

Mapping the Dynamics of Bilingual Conversational Topics with Network Science



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INTRODUCTION

AIM: apply Network Science (**mathematical foundations**) to quantify continuous individual differences in bilingual language experience (**group dynamics**).



Context of language use shown to impact brain & behavior (e.g., Beatty-Martínez et al., 2019; Green & Abutalebi, 2013; Grosjean, 2010; Gullifer & Titone, 2020).

We introduce the novel application of Network Science to represent the **complex dynamics** of bilingual language use across communicative contexts with greater granularity.

We do so by analyzing the specific **conversational topics** that bilinguals discuss in their most dominant and less dominant **languages**, as well as across five communicative **contexts** of daily life.

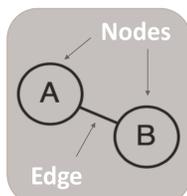
METHOD

115 bilingual adults in Montréal (English-French or French-English)

Self-reported which of 21 conversational topics they speak about in their dominant and non-dominant languages across 5 communicative contexts (work, home, family, school and social).

Determined whether each pair of conversational topics were discussed in the same (1) context and (2) language. Averaged across all participants to create networks.

Context Networks
Node = topics
Edge = discussed in same language
Edge strength = mean number of contexts



Language Networks
Node = topics
Edge = discussed in same context
Edge strength = mean number of languages

Network Measures

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

Applied **Community Detection** to thematically group conversational topics in each language using **Louvain algorithm for modularity**:

$P(\text{node belongs community of given network}) - P(\text{node belongs to community of random network})$ (Blondel et al., 2008)

RESULTS

Bilingual conversational topics across **communicative contexts**.

Node = topics

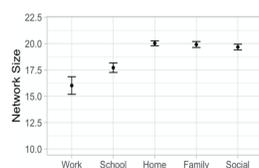
Edge = whether topics are discussed in same context

Edge strength = mean number of languages (color)



A. Work

N = 42



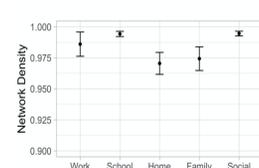
B. School

N = 106



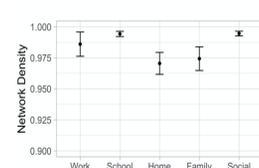
C. Home

N = 101



D. Family

N = 95



E. Social

N = 110

$F(4, 256) = 15.68, p < 0.001$

Tukey HSD: School-Family; Work-Family; School-Home; Work-Home; Social-School; Work-Social

$F(4, 256) = 12.88, p < 0.001$

Tukey HSD: Social-Family; Work-Family; Social-Home; Social-School; Work-Social

$F(4, 256) = 3.07, p = 0.016$

Tukey HSD: n.s.

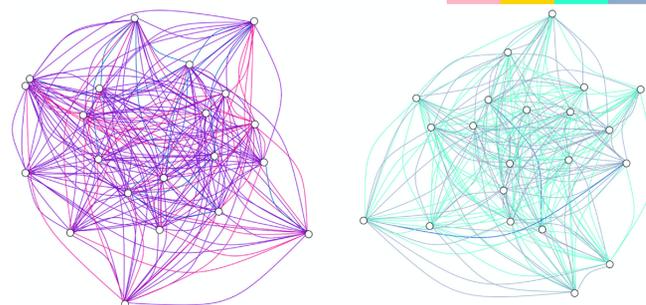
Error bars = +/- 1 SEM

Bilingual conversational topics across **dominant vs. non-dominant languages**.

Node = topics

Edge = whether topics are discussed in same language

Edge strength = mean number of contexts (color)



A. Dominant Language

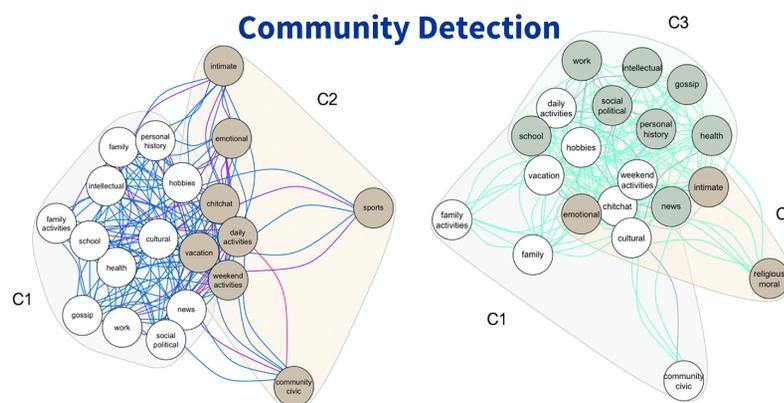
N = 115

B. Non-dominant language

N = 110

Network Size: $F(1, 259) = 48.33, p < 0.001$; Strength: $F(1, 259) = 78.62, p < 0.001$; Density: $F(1, 259) = 12.99, p < 0.001$

Community Detection



	Potential Theme	Component conversational topics
Dominant Language (Modularity=0.029)		
Community 1	Social-Intellectual	Cultural, Family, Family Activities, Gossip, Health, Hobbies, Intellectual, News, Personal History, School, Social-Political, Work
Community 2	Social-Personal	Chit chat, Community/Civic, Daily Activities, Emotional, Intimate, Sports, Vacation, Weekend Activities
Non-Dominant Language (Modularity=0.020)		
Community 1	Social	Chit chat, Community/Civic, Cultural, Daily Activities, Family, Family Activities, Hobbies, Vacation, Weekend Activities
Community 2	Personal	Emotional, Intimate, Religious/Moral
Community 3	Intellectual	Gossip, Health, Intellectual, News, Personal History, School, Social-Political, Work

DISCUSSION

We used Network Science to represent what Montréal bilinguals talk about.

Doing so demonstrates that certain contexts are distinguishable in what topics are discussed and the number of languages used. **Work** is used for the **least** number of topics in a **limited** number of languages (**compartmentalized**) whereas **social** has the **highest** number of topics across **many** different languages (**integrated**). **School, home, and family** are only distinguishable by the number of topics that are discussed, but not by the number of languages engaged.

The **dominant language** has greater network size, strength, and density than the non-dominant network. This means it is used to speak about **more topics**, across **more contexts**.

However, **the non-dominant language** is still used across multiple contexts. Community detection reveals a **greater number of thematic communities** in the non-dominant language, suggesting that it is used for more **specialized** reasons than the dominant language.

Important **implications** for theoretical models & empirical investigations of bilingual individual differences.



Read the full paper by scanning the QR code!

Tiv, M., Gullifer, J. W., Feng, R. Y., & Titone, D. (2020). Using network science to map what Montréal bilinguals talk about across languages and communicative contexts. *Journal of Neurolinguistics*, 56, 100913.

REFERENCES

Beatty-Martínez, A. L., Navarro-Torres, C. A., Dussias, P. E., Bajo, M. T., Guzzardo Tamargo, R. E., & Kroll, J. F. (2019). Interactional context mediates the consequences of bilingualism for language and cognition. *Journal of Experimental Psychology Learning, Memory, and Cognition*. Advance online publication. <https://doi.org/10.1037/xlm0000770>

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>

Grosjean, F. (2010). *Bilingual*. Harvard university press.

Gullifer, J. W., & Titone, D. (2019). Characterizing the social diversity of bilingualism using language entropy. *Bilingualism: Language and cognition*, 94(1), 1–18. <https://doi.org/10.1017/S1366728919000026>

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