Inhibition Mediates Individual Differences in Top-Down Lexical Processing

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Graz

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Research Questions

Are individual differences in top-down lexical processing a stable perceptual style [1] mediated by inhibition-related functions?

When does lexical processing occur in the perceptual time course of sound processing?

Background

Lexical information influences speech perception throughout the entire perceptual time course in the **TRACE model**. Lexical information influences speech perception at the decisional stage in the **MERGE model**.

Ishida, Samuel & Arai [1] indicated that **individual differences in lexical processing are stable** by finding that two tasks that measured lexical processing correlated highly within the individual.

Inhibition-related functions refer to the ability to suppress irrelevant information and responses [2]. They can be categorized into several subgroups:

- **resistance to distractor interference** inhibition operates during the **early stage** of perceptual processing
- **prepotent response inhibition** operates during the **late stage** of perceptual processing

Methods

Participants

- 32 native, monolingual speakers of North American English
- ages 18-30, M = 21.8

Materials

- LTRS task: 288 time-reversed/non-reversed token pairs
- Ganong task: 5 five-step /ɪ/ word condition continua, 5 five-step /ɛ/ word condition continua

Procedure

- Counterbalanced task order
- Alternate between inhibition and lexical tasks

Models

The relationship between individual lexical processing and individual cognitive abilities was investigated by running two mixed effects logistic regression models, One for the LTRS task and one for the Ganong task.

LTRS Task

Fixed Effects	Estimate	SE	z	p
(Intercept)	0.4	0.08	5.17	< 0.001 ***
Non-LTRS Lexical Status	1.4	0.05	21.47	< 0.001 ***
Go/No-go d' Score	0.04	0.05	0.85	0.39
Go/No-go Median Go Log RT	-0.13	0.05	-2.61	0.01 **
Flanker Difference Score (RT)	0.08	0.05	1.82	0.07 .
Flanker Median Log RT	0.03	0.05	0.63	0.53
Ganong Difference Score (Proportion Correct)	0.11	0.05	2.45	0.01 *
Go/No-go d' Score × Non-LTRS Lexical Status	-0.14	0.03	-4.05	< 0.001 ***
Go/No-go Median Go Log RT × Non-LTRS Lexical Status	-0.15	0.04	-3.88	< 0.001 ***
Flanker Difference Score (RT) × Non-LTRS Lexical Status	0.05	0.03	1.48	0.14
Flanker Median Correct Log RT × Non-LTRS Lexical Status	0.13	0.03	4.38	< 0.001 ***
Ganong Difference Score × Non-LTRS Lexical Status	0.29	0.04	8.0	< 0.001 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Ganong Task

Fixed Effects	Estimate	SE	z	p
(Intercept)	0.33	0.12	2.81	0.01 **
Continuum Step	2.56	0.09	27.40	< 0.001 ***
Go/No-go Median Go Log RT	0.12	0.10	1.15	0.25
Go/No-go d' score	-0.07	0.12	-0.60	0.55
Flanker Difference Score (RT)	0.02	0.11	0.24	0.81
Flanker Median Log RT	0.09	0.11	0.89	0.38
Non-LTRS Difference Score (d')	0.23	0.10	2.27	0.02 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- Ganong task and LTRS task were significant main effects in each other's models suggesting a stable perceptual style. [1]
- Significant Flanker RT × Non-LTRS Lexical Status interaction effect and positive trend of the Flanker Difference Score × Non-LTRS Lexical Status interaction effect in the LTRS model suggest individuals with worse early-stage inhibition had a larger lexical effect
- Direction of the trends of each Flanker measure in the Ganong model suggest that individuals with worse early-stage inhibition had a larger lexical effect
- Significant Go/No-go d' Score × Non-LTRS Lexical Status interaction effect and significant Go/No-go RT × Non-LTRS Lexical Status interaction effect in the LTRS model suggest that individuals with worse late-stage inhibition had a larger lexical effect
- Direction of the trends of Go/No-go measures in Ganong model suggested that individuals with worse late-stage inhibition had a larger lexical effect

References: , [1] Ishida, M., Samuel, A. G., & Arai, T. (2016). Some people are "More Lexical" than others. Cognition, 151, 68-75., [2] Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: a latent-variable analysis. Journal of experimental psychology: General, 133(1), 101 [3] Kingston, J., Levy, J., Rysling, A., & Staub, A. (2016). Eye movement evidence for an immediate Ganong effect. *Journal of experimental psychology: Human perception and performance*, *42*(12), 1969. Colby, S., Clayards, M., & Baum, S. (2018). The role of lexical status and individual differences for perceptual learning in younger and older adults. Journal of Speech, Language, and Hearing Research, 61(8), 1855-1874., Ganong, W. F. (1980). Phonetic categorization in auditory word perception. Journal of experimental psychology: Human perception and performance, 6(1), 110., Mattys, S. L., & Scharenborg, O. (2014). Phoneme categorization and discrimination in younger and, older adults: A comparative analysis of perceptual, lexical, and attentional factors. Psychology and Aging, 29(1), 150., McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. Cognitive psychology, 18(1), 1-86., Norris, D., McQueen, J. M., & Cutler, A. (2003). Perceptual learning in speech. Cognitive psychology, 47(2), 204-238., Revill, K., & Spieler, D. (2012). The effect of lexical frequency on spoken word recognition in young and older listeners. Psychol Aging, 27(1), 80–87., Warren, R. M. (1970). Perceptual restoration of missing speech sounds. Science, 167(3917), 392-393.

Lexical Tasks

Ganong Task

"Does the vowel in each sound file sound more like /ɛ/ as in bet or /ɪ/ as in bit?"

Locally Time-Reversed Speech (LTRS) Task

"Did the two speakers say the same thing (i.e. whether all of the vowels and consonant are the same)"

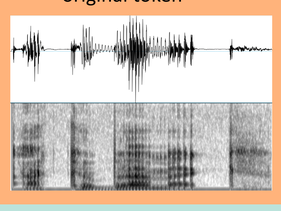
Example trial (1 pair of tokens)

"academic" – "acabemic"

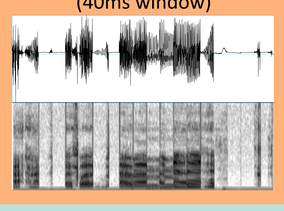
First token:
- time-reversed in 40ms or 60ms windows
- word or pseudoword

Second token:
- not time-reversed,
- word or pseudoword
- lexical effect found with this token

original token

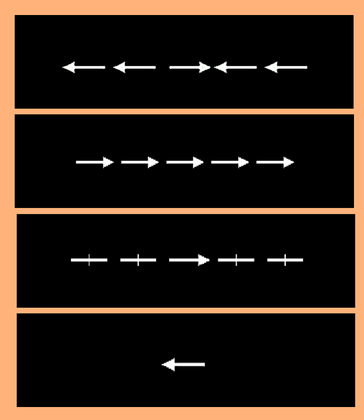


time-reversed token (40ms window)

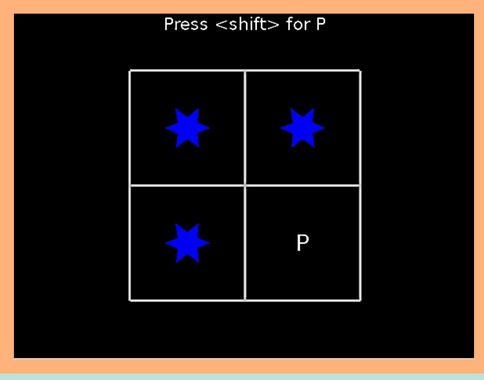


Inhibition Tasks

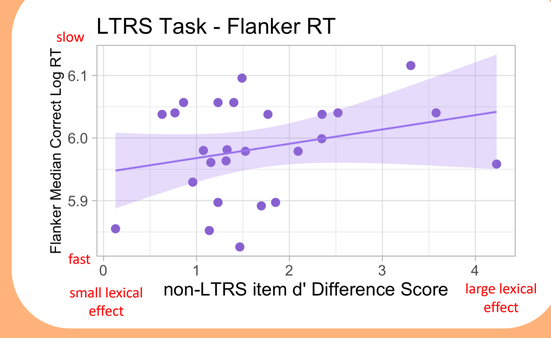
Flanker Task
(Early-stage inhibition)



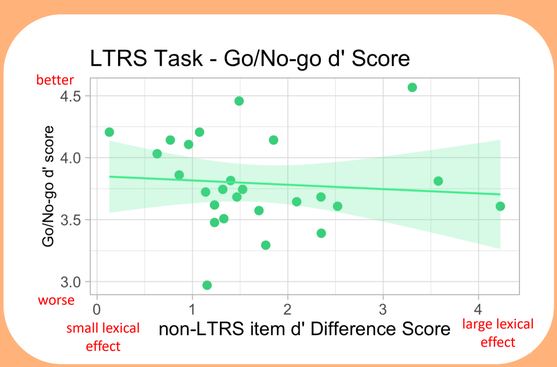
Go/No-go Task
(Late-stage inhibition)



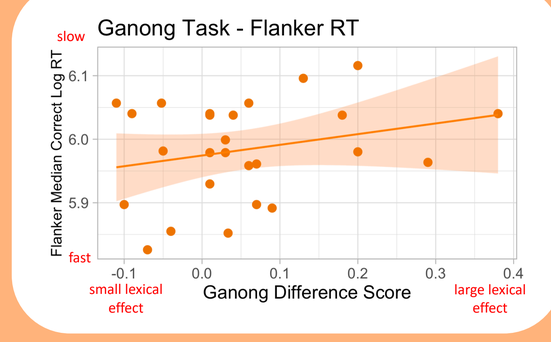
Correlations



Positive correlation means that those slower at the Flanker task exhibited a bigger LTRS effect suggesting that individuals with worse early-stage inhibition had a larger lexical effect.



Negative correlation means that those who were worse at the Go/No-go task exhibited a bigger LTRS effect suggesting that individuals with worse late-stage inhibition had a larger lexical effect.



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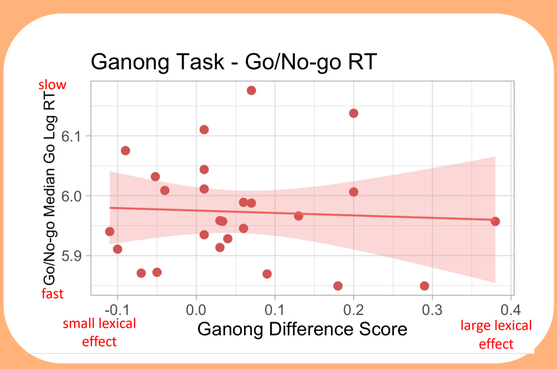
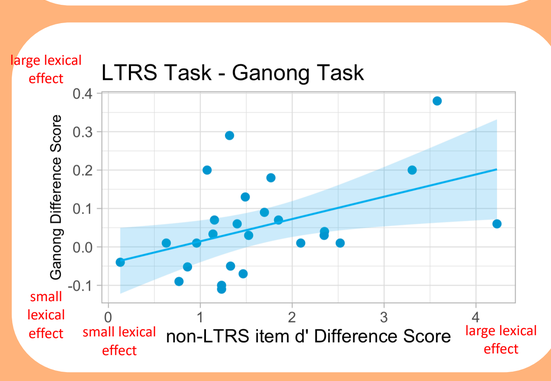


Negative correlation means that those who were faster at the Go/No-go task exhibited a bigger Ganong effect suggesting that individuals with better late-stage inhibition had a larger lexical effect.



Positive correlation means that those who exhibited a bigger LTRS lexical effect exhibited a bigger Ganong lexical effect suggesting a stable perceptual style. [1]

Correlation Table

Conclusion

Individuals with worse early-stage and late-stage inhibition [2] utilize more lexical processing as a stable perceptual style. [1]

Lexical processing occurs in parallel to perceptual processing, supporting the TRACE model of speech perception. [3]