Validating the use of a multiuser braincomputer interface to investigate interbrain synchronization during a shared robot control task.

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Background

Inter-brain synchronization: neural coordination between individuals, commonly seen during social interaction.





An increasingly popular social interaction activity is recreational robotics.



mBCIs can promote synchrony during shared tasks by recording neural signals from multiple users & translating task-relevant activity into goal-oriented output.

Research Question



Can a shared visual imagery-based robotics task elicit interbrain synchronization in a participant pair?

Methods & Analysis





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$(\mathbf{3})$ Validation

Extract average power in different frequency bands. Train machine learning classifiers to identify visual imagery vs. rest states.



Interbrain Synchronization Analysis (4)

Measure brain synchrony via phase-locking values (PLVs). Average the PLVs between different brain regions.

A shared robot control task driven by a multiuser braincomputer interface (mBCI) shows potential for promoting brain synchrony between paired participants

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Holland Bloorview Kids Rehabilitation Hospital





Image: Point of the state	Inter-brain Connectivity (theta band - 4-8 Hz)						2.0	Inter-brain Connectivity (alpha band - 8-12 Hz)													Inter-brain Connectivity (beta band - 12-30 Hz)						
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Frontal Le	t - 0.65	0.21	0.13	0.09	0.26	0.48	-0.38	- 1.5	Frontal Left -	-0.12	0.05	-0.10	0.11	0.15	-0.70	0.33	- 1.5	Frontal Left -	-0.98	-0.08	-0.16	0.13	0.11	-0.23	0.12	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Frontal Rigl	t - 0.43	-0.26	0.20	0.46	0.28		-0.28	- 1.0	Frontal Right -	-0.25	0.13	-0.48	-0.36	-0.92	-0.17	-0.34	- 1.0	Frontal Right -	-0.27	0.17	0.23	0.97	0.51	0.22	0.61	
Image: bit in the state in the sta	Central Le	t - 0.35	0.01	0.23	0.02	0.20	0.83	-0.27	- 0.5 br	Central Left -	0.45	0.79	0.48	0.11	-0.10	-0.30	-0.15	- 0.5 - Jaiue	Central Left -	-0.98	-0.18	-0.33	-0.26	-0.05	-0.38	-0.61	
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Posterior Right 0.07 0.03 0.05 0.02 0.07	Central Rigl	t - 0.17	-0.67	0.16	0.30	0.22	0.38	-0.94	0.5 S	مـ Central Right -	-0.09	0.99	0.18	-0.02	-0.20	-0.74	-0.09	0.5	≌ Central Right -	-0.74	0.29	0.15	1.14	0.18	0.26	0.52	
Posterior Right - 0.48 -0.08 -0.04 -0.41 - 0.47 - 0.42 -0.45	Posterior Le	t0.21	-0.07	-0.23	-0.55	-0.22	0.57	-0.07	1.0	Posterior Left -	-0.58	0.21	-0.20	-0.87	-0.06	0.24	0.03	1.0	Posterior Left -	-0.75	0.24	-0.54	0.60	0.62	0.56	0.46	
Frontal Left	Posterior Rigl	t0.48	-0.08	-0.64	-0.41	-0.47	-0.42	-0.45	1.5	Posterior Right -	-0.01	0.67	-0.12	0.72	-0.11	-0.26	0.28	1.5	Posterior Right -	-0.66	0.54	-0.10	1.31	0.78	0.23	0.84	
		Frontal Left -	Frontal Right -	Central Left -	Central -	Central Right -	Posterior Left -	Posterior Right -	2.0		Frontal Left -	Frontal Right -	Central Left -	Central -	Central Right -	Posterior Left -	osterior Right -	-2.0		Frontal Left -	Frontal Right -	Central Left -	Central -	Central Right -	Posterior Left -	Posterior Right -	



Preliminary results indicate relatively greater synchronization between central and frontal regions and, to a lesser degree, central and posterior regions.



The mBCI setup enables reliable shared control of a robot through visual imagery alone.



Promising patterns of neural coordination were observed between participants during this shared visual imagery robotics task.



2. Draw general conclusions about task-specific coordination amongst different brain regions.

mBCI technology helps clients with complex communication needs...

Overcome social interaction barriers in shared activities.



Results

Machine Learning Validation

For each participant, at least one classifier attains practical accuracy (0.70) in distinguishing visual imagery from rest.

Interbrain Synchronization





Conclusion

&

Next Steps

1. Conduct more sessions to increase data availability.

Relevance to Holland Bloorview



Participate to their full capacity in collaborative recreational contexts.



