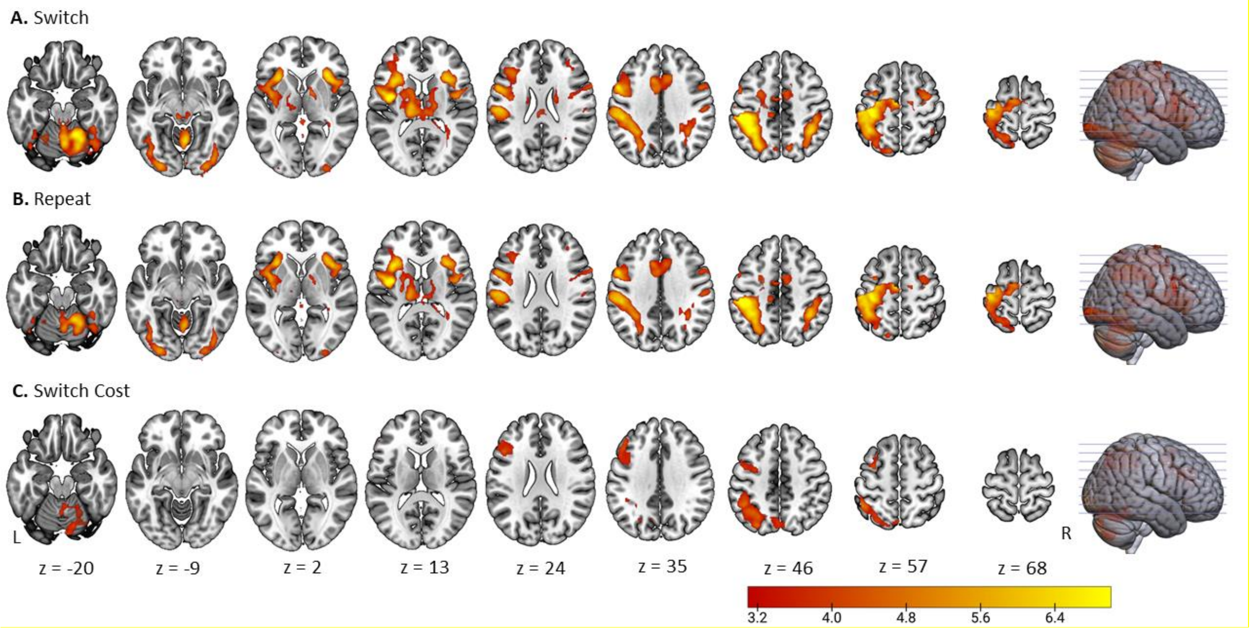
Supplementary Table 1 Effects of task condition on brain activation

	Hemisphere	**BA Label**	**Voxels**	**Coordinates (mm)**			**Z value**
				x	**y**	**z**	
Switch							
Frontal Pole	**Left**	**BA46**	**9677**	**-34**	**44**	**7**	**4.2**
Central Opercular Cortex	Left	NA		-40	-8	20	7.31
Frontal Operculum Cortex	Left	BA45		-32	20	10	6.86
Insular Cortex	Left	BA13		-38	-4	10	7.71
Superior Parietal Lobule	Right	BA40		38	-48	48	6.63
Supramarginal Gyrus	Right	BA7		43	-45	52	5.7
Angular Gyrus	Right	BA39		35	-54	41	4.64
Lateral Occipital Cortex	Right	BA39		36	-63	49	4.18
Frontal Orbital Cortex	**Right**	**BA13**	**2250**	**34**	**26**	**0**	**6.11**
Frontal Operculum Cortex	Right	BA44		42	10	8	5.91
Central Opercular Cortex	Right	BA44		44	6	8	5.8
Precentral Gyrus	Right	BA6		58	10	30	5.01
Insular Cortex	Right	BA13		32	22	8	7.14
Precentral Gyrus	**Left**	**BA4**	**11905**	**-38**	**-22**	**60**	**7.85**
Postcentral Gyrus	Left	BA1		-44	-30	48	8.56
Supplementary Motor Cortex	Left	BA6		-6	-12	56	7.27
Supramarginal Gyrus	Left	BA40		-52	-30	44	7.85
Cerebellum	**Left**	**NA**	**265**	**-28**	**-54**	**-54**	**4.59**
Cerebellum	**Right**	**NA**	**7012**	**26**	**-58**	**-54**	**6.46**
Occipital Pole	Right	BA18		30	-94	-4	7.06
Precuneous Cortex	**Right**	**BA7**	**138**	**12**	**-68**	**42**	**5.59**
Inferior Temporal Gyrus	**Left**	**BA37**	**2082**	**-44**	**-60**	**-12**	**5.7**
Lateral Occipital Cortex	Left	BA18		-34	-90	-12	5.7
Occipital Pole	Left	BA18		-28	-92	-10	5.86

Repeat							
Frontal Pole	**Left**	**BA46**	**5334**	**-36**	**45**	**10**	**3.95**
Frontal Operculum Cortex	Left	BA45		-32	20	10	7.08
Central Opercular Cortex	Left	BA6		-52	2	8	6.74
Insular Cortex	Left	BA13		-38	-4	10	7.58
Frontal Operculum Cortex	**Right**	**BA45**	**1983**	**34**	**20**	**10**	**6.85**
Inferior Frontal Gyrus	Right	BA44		42	17	11	5.92
Insular Cortex	Right	BA13		32	17	10	5.75
Central Opercular Cortex	Right	BA6		44	4	10	6.1
Paracingulate Gyrus	**Left**	**BA32**	**10207**	**-8**	**17**	**38**	**4.44**
Paracingulate Gyrus	Right	BA8		6	19	38	5.03
Anterior Cingulate Gyrus	Left	BA24		-7	6	38	5.06
Anterior Cingulate Gyrus	Right	BA24		6	10	30	4.48
Middle Frontal Gyrus	Right	BA6		30	0	60	4.57
Precentral Gyrus	Left	NA		-36	-22	60	7.51
Precentral Gyrus	Right	BA6		28	-8	56	4.32
Supplementary Motor Cortex	Left	BA6		-4	-12	56	6.92
Postcentral Gyrus	Left	BA1		-56	-20	28	6.96
Supramarginal Gyrus	Left	BA40		-50	-30	42	7.44
Superior Parietal Lobule	Left	BA7		-36	-44	42	7.14
Postcentral Gyrus	**Right**	**BA1**	**1627**	**52**	**-22**	**40**	**4.64**
Supramarginal Gyrus	Right	BA1		56	-20	36	4.53
Superior Parietal Lobule	Right	BA7		40	-46	50	6.45
Angular Gyrus	Right	BA39		36	-50	38	5.28
Lateral Occipital Cortex	Right	BA39		32	-64	40	4.71
Cerebellum	**Right**	**NA**	**4891**	**34**	**-54**	**-31**	**5.24**
Occipital Pole	Right	BA18		30	-94	-4	6.91
Cerebellum	**Left**	**NA**	**1593**	**-38**	**-54**	**-29**	**5.46**
Inferior Temporal Gyrus	Left	BA37		-44	-60	-12	5.04

Occipital Fusiform Gyrus	Left	BA19		-42	-66	-12	5.04
Lateral Occipital Cortex	Left	BA19		-40	-76	-8	5.01
Occipital Pole	Left	BA18		-28	-92	-10	5.69
Switch Cost							
Inferior Frontal Gyrus	**Left**	**BA44**	**1728**	**-46**	**22**	**22**	**4.62**
Middle Frontal Gyrus	**Left**	**BA9**		**-44**	**32**	**34**	**4.44**
Precentral Gyrus	Left	BA6		-47	1	50	3.41
Supramarginal Gyrus	**Left**	**BA40**	**2655**	**-48**	**-48**	**52**	**5.33**
Angular Gyrus	Left	BA39		-38	-58	44	4.51
Lateral Occipital Cortex	Left	BA7		-28	-68	56	4.44
Precuneous Cortex	Left	BA7		-4	-74	51	3.7
Postcentral Gyrus	Left	BA1		-48	-38	57	3.8
Occipital Fusiform Gyrus	**Right**	**NA**	**1278**	**12**	**-84**	**-22**	**3.6**

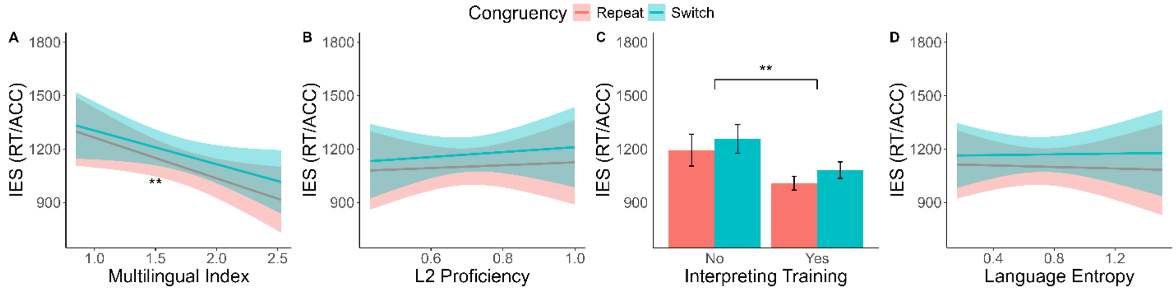
BA indicates Broadmann area.



Supplementary Figure 1 Effects of task condition on brain activation. Shown are A) Switch condition, B) Repeat condition, and C) Switch Cost (i.e., Switch – Repeat masked with Switch). Slices are depicted in increments of 11 mm, starting at z = −20 and ending at z = 68. L represents left, and R represents right. Color bar ranges from Z = 3.1 to Z = 7.

1. Supplementary Analysis on Behavioral Data

To provide a more integrated behavioral performance indicator, we calculated an Inverse Efficiency Score (IES, RT/ACC), for Repeat and Switch conditions respectively in each participant (Supplementary Figure 2). A regression was conducted, exploring the effects of multilingual index on IES (R^2 Marginal = .12, R^2 Conditional = .12). Results showed the higher multilingual index was significantly associated with lower IES ($\beta = 104.46$, SE = 33.27, p =.002; Supplementary Figure 2). Another regression (R^2 Marginal = .10, R^2 Conditional = .10) was conducted on IES to explore the effects of task condition, and its interaction with separate language factors including L2 proficiency, interpreting training, and language entropy. It was found that the main effect of interpreting training was significant ($\beta = 309.45$, SE = 73.24, t = 2.86, p =.005), such that individuals with interpreting training showed lower IES than those with no training. The effects of language entropy or L2 proficiency, as well as the interactions between language factors and task condition were not significant (ps > .1). In summary, analyses on IES indicate that multilinguals with higher level of multilingual experience driven by interpreting training experience showed better behavioral performance on task switching.



Supplementary Figure 2. Effects of language factors on the behavioral Inverse Efficiency Score (IES, RT/ACC). The main effects of integrated multilingual index (A), and interpreting training (C) were significant.

2. Supplementary Analysis on Network-Based Functional Connectivity

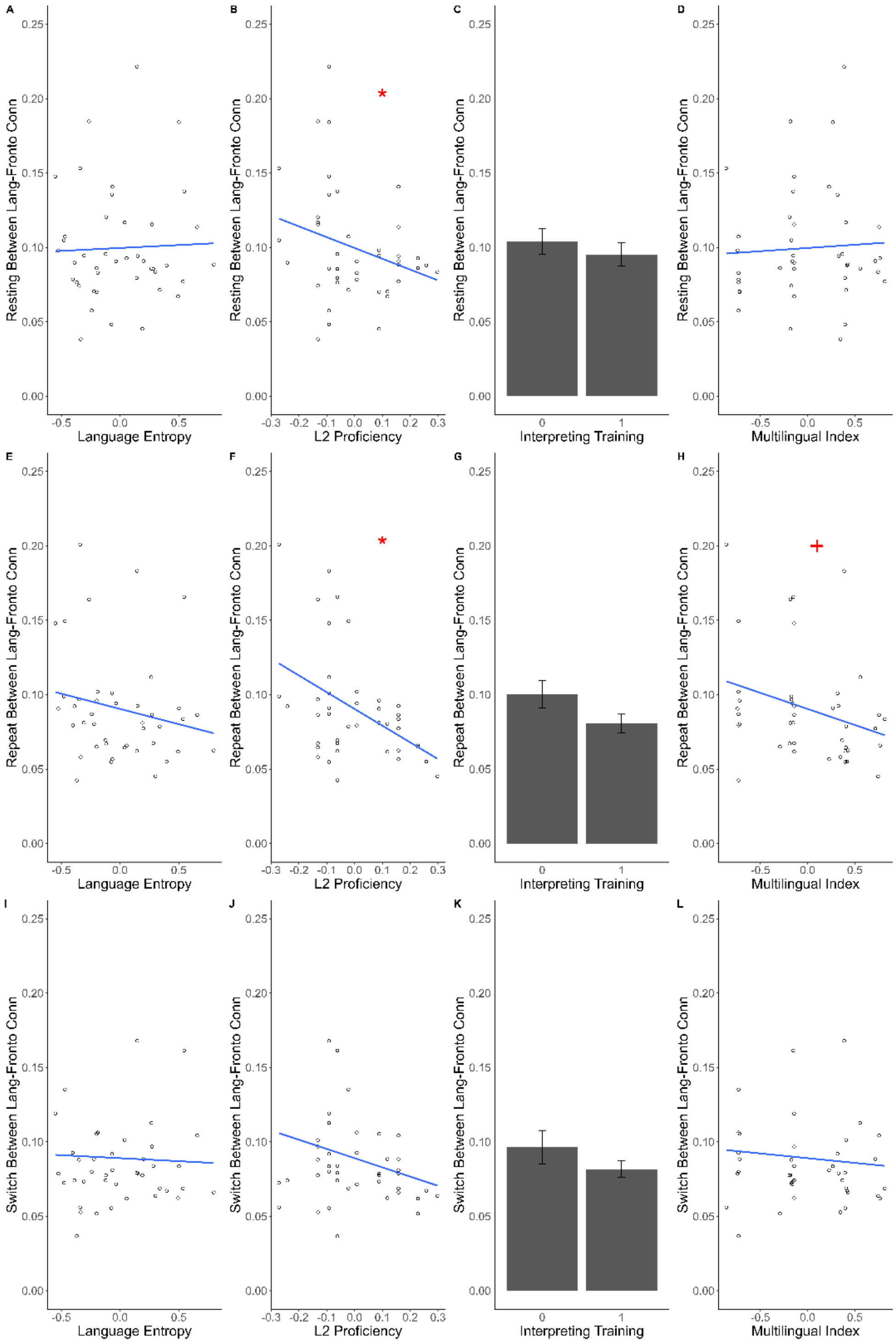
2.1 Node Definition and Network Measures

We used the same network definition approach as Zhang and Diaz (2023), where details can be found. Briefly, we used the same 264 locations from Power et al. (2011) and created the 5 mm radius non-overlapping nodes using the MNI152, 2mm brain as the reference. Power divided all nodes into 12 networks. Among all nodes, 33 were excluded from the analysis due to poor classification fit with the Power networks. To further identify nodes that belong to the language network, we used the language atlas identified by Fedorenko and colleagues (2010), representing a broad language processing network that supports both language comprehension and production. Any nodes that overlapped with the language network localizer were categorized as the language network. The remaining nodes were then binned across the 12 Power networks according to their location. Nodes were double checked to ensure that no location belonged to more than one network. Of the most relevance to the current project, we specifically focused on how language factors modulated the relationship between language network and fronto-parietal network, during resting, Repeat and Switch conditions.

For each participant, the time series of each node in the language and fronto-parietal control networks during resting state, and the Repeat and Switch conditions during the task were extracted, then a cross-correlation of each node's time course with every other node's time course was calculated. Correlation coefficients were converted to Z-values using Fisher's equation. Consistent with previous studies using similar approaches (Chan et al., 2014), negative correlations were not included in further analysis due to uncertainty regarding the meaning of negative correlations (Hallquist & Hillary, 2018). The functional connectivity between the language network and the frontal parietal control network was calculated as the mean correlation value between each node in the language network and each node in the frontal network.

2.2 Network Analysis

For the between network connectivity during each state (resting, repeat, and switch), two regressions were conducted. The first regression included separate language factors (L2 proficiency, interpreting training, language entropy), while the second regression included the integrated multilingual index. Significant results have been indicated on Supplementary Figure 3. In summary, higher L2 proficiency was significantly associated with lower connectivity between language and fronto-parietal control network during resting and repeat states (ps $< .05$), and higher multilingual index was also marginally associated with lower between network connectivity during repeat condition ($p = .057$).



*Supplementary Figure 3. Effects of language factors on the functional connectivity between language network and fronto-parietal control network during resting, repeat, and switch conditions. * indicates p < .05. + indicates .05 < p < .1.*

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