Network Analysis on Bilingual Interactional Contexts and Lexical Interconnectedness

Ruo Feng, Mehrgol Tiv, Jason Gullifer, Debra Titone

Department of Psychology, McGill University | Contact: ruo.feng@mail.mcgill.ca

Social Sciences and Humanities Research Council of Canada | Conseil de recherches en sciences humaines du Canada | Canada | NSERC CRSNG

Introduction

- Bilinguals differ in language use across their various social contexts.
- The Adaptive Control Hypothesis (Green & Abutalebi, 2013) predicts that the way bilinguals access, control and represent their languages is constrained by these differences.
- However, current quantitative approaches are limited in measuring this diversity.
- In our study, we use network analysis to quantitatively assess differences between dominant/non-dominant lexical interconnectedness and between context-dependant language use.

Takeaways

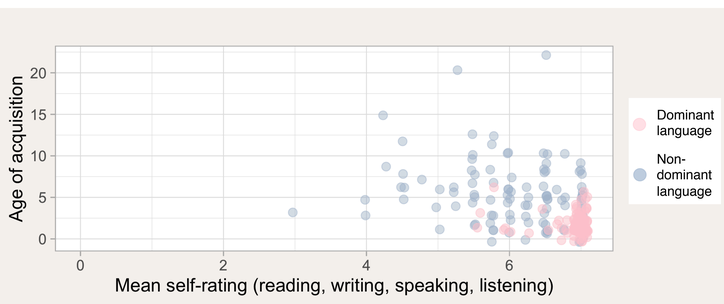
Bilinguals in Montreal…

- … talk about more topics in their dominant language (i.e., higher network size) in a wider variety of contexts (i.e., stronger edge strength), compared to their non-dominant language.
- … are more interconnected in their dominant language, while they are more compartmentalized in their non-dominant language (i.e., lower density).
- … have more clusters that are potentially more meaningful in their non-dominant language.
- … use the least number of languages in their work context and the most number of languages in their social context to talk about various topics.

Methods

Participants

- N = 117 bilingual adults (Fre-Eng)
- Age: Mean = 21.41, SD = 3.40



Procedure & Measures

At the lab, participants completed a Social Network Survey that asked about language background and usage across five contexts (work, home, family, school and social).

"Select which conversational topics you speak about in your dominant language, less dominant language…"

For each participant, we constructed an adjacency matrix, which was then used to create a network.

Language networks

If two conversational topics were discussed in the same **language**, we created an edge.

The number of contexts within which these two topics were discussed corresponds to their edge weight.

Context networks

If two conversational topics were discussed in the same **context**, we created an edge.

The number of languages with which these two topics were discussed corresponds to their edge weight.

Community detection

1. Two-step weight threshold: a) subject-level weight-based threshold: remove edges with weight of 1 or 2, b) network-level proportional threshold: keep top 75% of edges
2. Louvain algorithm (Blondel et al., 2008): an efficient and accurate method (Yang et al., 2016) to detect communities based on modularity.

Modularity *= probability that a node belongs to a community minus such probability if the edges were distributed at random*

Measures of analysis

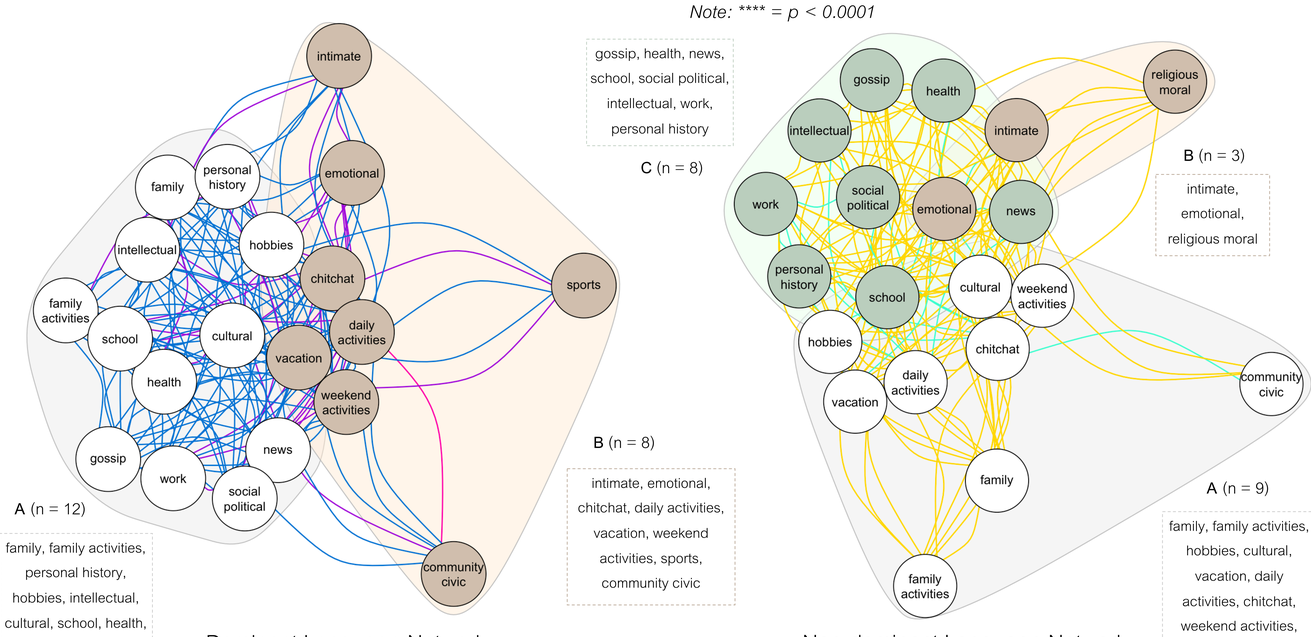
- **Network size** = number of conversational topics that were discussed in the same language/context
- **Network density** = number of edges divided by total number of possible edges
- **Edge strength** = sum of adjacent edge weights for one node, averaged across all nodes

What do bilinguals talk about in their dominant and non-dominant languages?

Language networks

Node = topic | Edge weight = mean number of **contexts**

*Note: **** = p < 0.0001*



Dominant Language Network

Mean network size = 20.55 | SD = 1.33****

Mean network density = 1.99 | SD = 0.06****

Mean edge strength = 30.57 | SD = 8.83****

Non-dominant Language Network

Mean network size = 15.84 | SD = 6.65****

Mean network density = 1.90 | SD = 0.26****

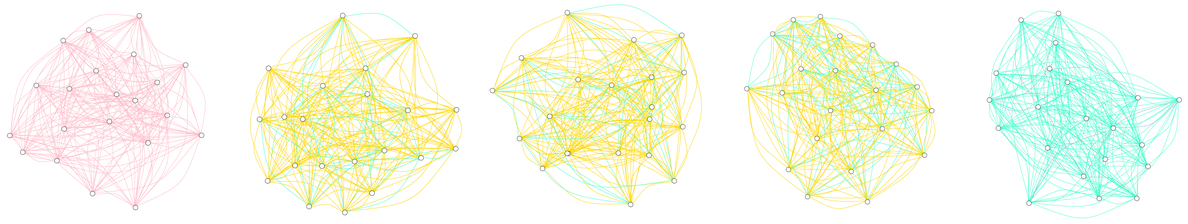
Mean edge strength = 20.87 | SD = 11.99****

How do bilinguals differ in language use across their social contexts?

Context networks

Node = topic | Edge weight = mean number of **languages**

*Note: * = p < 0.05, ** = p < 0.01, *** = p < 0.001, **** = p < 0.0001*



Work Network

Mean network size = 16.11

SD = 10.46

Mean network density = 1.94

SD = 0.19

Mean edge strength = 22.86

SD = 10.46

Family Network

Mean network size = 20.05

SD = 3.66

Mean network density = 1.98

SD = 0.05

Mean edge strength = 27.99

SD = 10.29

Home Network

Mean network size = 20.21

SD = 1.99

Mean network density = 1.96

SD = 0.13

Mean edge strength = 27.03

SD = 9.92

School Network

Mean network size = 16.89

SD = 4.61

Mean network density = 1.98

SD = 0.06

Mean edge strength = 25.72

SD = 11.08

Social Network

Mean network size = 20.26

SD = 1.94

Mean network density = 2.00

SD = 0.00

Mean edge strength = 30.85

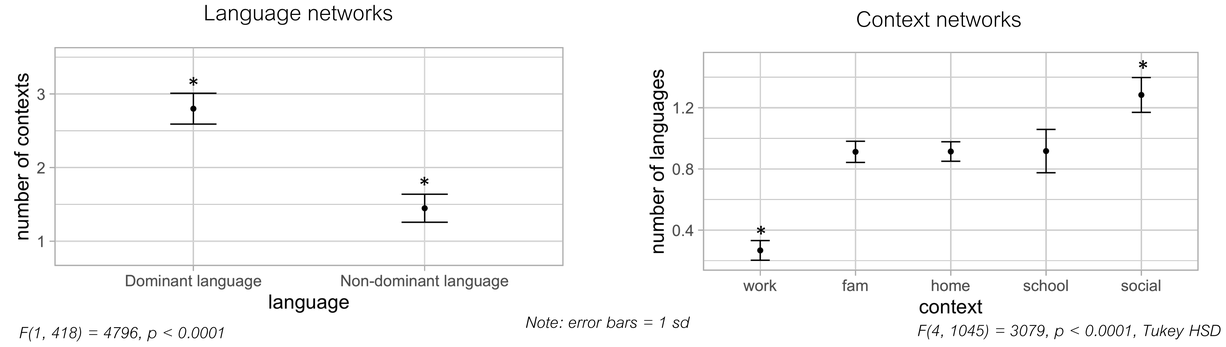
SD = 9.69

Network size *| F(4, 456) = 16.05, p < 0.0001, Tukey HSD: work-fam****, work-home****, work-school*, work-social****, school-fam****, school-home****, school-social****

Network density *| F(4, 456) = 3.032, p < 0.05, Tukey HSD: home-social**

Edge strength *| F(4, 456) = 5.753, p < 0.0001, Tukey HSD: work-fam***, work-home**, work-social***, school-fam*, school-social**

Mean edge weight



F(1, 418) = 4796, p < 0.0001

Note: error bars = 1 sd

F(4, 1045) = 3079, p < 0.0001, Tukey HSD

References

Blondel, V. D., Guillaume, J.-L., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. *Journal of Statistical Mechanics: Theory and Experiment*, *2008*(10), P10008. https://doi.org/10.1088/1742-5468/2008/10/P10008

Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of Cognitive Psychology*, *25*(5), 515–530. https://doi.org/10.1080/20445911.2013.796377

Yang, Z., Algesheimer, R., & Tessone, C. J. (2016). A Comparative Analysis of Community Detection Algorithms on Artificial Networks. *Scientific Reports*, *6*, 30750. https://doi.org/10.1038/srep30750