Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale

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Online First Publication, February 21, 2022. http://dx.doi.org/10.1037/cep0000273

CANADIAN PSYCHOLOGICAL ASSOCIATION
SOCIÉTÉ CANADIENNE DE PSYCHOLOGIE

Canadian Journal of Experimental Psychology / Revue canadienne de psychologie expérimentale

ISSN: 1196-1961

https://doi.org/10.1037/cep0000273

Bridging People and Perspectives: General and Language-Specific Social Network Structure Predict Mentalizing Across Diverse Sociolinguistic Contexts

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Mentalizing, or reasoning about others' mental states, is a dynamic social cognitive process that aids in communication and navigating complex social interactions. We examined whether exposure to diverse perspectives, afforded by occupying influential social network positions, predicted bilingual adults' performances on a behavioral mentalizing rating task in regions of high and low linguistic diversity. We calculated the degree to which respondents' social network position generally bridged unconnected others (i.e., general betweenness) and specifically bridged language communities (i.e., language betweenness). General betweenness predicted mentalizing performance regardless of region, whereas language betweenness only predicted mentalizing in a high linguistic diversity region, where bilingualism is ubiquitous and mentalizing to resolve perspective differences on the basis of language may be an adaptive cognitive strategy. These results indicate that human cognition is sensitive to social context and adaptive to the sociolinguistic demands of the broader environment.

Public Significance Statement
Opportunities in social network structure to bridge diverse perspectives patterned with higher mentalizing capacities across two distinct sociolinguistic regions, whereas bridging between language communities patterned with higher mentalizing capacities only in a linguistically diverse region. These results suggest that mentalizing, or understanding others' mental states, is sensitive to social context and may be adaptive to the sociolinguistic demands of the environment.

Keywords: social cognition, social network analysis, sociolinguistic contexts, language diversity, social-ecological behavior

Supplemental materials: https://doi.org/10.1037/cep0000273.supp

Mentalizing, or reasoning about others' thoughts and feelings through mental state inferences, is a critical component of everyday social communication (Frith & Frith, 1999). It is a *dynamic* social cognitive process, meaning that it is flexible to situational and cumulative social experiences across a variety of contexts that teach a person how to appropriately use their social cognition (Dumontheil et al., 2010; Todd et al., 2011). For example, people who occupy influential positions in social networks, through which they are

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This research was funded by the Natural Sciences and Engineering Research Council of Canada (Grant 261769-13 to Debra Titone), the Canada Research Chairs program (Debra Titone), and the Fonds de Récherche du Québec: Société et Culture (Mehrgol Tiv). The authors are grateful for the feedback and support of the members of the Language and Multilingualism Lab in preparing this manuscript.

The majority of this research was done while author Ethan Kutlu was a graduate student at the University of Florida in Gainesville, Florida.

The data and analytic code that support the findings of this study are openly available in the Open Science Framework at https://osf.io/m7h6g/.

The data are available at https://osf.io/m7h6g/.

The experiment materials are available at https://osf.io/m7h6g/.

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exposed to diverse perspectives, more strongly engage mentalizing neural regions during mentalizing-related tasks (O'Donnell et al., 2017; Weaverdyck & Parkinson, 2018). Similarly, bilinguals and monolinguals who are embedded in linguistically diverse contexts demonstrate greater mentalizing behavior (Fan et al., 2015; Tiv, O'Regan, & Titone, 2021). The present work synthesizes these two broad findings to assess how mentalizing is shaped by structural characteristics of one's social network, including those constrained by language experience, as well as the broader environmental language context in which social interactions take place.

What Is Mentalizing?

The term "mentalizing" was first introduced to denote the process of reasoning about others' behaviors on the basis of their mental states (Frith, 1989; Frith & Frith, 2021; Wellman, 2017). It grew from other prevalent terms, such as "theory of mind" or "perspective taking," though some contemporary scholars suggest these terms refer to distinct mental processes (Harris, 2017), use the terms interchangeably (Frith & Frith, 2021), or rely on one to capture all of these mental representational processes (Saxe & Kanwisher, 2003). Despite a lack of consensus around these terms, mentalizing (in the broad sense) seems essential to successfully navigate the complexities of everyday social life because peoples' behaviors are thought to be caused by their hidden mental states (Frith & Frith, 1999). We adopt a broad definition of "mentalizing" throughout this paper to refer to inferences of peoples' mental states, emotions, intentions, goals, and beliefs.

In the late twentieth century, mentalizing was predominantly tested in children and adults with neurodevelopmental disorders such as autism spectrum disorders (ASD). As such, the simple false belief task was considered a litmus test for assessing mentalizing capacities. However, this task has garnered criticisms (Bloom & German, 2000) and its relative simplicity means that most neurotypical adults perform at ceiling. While many survey, behavioral, and neuroimaging tasks have evolved to probe aspects of mentalizing in healthy adults (reviewed in Tiv, O'Regan, & Titone, 2021), only some map onto the daily, ubiquitous practices that individuals engage with in the real world when they mentalize, such as interpreting intention behind spoken or written language. For instance, recent studies on mentalizing asked participants to watch clips of popular television shows (e.g., *House, The Office*) to decipher the intentions and goals of the story characters (Bromberek-Dyzman et al., 2021; Krendl et al., 2021). Although this approach mirrors the social demands of real-world interactions, the naturalness of the design may leave unaccounted some subtle linguistic aspects of mentalizing.

To honor the social ubiquity of mentalizing via written language and account for subtle linguistic aspects of mentalizing, we developed a set of sentence pairs that rely on mental state or logical inferences in order to understand why a character behaves a certain way (Tiv, O'Regan, & Titone, 2021). We dissociated these items on linguistic coherence (i.e., a general way for a behavior to follow a context) and mentalizing (i.e., a specific way for a behavior to follow a context based on hidden mental states). Similar to past findings, our results indicated that people vary in their mentalizing capacities as a function of their cumulative social life experiences. Specifically, people who knew and used multiple languages in a balanced and diverse manner demonstrated greater mentalizing capacity than those with low personal language diversity. However, there are many other ways people may experience diversity in their social lives.

In what follows, we use social network analysis to examine how filling structurally central positions in one's social network, which can increase exposure to diverse perspectives, may also relate to mentalizing as measured by this task. In addition, we introduce a novel language-tagged approach to social network analysis which will allow us to probe how exposure to diverse perspectives *on the basis of language* may further relate to mentalizing.

Structural Characteristics of Social Networks

Social networks offer granular insight on the compositional and structural characteristics of an individual's social environment and the people in it (Borgatti et al., 2009; Scott, 2017). The two basic components of any network are nodes and edges. In social networks, nodes represent people, and edges represent relationships between them. Importantly, in an *egocentric* social network, a single respondent—the "ego"—reports on the people in the network, and these people are referred to as "alters." Edges, or "ties," which indicate some type of connection, may exist between the ego and the reported alters, or they may exist between the alters themselves. People are generally accurate at recalling their network structure, including relationships between other people in the network (Parkinson et al., 2017). Both a person's own relationships and those among the alters can influence their everyday interactions, behaviors, and cognition (Burt & Knez, 1995; Firth et al., 2017; Parkinson et al., 2017; Stiller & Dunbar, 2007).

One important structural measure that is computed from the constellation of relationships in a social network is *betweenness centrality*, or the extent to which a person connects others that are otherwise unconnected (Arnaboldi et al., 2013; Burt, 2009, 2015). A person in this influential, central position in the social network (commonly referred to as a broker or a bridger), lies along the shortest path between two alters. This makes them critical for transmitting information that would otherwise be stuck with each of those isolated alters (i.e., structural holes in the network), and also facilitates coordination of behaviors, mitigation of ideological polarization, and integration of ideas (e.g., Youm et al., 2021; see also Smith et al., 2020). For example, if a survey respondent ("ego") lies on the shortest path between two alters, then this means those alters are not themselves directly connected and any shared information between the two will be transmitted through the respondent. As the total number of shortest paths that go through the respondent grows, their betweenness centrality, or overall network influence and exposure to diverse perspectives, grows. Naïve experimental perceivers seem aware of the social importance of network brokers, attributing more qualities of agency, leadership, and charisma to those in this influential position (Brands & Kilduff, 2013; Brands et al., 2015), and they can accurately identify real-world network brokers from simply looking at strangers' faces (Alt et al., 2021).

Importantly, occupying a central social network position may increase exposure to diverse perspectives and increase opportunities to reflect on others' mental states. To illustrate, consider a respondent with two friends (A and B) who do not know each other but are applying to work at the same company. Friend A learns valuable insider information on the company, which they share with the respondent. The respondent, reflecting on friend B's similar goals to work for this company and realizing the insider information would boost their eligibility, shares this information with friend B. Thus, the respondent's unique position in the network facilitated an

opportunity to consider the mental states of their two friends and appropriately transmit information between them. In contrast, if the two friends knew each other independent of the respondent, then the respondent would have limited opportunities to reflect on the different beliefs held by their two friends.

Neuroimaging has revealed an association between social network positions offering greater opportunities for information brokerage or bridging (i.e., high betweenness centrality) and greater neural activation to traditional mentalizing regions in the brain, rooted in increased exposure to diverse others' perspectives. For instance, O'Donnell et al. (2017) found that more centrally positioned people demonstrated greater neural activation within the mentalizing neural network (e.g., temporoparietal junction, dorsomedial prefrontal cortex) while engaging in a social game based in considering others' mental states. Other evidence using the complete social network data of two rural Korean villages showed that people who had both high brain connectivity in the mentalizing neural network and occupied structural brokerage network positions were more understanding of diverse perspectives, as demonstrated by their self-reported attitudes on gender roles (Youm et al., 2021). Other core aspects of social network structure, such as network density (Schmälzle et al., 2017) and the diversity of social roles engaged by the network (Dziura & Thompson, 2014; Molesworth et al., 2015) also positively pattern with activation to mentalizing-related brain regions during other social games based on mental states. Betweenness centrality, density, and the diversity of social roles all rely on the extent to which alters in an egocentric network represent unique regions of the network's social space, and these patterns have been detected regardless of overall network size. These accounts of "network cognition" cement the notion that subtle social dynamics afforded by personal social networks shape core mental processes (Brashears & Quintane, 2015), thus highlighting a symbiotic relationship between the neural propensity for considering others' mental states and social-environmental experiences, like network centrality, that exercise this cognitive style.

There is growing behavioral evidence of enhanced mentalizing following exposure to diverse perspectives, though few studies have leveraged social network analysis to examine this (Antonio et al., 2004; Carter & Phillips, 2017; Crisp & Turner, 2011; Fan et al., 2015; Krendl et al., 2021; Lev-Ari & Sebanz, 2020; Sommers, 2006). For instance, Krendl et al. (2021) probed the social networks of healthy older adults, finding that greater diversity in social roles in the network patterned with stronger social cognitive skills. Indeed, some theoretical accounts (e.g., Crisp & Turner, 2011) posit that ongoing exposure to social diversity may render greater cognitive flexibility through which attention to categorical inferences (i.e., stereotypes) shifts to unique, person-specific attributes or situational content during information processing (i.e., *elaborative* processing) thereby engaging mentalizing (Antonio et al., 2004; Carter & Phillips, 2017; Harris, 2017; Hehman et al., 2014). Given that people who bridge otherwise unconnected others are in positions that may increase their exposure to different perspectives, it is plausible that the relationship between mentalizing and social network position engages similar cognitive mechanisms.

Exposure to Diverse Perspectives Through Bilingualism

Similar to central players in a social network, bilingualism (defined as the knowledge of two or more languages) and bilingual environments also offer opportunities to encounter different others as a result of knowing multiple languages or experiencing multiple cultures. This enhanced social flexibility (Ikizer & Ramírez-Esparza, 2018) was evidenced by Fan et al. (2015) who found that both bilingual and monolingual children situated in a bilingual environment performed better on a mentalizing task than monolingual children who were only exposed to one language (replicated with babies in Liberman et al., 2017). A growing body of work has also shown that personal experiences in bilingualism enhance mentalizing skills across the lifespan (Goetz, 2003; Navarro & Conway, 2021; Rubio-Fernández & Glucksberg, 2012; Schroeder, 2018; Sundaray et al., 2018; Tiv, O'Regan, & Titone, 2021). As mentioned, Tiv, O'Regan, and Titone (2021) tested adult bilinguals in Montréal on a novel mentalizing reading and rating task, finding that bilinguals with greater personal language diversity were more accurate at mentalizing, whereas linguistic coherence was unaffected. Some contend that because bilingualism fosters an expectation that people speak different languages, it also cultivates an understanding that they can also have different perspectives and mental states (Fan et al., 2015; Goetz, 2003; Liberman et al., 2017; Tiv, O'Regan, & Titone, 2021).

Analyses of bilingual posts on twitter have shown that bilinguals fill central positions in their online social networks. Specifically, in highly bilingual regions (e.g., Québec, Qatar, Switzerland) bilingual Twitter users occupy critical bridging positions between otherwise unconnected monolingual Twitter users (Kim et al., 2014). Moreover, bilingual Twitter users seem aware of the linguistic composition of their online network (including their own central positions between language groups) and adjust their tweet language choice to align accordingly (Eleta & Golbeck, 2014). Even research that doesn't explicitly use social network analysis reveals that some bilingual children act as critical "language brokers" for their monolingual, immigrant parents (López, 2020). While these emergent linguistic constraints of social network structure answer some important questions, they also open the door to other interesting questions. For example, are linguistically-bound aspects of a bilingual's social network structure implicated in other cognitive processes outside of language choice, such as mentalizing? Additionally, would similar patterns be observed from real-world social networks?

Properties of the broader environment in which bilinguals are embedded may further constrain their linguistic and cognitive processing. For example, social contexts where bilingualism and language diversity are more ubiquitous may cue attention to differences in perspective more than linguistically homogenous environments. Indeed, situating individuals' bilingual experiences within their respective ecological, sociolinguistic context has implications for cognition (Green, 2011; Luk & Bialystok, 2013). For instance, Beatty-Martínez et al. (2020) demonstrated that English–Spanish bilinguals who were equally proficient but situated in social contexts that demanded varying degrees of language mixing performed differently on cognitive control tasks, like the AX-Continuous Performance Test (AX-CPT; see also Gullifer et al., 2018; Hartanto & Yang, 2016). Other work tested bilinguals in Montréal, Canada (marked by high linguistic and ethnic diversity) versus Gainesville, USA (marked by low linguistic and ethnic diversity), finding that while race-related information (i.e., skin tone) impacted linguistic comprehension in Gainesville, no such bias was detected for the matched sample in Montréal (Kutlu et al., 2022). The authors concluded that the ambient chronic exposure to diversity in

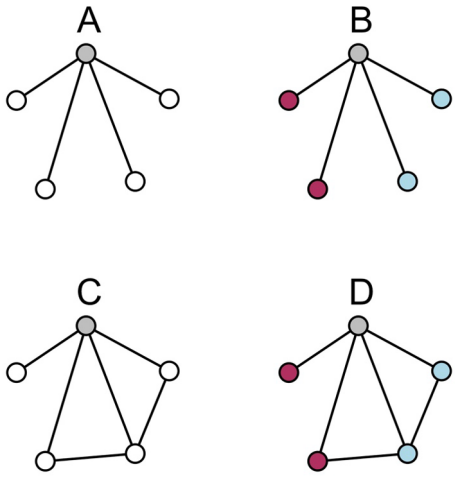
Montréal (which is less salient in Gainesville) primed respondents to create an expectation for perspective differences and engage deliberate cognitive information processing, a strategy that allowed them to focus on the linguistic input without activating stereotypes from the race of the associated face. These ambient contextual constraints may have consequences for other socially rooted cognitive process, such as mentalizing, which we examine in this paper.

The Present Study

Taken together, people who experience more social opportunities for exposure to different perspectives, whether that be through central social network positions or knowledge of multiple languages, demonstrate stronger neural responses and behavioral skills during mentalizing. Here, we integrate these cross-disciplinary findings by posing three key questions at the intersection of mentalizing, social networks, and bilingualism.

First, do people who occupy more central positions in their social networks, through which they may experience more opportunities to bridge information between others in the network, demonstrate better mentalizing capacity in a behavioral rating task? Critically, this question does not depend on any language-specific experiences, as people may generally occupy central positions in their social networks (Figure 1, panel A). Based on past evidence (Dziura & Thompson, 2014; Krendl et al., 2021; O'Donnell et al., 2017; Schmälzle et al., 2017; Youm et al., 2021), we expect to find a positive relationship between general betweenness centrality and mentalizing performance, as indexed by greater dissociation of the situations that mentalizing is needed to understand others' behaviors.

Figure 1
Toy Network Examples



Note. Toy networks of two example respondents (or "egos," represented as gray node at the top of each network). Panels A and B represent a network with exclusively ego–alter ties (i.e., no third-party, alter–alter ties), whereas Panels C and D represent a network with both ego–alter and alter–alter ties. The networks on the left (A and C) do not represent any alter attributes, whereas the networks on the right (B and D) represent the hypothetical language(s) used between the respondent and each alter. Here, one hypothetical language is shown in red (two leftmost nodes) and another in blue (two rightmost nodes). See the online article for the color version of this figure.

Second, do bilingual respondents' unique experience of bridging *between language groups* shape mentalizing performance over and above their general network betweenness centrality? To test this, we introduce a novel metric (language betweenness) to quantify the extent to which a respondent bridges otherwise unconnected language groups (Figure 1, panel B). Given past evidence that bilingualism offers novel insight on others' mental states (Fan et al., 2015; Goetz, 2003), we expect that greater *language* betweenness will also contribute to greater mentalizing performance.

Third, do the relationships between mentalizing and both general and language betweenness vary across regions of high (Montréal, Canada) and low (Gainesville, United States) sociolinguistic diversity? We do not expect to find differences between the two regions when considering general betweenness and mentalizing, as this does not depend on any place-specific characteristics. In contrast, we expect that people who bridge language groups and are embedded in a linguistically diverse ecology (Montréal) will chronically engage in more mentalizing to meet the sociolinguistic demands of their bilingual environment, whereas a linguistically homogenous ecology (Gainesville) will not cultivate similar social cognitive capacities.

Methods

Sociolinguistic Contexts

We examined two linguistically distinct regions: Montréal, Canada and Gainesville, United States. Montréal is a metropolitan city in the province of Québec, Canada, where French is recognized and legislatively enforced as the sole official language through the *Office québécois de la langue francçaise* (Leimgruber, 2020). However, due to Canadian federal policy acknowledging both English and French as official languages, the global pervasiveness of English, and the high proportion of immigrants and international students (e.g., at English-language universities McGill and Concordia), bilingualism is the norm in Montréal. According to the 2016 Canadian Census, 18.2% of the Montréal population predominantly used English at home, whereas 53.7% predominantly used French and 18.7% predominantly used other languages at home. Additionally, 9.3% of the population reported predominantly using multiple languages at home (Statistics Canada, 2016). Within the city, bilingualism is generally viewed favorably, as perhaps best demonstrated by the popular greeting, "bonjour, hi" (Heller, 1978; Sioufi & Bourhis, 2017).

In contrast, Gainesville is a small college town in the state of Florida, United States. According to the U.S. Census Bureau's American Community Survey, although 30.3% of people living in Florida reported speaking a language other than English at home (primarily Spanish), only 14.9% of the residents in Alachua County (where Gainesville is situated) reported speaking a language other than English at home (U.S. Census Bureau, 2019). This suggests a dominance of English in the Gainesville region, although government-collected census statistics, which have been suggested to center English proficiency (Leeman, 2018), may underreport minority languages like Spanish for various reasons. Additionally, although there is a substantial amount of Spanish spoken in Florida generally, the pervasive monolingual and Anglocentric hegemony in the United States has given rise to negative attitudes and low vitality associated with speaking Spanish (Kutlu & Kircher, 2021), which are also rooted in the racialization of Spanish and Spanish-

speaking individuals (Chaparro, 2019; Flores, 2015; Flores & Rosa, 2015; Ortega, 2019).

To summarize, people living in Gainesville experience less ambient, *public* exposure to bilingualism than do those living in Montréal, and to some extent the social status of bilingualism also varies between these two regions. Although we can provide general linguistic descriptions of each region, we cannot include these census statistics in our models due to critical differences in the wording of questions related to language on the Canadian versus U.S. Census.

Participants

Fifty-four healthy bilingual adults aged 18–35 (M_{age} = 20.5) living in Montréal, Canada (N = 25) or Gainesville, United States (N = 29) were recruited using flyers, online advertisements, and word of mouth. Recruitment in the two regions was comparable, though in Montréal advertisements were written in English and French whereas advertisements in Gainesville were written in English. One participant in Gainesville did not complete all portions of the experiment and their data was not analyzed (N = 53, $N_{Gainesville}$ = 28). Among the Montréal sample, most selected their gender as female (96%) and one as male (4%) from the options provided, and in the Gainesville sample, the majority also selected female (89.29%) and the remainder as male (7.14%) and queer/nonbinary (3.57%). Among the Montréal sample, 76% selected white as their racial-ethnic background, 8% East Asian, 12% Multiracial, and 4% Middle Eastern from the options provided. Among the Gainesville sample, 42.86% selected white as their racial-ethnic background, 32.14% Multiracial, 10.71% Latin American, 7.14% Black, 3.57% East Asian, and 3.57% Other from the options provided. Across both samples, the proportion of participants born in the country of testing (i.e., Canada for Montréal sample, United States for Gainesville sample) was comparable. Whereas 56% of the Montréal sample was born in Montréal, approximately 7% of the Gainesville sample was born in Gainesville. Nevertheless, the majority of the Gainesville sample (>60%) was born within the state of Florida. These and additional demographic details of the samples, which were not statistically different by region, are available in Table 1.

Across both regions, all participants knew English (the language of the task) and were recruited on the basis of knowing at least one other language. Among the Montréal sample, all participants reported knowledge of English and French (and some knew additional languages). Among the Gainesville sample, the majority of participants reported knowledge of English and Spanish and one knew English and Portuguese. Although recruitment materials indicated that participants must have knowledge of at least two languages, upon testing it became known that five Gainesville participants only used English. We conducted all analyses on the full sample (including the five monolinguals) and the bilingual-only sample, but we did not detect any differences. We report the results of the full sample to maximize our sample size and statistical power. Altogether, our sample reported knowledge of many languages beyond those that are focused in this paper, including American Sign Language, Arabic, Basque, Catalan, English, French, Greek, Hebrew, Italian, Mandarin, Portuguese, Spanish, and Yiddish (all participants knew English). Both samples demonstrated equal proficiency in English, as measured by the LexTale task (for details see Supplemental Materials, Lemhöfer & Broersma, 2012). Other aspects of the two samples' linguistic background (Table 1), except age of non-English language acquisition, were not statistically different (participants in Montréal acquired a language other than English at a younger age than those in Gainesville).

We also calculated personal language diversity using general language entropy (Gullifer & Titone, 2019). This index is based on self-reported usage patterns of each language, where a high entropy score indicates balanced, or integrated, use of multiple languages and a low entropy score indicates unbalanced, or compartmentalized, language use. Personal language diversity among the Montréal sample was higher than that of the Gainesville sample, consistent with the high and low language diversity characterization attributed to each region. However, language diversity was not statistically different between the two regions.

Materials and Procedure

All data were collected in the laboratory prior to the onset of the coronavirus disease (COVID-19) pandemic. These materials received Research Ethics Board (REB) approval from McGill University and Institutional Review Board (IRB) approval from the University of Florida.

Mentalizing Task

We used the inference reading and rating task from Tiv, O'Regan, and Titone (2021) to assess individual differences in mentalizing. In this task, participants read and rated 138 English sentence-pair item sets, in three inference type conditions: mental state, logical, and incoherent (see Table 2 for examples). Each item was composed of two sentences. The first sentence described a context involving a character, and it was unique across the three inference types. The second sentence described an action that was either somehow related to the first context sentence or unrelated to the context (i.e., incoherent), and this sentence was identical across the three inference types. By designing the items in this manner, we could affirmatively probe how varying contexts shape unique interpretations of literally identical words describing a person's actions and behaviors. There were 552 unique sentences (414 unique contexts + 138 unique actions) with an average of 13 words across both sentences.

The items were designed to invoke different types of inferences. In the mental state condition, the context and action sentences could be connected by inferences involving the thoughts, feelings, intentions, and beliefs of the story character (i.e., needing mentalizing). In contrast, the logical condition was based in general, nonsocial deductive inferences built from world knowledge and physical cause-effect (i.e., not needing mentalizing). Since the logical condition, like all conditions, involving the actions of a person in order to maintain parallel structure across conditions, it was possible that the reader may have experienced some degree of mentalizing. However, the logical condition was designed to involve substantially less mentalizing than the mental state condition, which is confirmed in this paper by a manipulation check (see "Overall Mentalizing in Gainesville vs. Montréal").

One example action sentence stated, "She locked the front door that day." This action was preceded by, "Jane took out the house keys" in the logical condition and by, "Jane read about the increase in crime" in the mental state condition. In the former, the reader must logically infer that the character (Jane) used the house keys to unlock the front

Table 1
Descriptive Statistics of Gainesville and Montréal Samples

Continuous	Montréal ($N = 25$)			Gainesville ($N = 28$)		
	M	*SD*	Range	*M*	*SD*	Range
Age	20.40	1.22	18–23	20.61	1.59	18–25
Age of acquiring English	0.04	0.20	0–1	0.86	2.21	0–10
Age of acquiring non-English language	2.64**	2.29	0–8	7.09**	7.08	0–20
Percent Daily conversations in English	84.48	13.31	40–100	85.56	16.60	34–100
Percent daily conversations in non-English language	15.52	13.31	0–60	14.44	16.60	0–66
General language entropy	0.59	0.30	0–1.16	0.48	0.44	0–1.69
Parental/guardian socioeconomic status[a]	5.26	1.07	3.5–7	5.19	1.02	3–7
LexTale English score	86.31	10.22	66.25–100	89.18	7.87	65–98.75
Categorical	**Count**	**Percent of subsample**		**Count**	**Percent of subsample**	
Gender[b]						
Female	24	96.00%		25	89.29%	
Male	1	4.00%		2	7.14%	
Queer/nonbinary/multiple selections	0	0.00%		1	3.57%	
Race/Ethnicity[c]						
Black	0	0.00%		2	7.14%	
East Asian	2	8.00%		1	3.57%	
Latin American	0	0.00%		3	10.71%	
Middle Eastern	1	4.00%		0	0.00%	
Southeast Asian	0	0.00%		0	0.00%	
White	19	76.00%		12	42.86%	
Multiracial	3	12.00%		9	32.14%	
Other	0	0.00%		1	3.57%	
Prefer not to answer	0	0.00%		0	0.00%	
Education[d]						
Graduate school (PhD/MD/JD)	0	0.00%		2	7.14%	
Graduate school (master's)	0	0.00%		2	7.14%	
University/college	25	100.00%		21	75.00%	
CEGEP/associate's degree	0	0.00%		0	0.00%	
Secondary/high school	0	0.00%		3	10.71%	
Country of birth						
Canada	21	84.00%		0	0.00%	
United States	1	4.00%		25	89.29%	
Other	3	12.00%		3	10.71%	
City of birth						
Montréal	14	56.00%		0	0.00%	
Québec (not Montréal)	4	16.00%		0	0.00%	
Outside of Québec (within Canada)	3	12.00%		0	0.00%	
Gainesville	0	0.00%		2	7.14%	
Florida (not Gainesville)	0	0.00%		15	53.57%	
Outside of Florida (within USA)	1	4.00%		8	28.57%	

Note. CEGEP = Collège d'enseignement general et professionnel. Linear regressions were conducted between Montréal and Gainesville samples for all continuous variables. Chi-squared tests were conducted between Montréal and Gainesville samples for categorical variables (though country and city of birth were not tested due to inherent differences in these variables between the two groups). Results indicated with the following marks: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Variables with no marks did not statistically differ between two groups.
[a] Parental/guardian socioeconomic status was calculated by converting each of the two parent/guardians' highest education level into an ordered, numerical value (1–7) and averaging across the two. In cases of single parentship/guardianship, this value reflects the single education level. [b] Participants selected all the gender options that best represented them from the following list: female, male, trans, intersex, queer/nonbinary, and other. [c] Participants selected all the racial and ethnic options that best represented them from the following list: Black, White, East Asian, Southeast Asian, Latin American, Middle Eastern, Indigenous, Pacific Islander, Other, prefer not to answer. Anyone who selected more than one option is represented as Multiracial in this table. [d] Education refers to the highest degree obtained by the participant, although some respondents understood this question to mean current level of education (i.e., degree in progress).

door. In the latter, the reader must consider the character's mental state to infer that they locked the front door due to nervous thoughts of someone breaking into the home. In contrast, the incoherent condition served as a baseline control for contexts that did not reasonably connect to the action sentence, such as, "Jane had a fancy pencil case." These items were designed to involve a wide range of emotional and cognitive experiences, including both positive and negative ones. Additionally, spillover processing regions were added to the end of all action sentences, such as "that day" or "in that moment." These words conveyed generic, temporal information that did not change the meaning of the sentence.

Participants were only shown each item in one of the conditions, and presentation order of the items was randomly shuffled. Participants were instructed to silently read the sentences for comprehension. Given that mental state inferences are "first and foremost inferences" (Harris, 2017), meaning they are susceptible to linguistic

Table 2
Sample Mentalizing Items

Example	Condition	Sentence 1 (Context)	Sentence 2 (Action)
1	Logical inference	Jane took out the house keys.	She locked the front door that day.
	Mental state inference	Jane read about the increase in crime.	She locked the front door that day.
	Incoherent	Jane had a fancy pencil case.	She locked the front door that day.
2	Logical inference	Mark turned down the music at home.	His apartment got much quieter that day.
	Mental state inference	Mark received the bad news at home.	His apartment got much quieter that day.
	Incoherent	Mark was too short to reach the shelf.	His apartment got much quieter that day.

Note. Two example items in the three inference type conditions (logical, mental state, and incoherent). The first sentence (context) varies across inference type conditions, but the second sentence (action) is identical across inference type conditions.

constraints of logic, participants first rated the extent to which the item was linguistically coherent (1–5, 1 = no coherence, 5 = full coherence). After, participants rated the extent to which the item relied on mentalizing, or an understanding of the story character's mental states, emotions, intentions, goals, and beliefs (1–5, 1 = no mentalizing, 5 = full mentalizing). These two ratings allowed us to distinguish the socially-rooted mental state content of the inferences from more general linguistic processing demands. While reaction times to each rating probe were collected, they were not analyzed due to methodological choices discussed in Tiv, O'Regan, and Titone (2021) that asking participants to find the corresponding number key for their ratings and to make multiple, subsequent judgments to the same item probe may have resulted in noisy reaction time data. Otherwise, all other aspects of this analysis were consistent with the approach taken in Tiv, O'Regan, and Titone (2021).

Our primary goal was to selectively assess individuals' mentalizing capacity. As discussed in other work (Harris, 2017), adaptive mentalizing involves dissociating situations when mentalizing is needed to understand others' behaviors from those when mentalizing is not needed to understand others' behaviors. In other words, successful mentalizing, or strong mentalizing capacities, will reflect this ability to upregulate and downregulate mentalizing appropriately. In this task, such behavior would be indexed by higher mentalizing ratings to mental state inferences (upregulation of mentalizing), lower mentalizing ratings to logical inferences (downregulation of mentalizing), or a combination of these strategies.

Social Network Survey

Participants completed an egocentric social network survey, administered in-person with Network Canvas (Complex Data Collective, 2016). First, respondents (egos) were instructed to nominate eight to twelve people (alters) with whom they interacted over the past 6 months, across all interactional contexts (e.g., home, school, work, etc.). Next, respondents provided basic demographic information for each alter and responded to the nature of their relationship, including the language(s) they use to communicate with each alter. Lastly, respondents indicated whether each pair of alters communicated with one another (ties).

We used the *egor* (Krenz et al., 2020) and *igraph* (Csardi & Nepusz, 2006) packages in R to construct personal social networks for each respondent in our sample. From these, we calculated two betweenness centrality measures from each respondent's personal social network: *general betweenness* and *language betweenness.*

General betweenness was calculated from each personal network in which the respondent was included, using the *igraph* package "betweenness" function with following formula:

$$\text{Betweenness}(v) = \sum_{s \neq v \neq t \in V} \frac{\sigma_{\text{st}}(v)}{\sigma_{\text{st}}}, \quad (1)$$

where σ_{st} is the total number of shortest paths from node s to node t, and σ_{st} (v) is the number of those paths that pass through v (Brandes, 2001; Freeman, 1979). We extracted this score for the respondent, which indexes the total number of times they lie on the shortest path between any two other alters. Here, higher values indicate more opportunities for the respondent to bridge or broker between individuals in the network who are otherwise unconnected (structural holes; Burt et al., 2013). For example, in Figure 1, panel A illustrates a respondent with high general betweenness, given that the shortest paths between any two alters go through them. In contrast, panel C illustrates a respondent with lower general betweenness, which due to the presence of third-party ties means that some shortest paths between two alters do not go through them.

Then, to calculate language betweenness, we added ego–alter language as a node attribute to each alter. In Montréal, ego–alter language was coded according to the following scheme: English, English/Other, French, French/Other, English/French, English/French/Other, Other. In Gainesville, ego–alter language was coded similarly to Montréal except that French was replaced with Spanish: English, English/Other, Spanish, Spanish/Other, English/Spanish, English/Spanish/Other, Other. Then, we used the "bridge" function from the *networktools* package in R (Jones, 2020) to quantify betweenness bridging across language communities. This is defined as the number of times the respondent lies on the shortest path between nodes A and B, specifically where nodes A and B come from different language communities, normalized to account for differently sized language communities. For this calculation, the respondent was omitted from the network so that we could examine the extent to which alters from different language communities were connected to one another. Thus, low language betweenness (e.g., 0) indicated the presence of structural holes between language communities which only the respondent could bridge (e.g., panel B in Figure 1). In contrast, high language betweenness (e.g., 1) indicated few structural holes between language communities, in which case the respondent was not critical to bridge language communities (e.g., panel D in Figure 1). Linguistically homogenous networks (i.e., all alters used one language with the respondent) were given a score of 1 since the respondent did not bridge linguistic communities. Of note, these scores were reversed (i.e., 1-value) strictly for

illustrative purposes in Figure 3 to directionally align with Figure 2. For a similar protocol see (Jones et al., 2021).

Language betweenness did not correlate with other common sociolinguistic indices of bilingual language use. These include general language diversity computed as language entropy ($r = -0.07$), which reveals the overall balance of languages (e.g., 50% English, 50% Spanish) and entropy calculated from ego–alter language use ($r = 0.02$), which reveals the individuals in the network who use distinct languages (e.g., 50% English speakers, 50% Spanish speakers). Instead, language betweenness conceptually maps the network *structure* (i.e., relationships in the network) and the unique role a respondent may play in closing structural holes between individuals of different language backgrounds.

Summary statistics for general and language betweenness are displayed in Appendix (Figure A1, Table A1), and they reveal no differences between respondents in Gainesville and Montréal. The correlation of general betweenness and language betweenness was greater in Gainesville ($r = -0.25$) than Montréal ($r = -0.13$). While this difference may have influenced our results, neither correlation coefficient met conventional thresholds (e.g., 0.4) to qualify concerns of multicollinearity.

Results

Data Preprocessing and Analysis

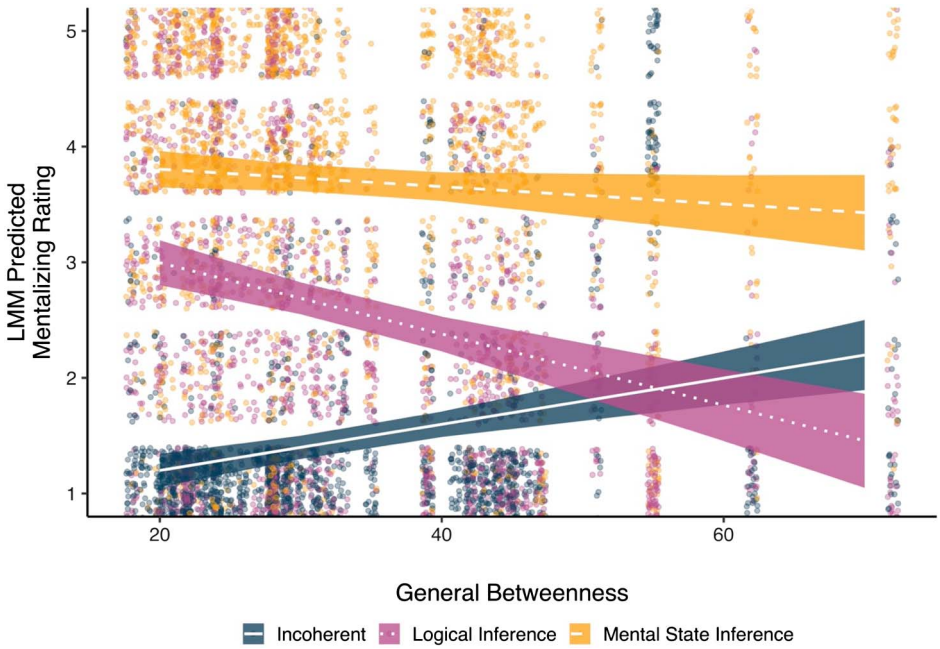
Prior to data analysis, we undertook a series of predetermined preprocessing steps from Tiv, O'Regan, and Titone (2021). These steps yielded the removal of three out of 138 total full item sets (resulting in 135 analyzed items), one full participant from Gainesville (due to incomplete data), and single trials that were slower than 10 s. Details regarding these steps and their justification can be read in Supplemental Materials.

All data analysis was conducted using the R software (R Core Team, 2020). Linear mixed-effects regression models (LMM) were computed on raw, trial-level responses using the *lme4* package in R (Bates et al., 2014). Models coded for maximal random intercepts and slopes by-subject and by-item for inference type condition (Matuschek et al., 2017). Inference type was Helmert coded, such that the first contrast reflected the critical difference between logical versus mental state inferences (C1-Log/Men) and the second contrast reflected the overall difference between coherent inferences (mean of logical and mental state) versus incoherent (C2-Coh/Inc). Region was deviation coded (−0.5 = Gainesville, 0.5 = Montréal). Both general betweenness and language betweenness were treated continuously and scaled. For each effect of interest, 95% confidence intervals were calculated using the "confint" function (Wald method) from the *stats* packages in R (R Core Team, 2020). In addition, marginal and conditional R^2 values were calculated using the "r.squaredGLMM" function from the *MuMIn* package in R (Bartoń, 2020). Analysis code is available on the Open Science Framework: https://osf.io/m7h6g/. Tiv, Kutlu, et al. (2021).

Overall Mentalizing in Gainesville Versus Montréal

First, we checked whether the overall mentalizing ratings of participants tested in Gainesville versus Montréal differed. We

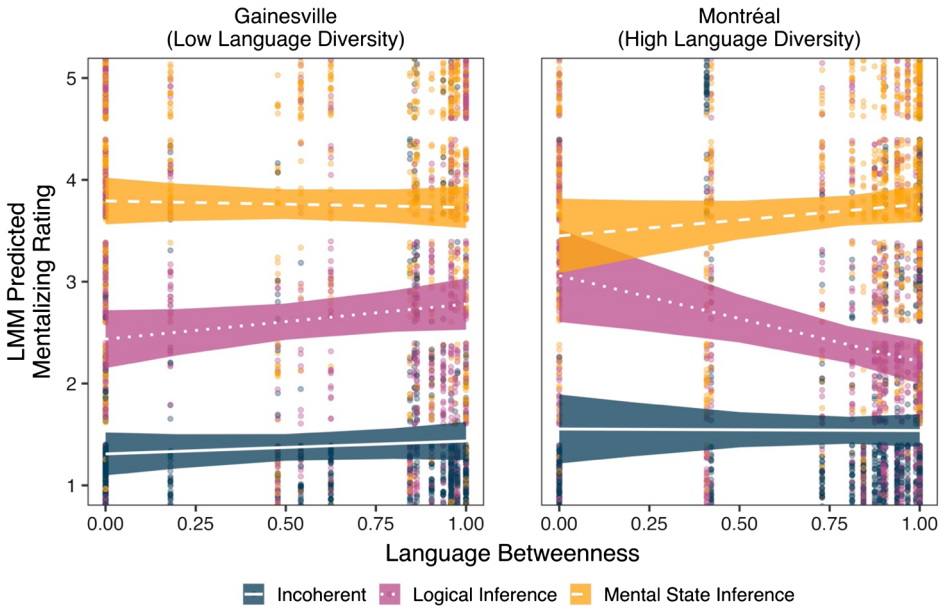
Figure 2
General Betweenness and Mentalizing Ratings



Note. An illustration of general betweenness on Linear mixed model (LMM)-predicted mentalizing ratings. High general betweenness reflects respondents with high bridging opportunities whereas low general betweenness reflects respondents with low bridging opportunities. Mental state inferences are shown in dashed line, logical inferences in dotted line, and incoherent items in solid line. Raw observations are represented as jittered dots. Error bands represent ±1 standard error of the mean. See the online article for the color version of this figure.

Figure 3

Language Betweenness and Mentalizing Ratings



Note. An illustration of the interaction involving language betweenness and region on mentalizing ratings. In this image, high language betweenness reflects egos who are critical for bridging language communities within the network whereas low language betweenness reflects egos who are not critical for bridging language communities. Of importance, language betweenness was reversed strictly for illustrative purposes to align with Figure 2 (i.e., 1-value). Mental state inferences are shown in dashed line, logical inferences in dotted line, and incoherent items in solid line. Gainesville participants are shown in the left panel and Montréal participants in the right panel. Raw observations are represented as jittered dots. Error bands represent ±1 standard error of the mean. See the online article for the color version of this figure.

computed a linear mixed-effect regression model to predict mentalizing ratings from the interaction between inference type and region. As expected, this model did not detect a significant interaction between inference type and region at either contrast (C1-Log/Men: $B = -0.12$, $SE = 0.12$, $t = -0.98$, $p = .33$, 95% CI [−0.35, 0.12]; C2-Coh/Inc: $B = -0.15$, $SE = 0.11$, $t = -1.37$, $p = .18$, 95% CI [−0.35, 0.06]). As a manipulation check, the model did detect a significant main effect of inference type at both contrasts (C1-Log/Men: $B = 0.62$, $SE = 0.06$, $t = 9.80$, $p < .001$, 95% CI [0.49, 0.74]; C2-Coh/Inc: $B = -0.55$, $SE = 0.05$, $t = -10.08$, $p < .001$, 95% CI [−0.65, −0.44]). This indicates that while mental state inferences were generally rated higher in mentalizing than logical or incoherent inferences, consistent with our manipulation, there was importantly no overall difference in mentalizing rating between participants tested in Gainesville versus Montréal. Full model outputs are available in Supplemental Materials.

Modeling General Betweenness and Language Betweenness

We next addressed the key questions of this paper by examining individual differences in general betweenness, language betweenness, and region. Our first hypothesis was that respondents with greater general betweenness centrality, who have more opportunities to bridge information across different others, will demonstrate higher mentalizing ratings. Here, we did not expect any mentalizing differences between Montréal and Gainesville given that general betweenness was not based in language or social group information. Our second hypothesis was that bridging between language groups (i.e., language betweenness) related to mentalizing over and above general betweenness. Here, we did expect regional differences such that high language bridging people who are embedded in a linguistically diverse ecology (Montréal) will demonstrate higher mentalizing ratings as a result of the sociolinguistic demands of their bilingual environment, whereas a linguistically homogenous ecology (Gainesville) will not cultivate similarly enhanced mentalizing capacities. Finally, we expected these results to be specific to mentalizing, rather than some general aspect of linguistic coherence.

We codified these questions into a single linear mixed-effects regression model to predict mentalizing ratings. This model coded for a two-way interaction involving inference type and general betweenness as well as a three-way interaction involving inference type, language betweenness, and region (see Table 3). To enhance model performance, we used the default "bobyqa" optimizer for linear mixed models. Here, two Gainesville participants were excluded from the analysis as they did not report any alter–alter ties, which meant that betweenness could not be computed ($N = 51$). Otherwise, all participants are included in these models. The marginal R^2 (i.e., fixed-effects only) of this model was 0.38, and the conditional R^2 (i.e., fixed and random effects) of this model was 0.65.

As expected, this model returned a significant two-way interaction between inference type and general betweenness at both contrasts (C1-Log/Men: $B = 0.14$, $SE = 0.06$, $t = 2.56$, $p = .01$, 95% CI [0.03, 0.25]; C2-Coh/Inc: $B = 0.16$, $SE = 0.05$, $t = 3.05$, $p = .003$, 95% CI [0.05, 0.26]). Relevant to our hypothesis, this interaction indicated that more generally central respondents demonstrated greater dissociation in mentalizing ratings between logical and mental state inferences. A follow-up simple slopes analysis on only-mental state and only-logical inferences indicated that the pattern of results was due to changes in mentalizing ratings to logical inferences ($B = -0.37$, $SE = 0.13$, $t = -2.92$, $p = .005$, 95% CI [−0.62, −0.12]) whereas ratings to mental state inferences did not change. This model also indicated that as respondents increase in general betweenness, their mentalizing ratings of incoherent items also increase, which we did not directly predict.

To affirmatively test that the effect of general betweenness was general to all participants, regardless of region, we constructed an additional model that coded for a three-way interaction involving inference type, general betweenness, and region. We compared this model to the original model using Akaike Information Criterion (AIC), where a lower AIC score indicates better model fit (Burnham & Anderson, 2003). AIC of the original model (i.e., two-way interaction) was 18867.62 whereas AIC for the second model (i.e., three-way interaction) was 18868.19. Given this increase in AIC (Burnham & Anderson, 2004), the added interaction of region was not determined to improve model fit.

Also consistent with our hypothesis, the model detected a significant three-way interaction between inference type, language betweenness, and region, specifically in the first critical contrast between logical and mental state inferences ($B = 0.33$, $SE = 0.12$, $t = 2.68$, $p = .01$, 95% CI [0.09, 0.56]). This interaction indicated that respondents who are more critical in bridging otherwise unconnected language communities (i.e., low language betweenness) also demonstrated greater dissociation in mentalizing ratings to logical and mental state inferences, but only in Montréal. A follow-up simple slopes analysis on only-mental state and only-logical inferences indicated that the observed results were not attributed to changes in any one condition. Thus, as illustrated in Figure 3, the observed results are most likely due to an increasing difference between the two conditions as a function of language betweenness (i.e., more mentalizing to mental state inferences and less mentalizing to logical inferences).

To test whether the effects of general betweenness and language betweenness were specific to mentalizing, we recomputed the model to predict linguistic coherence ratings given to the same items. Here, we did not expect to find significant interactions of either betweenness measure with the logical and mental state inference conditions on coherence ratings. This model revealed the interaction involving inference type and general betweenness was significant between logical and mental state inferences ($B = 0.05$, $SE = 0.02$, $t = 2.37$, $p = .02$, 95% CI [0.008, 0.09]). However, the confidence interval of this interaction was very close to zero, suggesting that the actual coefficient of this interaction may be near zero. The model also revealed the interaction involving inference type, language betweenness, and region was not significant ($B = 0.01$, $SE = 0.05$, $t = 0.29$, $p = .77$, 95% CI [−0.08, 0.11]). Together, these results indicate that while general betweenness may weakly predict linguistic coherence, language betweenness does not predict linguistic coherence (full model results available in Supplemental Materials).

Discussion

We examined whether social experiences that increased exposure to diverse perspectives, that is, being centrally located in one's social network generally and on the basis of language, predicted the behavioral performance on a mentalizing task of bilingual adults situated in high and low linguistic diversity regions. An initial analysis confirmed no overall mentalizing differences between the two regions. However, our primary results highlighted two interesting findings. First, people who were centrally positioned in their social network, regardless of their language experiences, demonstrated higher mentalizing capacity, indexed by a greater behavioral dissociation between mental state and logical inferences in the language task. We detected this pattern across both regions, which aligned with our prediction that across sociological contexts, influential network positions may increase overall exposure to unique perspectives and, over time, build up mentalizing capacities. Second, people who critically bridged language communities by occupying the shortest path between two alters with differing language backgrounds, also demonstrated a greater dissociation in mentalizing scores to logical and mental state inferences, *over and above general network centrality*. However, as expected, this pattern was only detected within the Montréal sample (high linguistic diversity), potentially due to differences in the environmental ubiquity and societal status of bilingualism between the two regions.

Of relevance, there was some evidence from the coherence rating model that the effects discussed here, particularly those related to language betweenness, were specific to the social content of mental state inferences, rather than some general linguistic or cognitive coherence process. Still, we did detect a weak relationship (albeit small coefficient compared to the mentalizing ratings) between general betweenness and coherence, suggesting that additional research is needed to conclusively determine the specificity of these effects. In addition, we find it interesting that bilinguals with high general betweenness rated incoherent items higher in mentalizing than bilinguals with low general betweenness (Figure 2). While we did not predict this effect, one interpretation of this pattern is that it is consistent with our hypothesis that high network bridgers, who may routinely engage with diverse perspectives, adaptively rely on mentalizing to understand others' behaviors. This may be the case as this response style may illuminate a tendency to seek mentally motivating meaning behind seemingly disjointed social context and a character's actions. It is of further interest that the pattern of observed results for general betweenness were driven by decreased mentalizing to logical inferences, whereas results for language betweenness were based in a growing dissociation in mentalizing to logical and mental state inferences. It is possible that mentalizing ratings to mental state inferences may be at ceiling (see Figure 2). Future research utilizing a more sensitive measure without an artificial range limitation may further reveal if this type of inference tracks with social network structure.

While growing research from social network analysis and bilingualism are separately examining how experiences with social diversity relate to mentalizing, we aimed to "bridge" these literatures in this paper. Indeed, both general social network centrality (regardless of language behaviors) and bilingualism itself offer opportunities for increased exposure to diverse perspectives over time. This chronic exposure to diverse perspectives and the potentially internalized knowledge that different perspectives cue different mental

Table 3
Results of LMM for Mentalizing Ratings

Model terms	*B*	*SE*	*t*	*df*	*p*	95% CI low	95% CI high
Fixed effects							
(Intercept)	2.58	0.07	36.01	61.52	<.01	2.44	2.73
Inference C2(Coh/Inc)	−0.56	0.05	−10.38	54.17	<.01	−0.66	−0.45
Inference C1(Log/Men)	0.56	0.06	9.24	64.48	<.01	0.44	0.67
General Betweenness (Scaled)	−0.07	0.07	−1.11	50.9	.27	−0.21	0.06
Language Betweenness (Scaled)	0.01	0.07	0.13	50.81	.90	−0.13	0.15
Region	0.03	0.14	0.20	50.76	.84	−0.24	0.3
Inference C2(Coh/Inc):General Betweenness (Scaled)	**0.16**	**0.05**	**3.05**	**51.01**	**<.01**	**0.06**	**0.26**
Inference C1(Log/Men):General Betweenness (Scaled)	**0.14**	**0.06**	**2.56**	**50.94**	**.01**	**0.03**	**0.25**
Inference C2(Coh/Inc):Language Betweenness (Scaled)	−0.02	0.06	−0.29	50.94	.77	−0.13	0.1
Inference C1(Log/Men):Language Betweenness (Scaled)	−0.08	0.06	−1.28	50.67	.21	−0.2	0.04
Inference C2(Coh/Inc):Region	−0.09	0.11	−0.85	50.9	.4	−0.3	0.12
Inference C1(Log/Men):Region	−0.01	0.11	−0.12	50.48	.9	−0.24	0.21
Language General Betweenness (Scaled): Region	−0.13	0.15	−0.91	51.37	.37	−0.42	0.15
Inference C2(Coh/Inc):Language Betweenness (Scaled):Region	0.04	0.11	0.33	51.3	.74	−0.18	0.26
Inference C1(Log/Men):Language Betweenness (Scaled):Region	**0.33**	**0.12**	**2.68**	**52.69**	**.01**	**0.09**	**0.56**
Random effects							
Item							
sd__(Intercept)	0.38						
sd__Inference (Condition: Mental state)	0.48						
sd__Inference (Condition: Incoherent)	0.35						
Subject							
sd__(Intercept)	0.87						
sd__Inference (Condition: Mental state)	0.73						
sd__Inference (Condition: Incoherent)	1.17						
Residual							
sd__Observation	0.94						

Note. LMM = Linear mixed model. Interactions of interest involving general betweenness and language betweenness are bolded.

states, may spur adaptations in how information is processed in novel social contexts and the cognitive processes, like mentalizing, engaged in those contexts (Carter & Phillips, 2017; Crisp & Turner, 2011). Given the inherently social function of language, we see the integration of social network analysis as a natural fit for quantitatively characterizing subtle, interpersonal social dynamics which may impinge on internal cognitive processes. Indeed, the results reported here highlight a need for theories of human cognition to expand beyond cognition without context and incorporate the dynamic, malleable, and socially-gated nature of the human mind (e.g., López et al., 2021; Tiv et al., in press; Vlasceanu et al., 2018). We suggest social network analysis as one useful tool in progressing towards this goal.

Consistent with a socially contextualized view, our results indicated that bridging between language communities patterned with greater mentalizing capacities in Montréal, but there was no relationship in Gainesville. Prior to obtaining this result, we confirmed no inherent differences in mentalizing performance between the two samples, which meant that our observed regional results are rooted in how language-specific network centrality plays out across these two contexts as people dynamically adapt to the demands of their environment. In other words, the only differences we detected between the two regions was in how mentalizing played out for social network experiences that are completely based on language (language betweenness). However, since Montréal and Gainesville differ in many ways, it is not possible to conclusively discern the root cause of our observed pattern. Still, it is important to note some of the ways in which these contexts differ as plausible explanations.

The prevalence of bilingualism in Montréal may set a global expectation for differences in perspective, much like other settings of social diversity, for which mentalizing becomes an effective cognitive strategy to resolve these potential differences. Similarly, the public ubiquity of linguistic diversity in Montréal may enhance the likelihood of intergroup interactions, which are situations in which mentalizing is particularly adaptive (Savitsky et al., 2011; Todd et al., 2011). Finally, given the tumultuous linguistic history of the province and that today, language practices are encoded in Québec and Canadian laws (Leimgruber, 2020), language and linguistic identity may be salient topics for Montréalers. Altogether, these sociolinguistic attributes render Montréal a place where people are expected to speak different languages in public spaces, which may trigger other perspective differences that in turn exercise mentalizing capacities in everyday contexts.

The sociolinguistic environment in Gainesville, Florida is observably different. Many bilinguals in Gainesville are context-specific bilinguals, such as heritage language speakers, who predominantly

use English (i.e., the "majority" language) except for when conversing with family or at home (i.e., the "minority" language; Kutlu & Kircher, 2021). Additionally, the institutionalized stigmatization, racialization, and criminalization of Spanish contributes to a hegemonic English monolingualism in many parts of the United States, including Gainesville (Chaparro, 2019; Flores, 2015; Flores & Rosa, 2015; Ortega, 2019). Indeed, Kutlu and Kircher (2021) analysis of English and Spanish geo-tagged tweets within Florida illustrated primarily *negative* attitudes of Spanish status, but predominantly *positive* attitudes of Spanish solidarity (i.e., feelings of attachment and belonging). And while the English–French bilingualism in Canada consists of two globally high-status languages, Spanish in the United States is systemically racialized, which may prevent widespread bilingualism from publicly taking root (Crystal, 2003; López-Beltrán & Carlson, 2020).

Thus, our primary results, that general betweenness related to mentalizing across people in Montréal and Gainesville but *language betweenness* only patterned with mentalizing in Montréal, could be evidence in support of the *ecologically based, context-specific nature* of how social information relates to dynamic cognition. Specifically, if language use is generally context-bound in Gainesville (e.g., Spanish at home, English at school), then there may be no global, public expectation for bilingualism, and language may be a less meaningful identity marker in public space. If so, language may not publicly cue perspective differences in the same way that it may in Montréal, in which case mentalizing is not a cognitively adaptive strategy.

Indeed, a follow-up exploratory analysis available in Supplemental Materials suggests that bilinguals in Gainesville who may be bridging multiple languages only among their close family alters, do show better mentalizing performance than respondents whose close family alters use a single language. As multiple languages within close family may set a within-context expectation for perspective differences (e.g., within the private sphere), this pattern provides additional evidence that the specific demands of one's social environment shape the adaptiveness, relevance, and usefulness of certain cognitive processes, particularly when it comes to complex, multifaceted, and diverse life experiences such as bilingualism. We encourage future research to reflect on how these principles of situated cognition bear upon theory and consider the sociolinguistic demands of their testing context may constrain observed behavioral patterns. Inconsistent patterns may not reflect inherent deficiencies in the sample or replication failures, but rather the different ways that people interact with their environments.

Finally, while the primary focus of this discussion has been on individual and regional *language* experiences, language inherently intersects with many other dimensions such as culture, race, socioeconomic status, politics, and more. This intersectionality is at the core of a socially-contextualized view of cognition (Tiv et al., in press), and likely influences our analysis of mentalizing in some way. For instance, it is possible that some aspect of English–Spanish bilingualism (i.e., the Gainesville sample) relates differently to mentalizing than some aspect of English–French bilingualism (i.e., the Montréal sample), but these languages and their speakers do not inherently differ—rather, their histories and socializations in global and local contexts differ. Thus, we do not expect our results to necessarily be specific to language experiences. Instead, we would expect to find similar sociolinguistic constraints on mentalizing if we examined betweenness on the basis of another salient social dimension, such as race, culture, or class.

We acknowledge several limitations of this paper. As discussed in past work (Tiv, O'Regan, & Titone, 2021), the nature of the mentalizing outcome variable (rating judgments) may be reflecting downstream recognition of mentalizing as opposed to in-the-moment mentalizing behavior. Our ongoing work is using eye-tracking to better examine mentalizing as it occurs in real time. Additionally, while we have approached this paper from a theoretical perspective that social-environmental constraints of social network structure shape mentalizing capacities, our correlational analysis precludes us from asserting the direction of this relationship. However, given the absence of consistent longitudinal or other causal network data in the literature, we do not know of any studies that can adjudicate this directionality among humans. Among nonhuman primates, those randomly assigned to live in large social groups over time developed more gray matter in brain regions associated with social and emotional information processing than those in small groups (Sallet et al., 2011). To the extent that these neural dynamics align with human brain patterns, social experiences likely shape cognition and the brain, as discussed here. In reality, most researchers agree that the arrow of causality is to some extent bidirectional (Smith et al., 2020).

Furthermore, our methodological choice of eliciting eight to twelve alters from each respondent may only provide a snapshot of their social network, potentially people who are closest to them. To mitigate this possibility, we asked respondents to nominate alters from all spheres of their social life, and this produced results consistent with past research that has computed network betweenness from full social networks online (O'Donnell et al., 2017) and in the real world (Youm et al., 2021). Additionally, due to differences between the American and Canadian census surveys, we were not able to include quantitative indices of population language patterns to our models. Future research may address this limitation by targeting two linguistically unique regions within the same country so that population statistics can be directly compared (e.g., Gainesville vs. Miami).

Lastly, the characteristics of our sample pose some limitations. Our sample consisted of fewer than thirty participants for each region, which may be a low number for testing individual differences and may have impacted the results. Our sample also primarily consisted of female/woman gender identities, which may limit the generalizability of our conclusions. To this end, the overall relationship between network centrality and mentalizing reported in this paper is consistent with past work from a neuroscientific study on an all-male sample (O'Donnell et al., 2017). Finally, our sample did not represent the full spectrum of diversity in the underlying population, and future research must prioritize recruiting more diverse samples to fully understand the link between social-environmental constraints and human cognition.

To conclude, we found evidence that people who occupy influential social network positions that offer opportunities to bridge information between other people generally exhibit greater mentalizing across diverse sociolinguistic contexts. Over and above this general pattern, people who bridge between language communities also exhibit greater mentalizing, but only in regions where bilingualism is ubiquitous and mentalizing to resolve perspective differences on the basis of language could be an adaptive cognitive strategy. Of note, these findings, particularly language betweenness,

appear specific to mentalizing and not strongly predictive of general coherence, which may be more of a general linguistic or cognitive process. These findings also hold theoretical import for our understanding of human cognition—how it dynamically adapts to social-environmental constraints and demands. Importantly, these results carry pragmatic implications for intergroup relations in the real world. Mentalizing helps people understand others' distinct experiences and perspectives. Identifying social experiences, such as exposure to diverse perspectives, which may boost this cognitive style, may have a positive, lasting impact on historically marginalized, exploited, and dehumanized groups of the human population.

Résumé

La mentalisation, ou le raisonnement sur les états mentaux des autres, est un processus cognitif social dynamique qui aide à comprendre les interactions sociales complexes. Nous avons examiné si l'exposition à diverses perspectives, offertes par l'occupation de positions influentes au sein d'un réseau social, prédit les performances d'adultes bilingues dans une tâche d'évaluation de la mentalisation dans des régions à forte et faible diversité linguistique. Nous avons calculé le degré auquel la position des répondants dans leur réseau social rapproche les membres isolés de ce réseau les uns des autres (c.-à-d., la centralité d'intermédiarité générale) et rapproche spécifiquement les communautés linguistiques les unes des autres (c.-à-d., la centralité d'intermédiarité linguistique). La centralité d'intermédiarité générale prédit les performances de mentalisation quelle que soit la région. Cependant, la centralité d'intermédiarité linguistique prédit seulement la mentalisation dans une région à forte diversité linguistique, où le bilinguisme est omniprésent, et où la mentalisation pour résoudre des différences de perspective par le biais de la langue pourrait être une stratégie cognitive adaptative. Ainsi, ces résultats indiquent que la cognition humaine est sensible au contexte social et s'adapte aux demandes sociolinguistiques de l'environnement plus large.

Mots-clés : cognition sociale, analyse des réseaux sociaux, contextes sociolinguistiques, diversité linguistique, comportement socio-écologique

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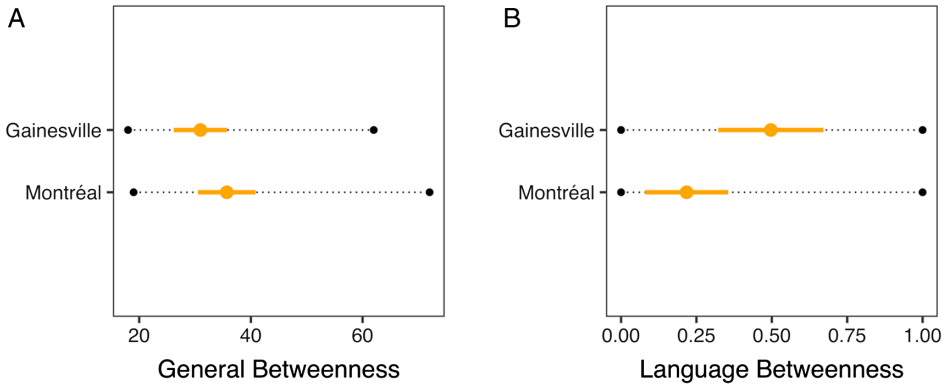
(*Appendix follows*)

Appendix

General and Language Betweenness

Figure A1

General and Language Betweenness Summary Statistics



Note. Summary statistics for (A) General Betweenness and (B) Language Betweenness. Across both panels, means, 95% confidence intervals, minimums, and maximums are plotted for participants in Gainesville and Montréal. The black endpoints on each panel display the minimum and maximum values. The middle, yellow point displays each mean and the yellow segments display the 95% confidence intervals around the means. See the online article for the color version of this figure.

Table A1

General and Language Betweenness Summary Statistics

Measure by region	*M* (*SD*)	95% CI	Min	Max
General betweenness				
Montréal	35.7 (12.5)	(30.5, 40.9)	19	72
Gainesville	31.0 (11.8)	(26.2, 35.7)	18	62
Language betweenness				
Montréal	0.22 (0.34)	(0.08, 0.36)	0	1
Gainesville	0.50 (0.45)	(0.32, 0.67)	0	1

Note. *M* = mean; *SD* = standard deviation; 95% CI = 95% confidence interval (lower, upper); Min = minimum; Max = maximum.

Received June 21, 2021
Revision received December 16, 2021
Accepted December 21, 2021 ■