfer (untrained naming)	Near transfer (semantic processing)	Far transfer (broader language & cognitive skills)

- Improvement in overarching language function[1,2,6]

- No improvement in domain-general cognitive skills[1,2]

- Effects of SFT may be specific to linguistic and semantic domains

- **Western Aphasia Battery Aphasia Quotient (WAB-AQ)**

- **Raven's Coloured Progressive Matrices (RCPM)**

1. Li & Kiran 2023; 2. Gilmore et al., 2020; 3. Collins & Loftus, 1975; 4. Dell, 1986; 5. Jeffries & Lambon Ralph, 2006; 6. Bihovsky et al., 2023
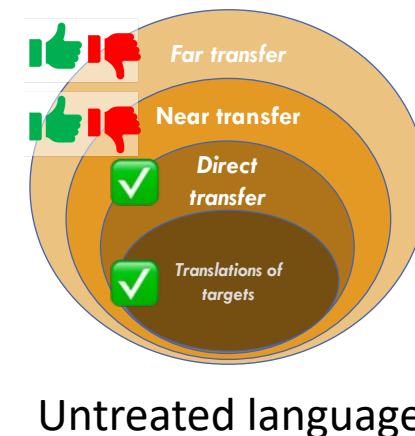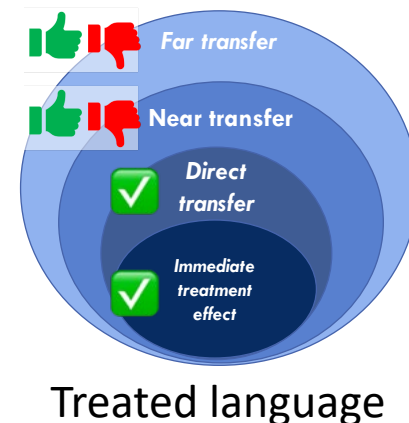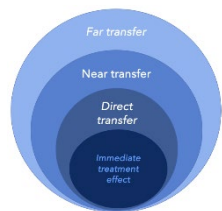
? Hypotheses

Following SFT, BWA will show:

✅ <u>Direct transfer</u> effects to untrained naming items

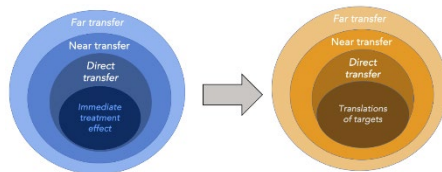👍👎 <u>Near transfer</u> effects to untrained semantic processing tasks

👍👎 <u>Far transfer</u> effects to broader linguistic and non-linguistic tasks

Treated language

Untreated language

Conclusions and future directions

Improvement in untrained words and language abilities beyond naming ✅

Cross-language generalization ✅

Transfer effects appear to be domain-specific

Future research:
- **Wider range of measures**
- **Intervention and patient-level predictors of generalization**

Acknowledgements

- Participants and their families
- NIH/NIDCD U01 DC014922; PI: Swathi Kiran
- PROCoM Team
- Center for Brain Recovery