

Review

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How ASIA-PACIFIC and Arabian Countries Published Articles in the Scopus and WoS Indexed Sources with EEGLAB in 20 Years: A Bibliometric Study

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Keywords: EEGLAB; Bibliometric Analysis; Asia-Pacific; Arabian States; SCOPUS; Web of Science



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Review

How ASIA-PACIFIC and Arabian Countries published articles in the Scopus and WoS indexed Sources with EEGLAB in 20 years: A Bibliometric Study

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Abstract : Introduction: The EEGLAB is one of the main and primary software for designing and analyzing experiments with electroencephalography datasets. It has been used globally for more than 20 years. The aim of this bibliometric research is to study the ASIA-PACIFIC and Arabian states regions with 80 countries and territories and the way they used EEGLAB and published articles in SCOPUS and Web of Science (WoS) Indexed Sources. **Methods :** The bibliometrix package in R was used to analyze all SCOPUS and WoS indexes-sources citations of EEGLAB's main article from the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) with 5 subregions and 58 countries and territories and United Nations Economic and Social Commission for West Asia (ESCWA) or Arab States with 22 countries and territories until 03/28/2024. **Results:** There are 22,298 Google Scholar citations for EEGLAB software, meanwhile, this number is reduced to 14,958 ($\approx 67.1\%$) citations in the WoS and 15,827 ($\approx 70.1\%$) citations in the Scopus, respectively. The Bibliometric indices, Lotka's law coefficient estimation, core sources based on Bradford's law, the most globally cited documents in all time, after 2020 and 2022, Co-Occurrence Network of WoS subject, Co-Citation Network Papers and Historiography are presented. Most analyses have been grouped by database, regions, and subregions. The Supplementary materials includes further analysis for example country-based analysis for China, Japan, India, Russian Federation and Iran. **Conclusions:** About 35% of all WoS documents and 41% of authors came from these two regions (ESCAP and ESCWA) while the average citation per doc in the world is doubled these two regions.

Keywords: EEGLAB; bibliometric analysis; Asia-Pacific; Arabian states; SCOPUS; web of science

Key messages

- The bibliometric analysis of all EEGLAB Citations from SCOPUS & Web of Science
- Focus on 80 countries & territories including the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and West Asia (ESCWA)
- Estimating and Comparison of Lotka's law coefficient estimation for Author Scientific Productivity among subregions with Functional Data Analysis
- Provided the Most Global Cited Documents, historiographies, co-citation networks and co-occurrence network of WoS subject group by subregions, periods and databases

- Further analysis in the online Supplementary materials including specific analysis for China, Japan, India, Russian Federation and Iran.

1. Introduction [409 words]

After the development of the electroencephalogram (EEG) by Hans Berger in 1929 and since 1936 it became a major diagnostic tool and instrument in neuroscience globally (Keshavan et al., 2024; Mecarelli, 2019; Pavlov et al., 2021). From the 1990s many different academic software applications were developed for brain mapping with EEG (Baillet et al., 2011) such as EEGLAB (Delorme & Makeig, 2004), Field-Trip (Oostenveld et al., 2011), SPM (Litvak et al., 2011) and recent advances in Python such as MNE (Gramfort et al., 2014). The EEGLAB is an open source application developed by a team with the leading of Professor Arnaud Delorme and Scott Makeig from Swartz Center for Computational Neuroscience, Institute for Neural Computation, University of California San Diego, USA. (Delorme & Makeig, 2004) The main features are providing Independent Component Analysis (ICA) and time/frequency analysis, various methods for artifact removal, a user-friendly graphical user interface (GUI), multifformat data importing, and interactive plotting. It has been downloaded about 350,000 times more than 15,265 researchers in the EEGLAB news list and more than 160 plug-ins (*EEGLAB Website*).

More than 12,700 Web of Science indexed research articles and documents cited EEGLAB papers worldwide with an estimated international Co-authorship is 37.27% (Fayaz, 2023). As stated in many bibliometric analysis, for example in Construction Health and Safety Management (Ding et al., 2023), Visualizations in Computer Graphics (Sajovic & Boh Podgornik, 2022), Brain-Computer Interface (Stegman et al., 2020) and Good Scientific Practice (Niso et al., 2022), EEGLAB is the main software.

The bibliometric study of geographically specific regions is of interest in neuroscience such as : neuroscience research in Saudi Arabia (Alhibshi et al., 2020), Turkey (Kocak et al., 2019), Iran (Ashrafi et al., 2012), Latin America (Forero et al., 2020), Brazil (Hoppen & Vanz, 2016), Neurosurgical Research in Southeast Asia (Omar II et al., 2022), Egyptian neurosurgical publications (Azab & Salem, 2022), Neurodegenerative Disorders in Arab Countries (El Masri et al., 2021) and Alzheimer's Disease in the world and China (Dong et al., 2019). Usually, the most cited articles came from the United States (US) and North America, European countries, etc., and the remaining parts of the world were not well-studied (Fayaz, 2023). However, there is no bibliometric analysis for EEGLAB paper citations in specific regions such as Asia-Pacific and Arabian states with 80 countries and territories. In this study, the SCOPUS and WOS databases were analyzed for these regions with bibliometrix R packages (Aria & Cuccurullo, 2017).

2. Material and Methods [335 words]

2.1. Selected Regions

The countries and territories in two of the five regional commissions under the jurisdiction of the United Nations Economic and Social Council are considered. (*Regional Commissions*) They are including:

1. United Nations Economic and Social Commission for Asia and the Pacific (**ESCAP**) with 58 countries and territories (Division, 2024). They divided into 5 Asia-Pacific subregions:
 - I. **East and North East Asia (ENEA):** China, Democratic People's Republic of Korea, Hong Kong (China), Japan, Macao (China), Mongolia and Republic of Korea;
 - II. **North and Central Asia (NCA):** Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan and Uzbekistan;

- III. **Pacific (PACIFIC):** American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu;
 - IV. **South East Asia (SEA):** Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste and Vietnam;
 - V. **South and South West Asia (SSWA):** Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan, Sri Lanka and Türkiye.
2. The United Nations Economic and Social Commission for West Asia (**ESCWA**) or Arab States with the following 22 countries and territories (*United Nations Economic and Social Commission for Western Asia*, 2024):
- I. Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, State of Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen.

2.2. Databases

The Web of Science (WoS) and Scopus are used as two citation databases. The search strategy considers all citations grouped by regions, subregions, and countries of the *Delorme A, Makeig S. EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. Journal of neuroscience methods. 2004 Mar 15;134:9-21. (Delorme & Makeig, 2004)* The date of searching and downloading is 03/28/2024.

2.3. Statistical and Data Analysis

The bibliometric analysis methods are used with bibliometrix package (Aria & Cuccurullo, 2017) in POSIT (<https://posit.co/>) and R software (<https://www.r-project.org/>)(R, 2023).

3. Results (1958 Words)

3.1. The Descriptive Statistics

In Google Scholar, there exits 22,298 citations for EEGLAB software (until 03/28/2024) (Delorme & Makeig, 2004), meanwhile this number is reduced into 14,958 ($\approx 67.1\%$) citations in the WoS and 15,827 ($\approx 70.1\%$) citations in the Scopus, respectively. The accessible WoS results include 14,598 citations. The number of total citations in WoS for all selected regions is 4,836 ($\approx 21.6\%$) articles and for ENEA, NCA, PACIFIC, SEA, SSWA and Arab states were 3,168 ($\approx 14.2\%$), 172 ($\approx 0.77\%$), 836 ($\approx 3.75\%$), 276 ($\approx 1.23\%$), 564 ($\approx 2.52\%$) and 155 ($\approx 0.69\%$) citations respectively. These citations were published from 2004 to 2024 in 975 sources (journals, conference proceedings, etc.), written by 12,140 authors and they cited 134,022 unique references. The annual growth rate (considering the first three months of 2024) is estimated at 20.85%, the international co-authorship is 42.39%, and the average citation per doc is 13.97 documents. According to the table 1, the ENEA subregion is in one cluster and other subregions are in another cluster based on the k-mean clustering with a single linkage.

The list of citations grouped by country name and region is presented in *Supplementary materials, Table S1* for both WoS and Scopus databases. According to this table, China (2,257), Australia (755),

Japan (574), the Republic of Korea (392), India (231), Iran (191), the Russian Federation (163), Singapore (151), New Zealand (103), both Malaysia (79) and Türkiye (79) are top-ten countries according to the WoS citations. The difference between the number of citations in WoS and Scopus for each country is calculated as $Diff = \#WoS - \#Scopus$. Hong Kong (China), India, Japan, China, Russian Federation, Iran and Macao (China) have $Diff \geq 40$ citations. Hence, further analysis such as the country-specific profile based on Scopus is provided in *Supplementary materials, Part B Country Profile* based on Scopus citations.

Table 1. The Bibliometric indices group by Database and Subregions until 03/28/2024.

Database		WoS							Scopus
		Subregions							All
Subregions	All								World
		ESC	ENE	NC	PACI	SEA	SS	Arab	
		World*	A	A	FIC		WA	States	
Indices									
From (Year)		2004	2004	2005	2005	2004	2008	2007	2004
To (Year)		2023	2024	2024	2023	2024	2024	2024	2024
Documents		12,700	4,836	3,168	172	836	276	564	15,827
Sources		1,125	975	652	88	291	159	289	2,072
Authors		29,125	12,140	7,665	538	2,569	917	1,673	33,070
Keywords		19,062	9,375	6,729	557	2,113	848	1,719	21,384
References		279,617	134,022	94,266	8,576	33,891	11,719	22,987	763,160
Annual Growth Rate		28.12%	20.85%	15.3%	15.3%	14.11%	10.5%	15.1%	18.63%
International Authorship	Co-Authorship	37.27%	42.39%	35.9%	56.4%	65.79%	71.0%	48.7%	34.8%
Co-Authors per Doc		4.89	5.42	5.58	5.28	5.69	5.41	4.70	5.14
Document Average Age		5.03	4.88	4.66	6.97	5.36	5.64	4.34	5.85
Average Citation per Doc		22.51	13.97	12.54	19.74	19.21	19.85	12.44	23.02

*They are extracted from (Fayaz, 2023) until 08/27/2023; Abbreviations: United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), East and North East Asia (ENE), North and Central Asia (NCA), Pacific (PACIFIC), South East Asia (SEA), South and South West Asia (SSWA), United Nations Economic and Social Commission for West Asia (ESCWA)

3.2. Lotka’s law coefficient estimation for Author Scientific Productivity

The Lotka's law coefficient,"the frequency of publication by authors in any given field as an inverse square law, where the number of authors publishing a certain number of articles is a fixed ratio to the number of authors publishing a single article", is estimated with lotka() function in bibliometrix package (Aria & Cuccurullo, 2017; Lotka, 1926) for author scientific productivity in each region. (Table 2) The goodness of fit ,R²,of all models are more than 0.95 and the p-value of the two-sample Kolmogorov-Smirnov test between the empirical and the theoretical Lotka's Law distribution (Beta=2) are higher than 0.05, and they are not statistically different.

To compare the Lotka curves between regions, the two groups are created: 1) ENEA, PACIFIC and SEA for East Asia regions and 2) NCA, SSWA and Arab States for central and west Asia regions. The lotka curves are compared with an ANOVA test for functional data with fanova.onefactor () function in fda.usc package.(Cuevas et al., 2004; Febrero-Bande & De La Fuente, 2012) The P-value based on the 1000 bootstrap resamples for number and proportion of authors are estimated 0.174 and 0.226 , respectively. Therefore, there is no statistical difference between these two regions. (Supplementary materials, Part C)

Table 2. - The Lotka’s Statistics.

Region	C	Beta	R ²	P-Value
ENEA	0.17	2.12	0.99	0.98
NCA	0.68	2.44	0.99	0.75
PACIFIC	0.70	2.35	0.98	0.40
SEA	0.69	2.43	0.97	0.40
SSWA	0.89	2.71	0.95	0.16
Arab States	0.58	2.37	0.93	0.40
All	0.75	2.22	0.99	0.75

3.3. *Bradford Law*

The core sources based on Bradford's law are estimated with bradford() function for all six regions: Neuroimage, Frontiers In Human Neuroscience, Scientific Reports, Frontiers In Neuroscience, Psychophysiology, Plos One, International Journal Of Psychophysiology, IEEE Transactions On Neural Systems And Rehabilitation Engineering, Neuropsychologia, Journal Of Neural Engineering, Brain Sciences, Biological Psychology, Frontiers In Psychology, Clinical Neurophysiology And Cerebral Cortex. The core sources for each region are presented separately in the Supplementary materials, Part D.

3.4. *The Most Global Cited Documents*

Table 3 presented the two most globally cited documents for each region group by all times and after 2020 based on SCOPUS database. Their total citation (TC) frequency and average per year are provided. Some authors have more than one affiliation from different countries or their affiliation is changed. Therefore, only the mentioned affiliation of the published papers is considered in Table 3.

Table 3. The Most Global Cited Documents Group by Region and Period based on SCOPUS.

Region	Period	Ref	TC	Article Title/Description
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		#	per Year		
ENEAA	All Time	(Bin et al., 2009)	558	34.88	Online Multi-Channel Steady-State Visual Evoked Potential (SSVEP)-based BCI with Canonical Correlation Analysis (CCA)
		(Norton et al., 2015)	270	27.00	Online Multi-View Transfer Takagi-Sugeno-Kang (TSK) fuzzy system for estimating EEG-Based Driver Drowsiness
	≥2020	(Jiang et al., 2020)	120	30.00	Soft, curved electrode systems capable of integration on the auricle for a persistent BCI
		(Jin et al., 2020)	85	17.00	Bispectrum based channel selection (BCS) method for motor imagery (MI)-based BCI
NCA	All Time	(G. Knyazev et al., 2009)	169	10.56	Synchronization Of Event-Related Delta and Theta In Explicit And Implicit Emotion Processing
		(Knyazev et al., 2011)	162	11.57	Relations between Heart–brain interactions and somatosensory perception and evoked potentials
	≥2020	(Al et al., 2020)	104	20.80	Independent Component Analysis (ICA) in default mode network and EEG alpha oscillations
		(Jin et al., 2020)	85	17.00	Bispectrum based channel selection (BCS) method for motor imagery (MI)-based BCI
PACIFIC	All Time	(Whitham et al., 2007)	343	19.06	Statistical Significance that EEG frequencies above 20 Hz are contaminated by electromyogram (EMG) in the presence and absence of complete neuromuscular blockade, sparing the dominant arm trial. Validation of the Emotiv EPOC® EEG Gaming System for Measuring Research Quality Auditory for Auditory Event-Related Potentials (ERPs)
		(Badcock et al., 2013)	229	19.08	
	≥2020	(Jiang et al., 2020)	120	30.00	Soft, curved electrode systems capable of integration on the auricle for a persistent BCI
		(Klug & Gramann, 2021)	80	20.00	The ICA method improves the quality of EEG mobile and stationary experiments
SEA					

	All Time	(Norton et al., 2015)	270	27.00	Online Multi-View Transfer Takagi-Sugeno-Kang (TSK) fuzzy system for estimating EEG-Based Driver Drowsiness
		(Islam et al., 2016)	219	24.33	A Review about Detection and Removal Artifacts in Scalp EEG
	≥2020	(Fahimi et al., 2020)	77	19.25	Deep Convolutional Generative Adversarial Networks (DCGANs) for Generating Artificial EEG in BCI
		(Jeong et al., 2020)	70	14.00	Decoding Movement-Related Cortical Potentials (MRCP) based Brain-Machine Interface (BMI)
	All Time	(Acar et al., 2011)	397	28.36	Scalable Tensor Factorizations, CANDECOMP/PARAFAC (CP), with Missing Data
		(Islam et al., 2016)	219	24.33	A Review about Detection and Removal Artifacts in Scalp EEG
SSWA		(Hosseini et al., 2020)	113	28.25	A review of Machine Learning Methods for EEG signal Processing
	≥2020	(Rossini et al., 2020)	106	21.20	A Review about Biomarkers (also EEG based) for Early diagnosis of Alzheimer’s disease based on the International Federation of Clinical Neurophysiology (IFCN)
Arab States	All Time	(Arnal et al., 2015)	177	17.70	EEG Delta–Beta Coupled Oscillations Underlie Temporal Prediction Accuracy
		(Alhanbali et al., 2019)	143	10.21	A Trial about Listening Effort with capturing EEG
	≥2020	(Čukić et al., 2020)	27	5.40	Using Higuchi's fractal dimension (HFD) and sample entropy (SampEn) methods to study the Biomarkers of major depressive disorder (MDD) with EEG.
		(Islam et al., 2020)	25	5.00	EEG mobility artifact removal for ambulatory epileptic seizure prediction applications
	All Six Regions	(Bin et al., 2009)	558	34.88	Online Multi-Channel Steady-State Visual Evoked Potential (SSVEP)-based BCI with Canonical Correlation Analysis (CCA)

	(Acar et al., 2011)	397	28.36	Scalable Tensor Factorizations, CANDECOMP/PARAFAC (CP), with Missing Data
≥2020	(Jiang et al., 2020)	120	30.00	Soft, curved electrode systems capable of integration on the auricle for a persistent BCI
	(Hosseini et al., 2020)	113	28.25	A review of Machine Learning Methods for EEG signal Processing

Abbreviations: TC (Total Citations).

Table 4 compares the top 10 articles with the highest number of globally total citations after 2022 between ESCAP and ESCWA regions in WOS database and all countries in the world in SCOPUS.

Table 4. The Most Global Cited Documents Group by Database and Region after 2022.

Database	Region	Ref	TC	Title/Description
WoS	ESCAP & ESCWA	(Wang, Wang, Hu, et al., 2022)*	49	Transformers for EEG-based emotion recognition: A hierarchical spatial information learning model
		(Li et al., 2021)*	38	A Temporal–Spatial Deep Learning Approach for Driver Distraction Detection Based on EEG Signals
		(Aslan & Akin, 2022)*	33	A deep learning approach in automated detection of schizophrenia using scalogram images of EEG signals
		(Hill et al., 2022)	33	Periodic and aperiodic neural activity displays age-dependent changes across early-to-middle childhood
		(Sadiq et al., 2020)	32	A Matrix Determinant Feature Extraction Approach for Decoding Motor and Mental Imagery EEG in Subject Specific Tasks
		(Zhou et al., 2021)	31	A Review about Cognitive Workload Recognition Using EEG Signals and Machine Learning.
		(Cho et al., 2021)	27	NeuroGrasp: Real-Time EEG Classification of High-Level Motor Imagery Tasks Using a Dual-Stage Deep Learning Framework
		(Guney et al., 2021)	26	A Deep Neural Network for SSVEP-based BCIs

		(Yu et al., 2022)	25	EEG-based emotion recognition in an immersive virtual reality environment: From local activity to brain network features
		(Wang, Wang, Zhang, et al., 2022)	25	Spatial-temporal feature fusion neural network for EEG-based emotion recognition
Scopus	All World	(Jung & Sejnowski, 2019)	89	Utilizing deep learning towards multi-modal bio-sensing and vision-based affective computing
		(Cecchetti et al., 2022)	58	Cognitive, EEG, and MRI features of COVID-19 survivors: a 10-month study
		(Wang, Wang, Hu, et al., 2022)*	57	Transformers for EEG-based emotion recognition: A hierarchical spatial information learning model
		(Amorim et al., 2023)	47	The international cardiac arrest research consortium electroencephalography database
		(Li et al., 2021)*	42	A Temporal-Spatial Deep Learning Approach for Driver Distraction Detection Based on EEG Signals
		(Aslan & Akin, 2022)*	42	A deep learning approach in automated detection of schizophrenia using scalogram images of EEG signals
		(Di Gregorio et al., 2022)	42	Tuning alpha rhythms to shape conscious visual perception
		(Attaheri et al., 2022)	42	Delta-and theta-band cortical tracking and phase-amplitude coupling to sung speech by infants
		(Apicella et al., 2022)	41	EEG-based measurement system for monitoring student engagement in learning 4.0
		(Krishna et al., 2023)	41	Glioblastoma remodelling of human neural circuits decreases survival

Abbreviations: TC (Total Citations), * indicate the three common articles in both databases.

3.5. The Co-Occurrence Network of WoS subject

The co-occurrence network of WoS subjects classification for all six regions is presented in Figure 1. (Supplementary materials, Part E provides a separate analysis for each region)

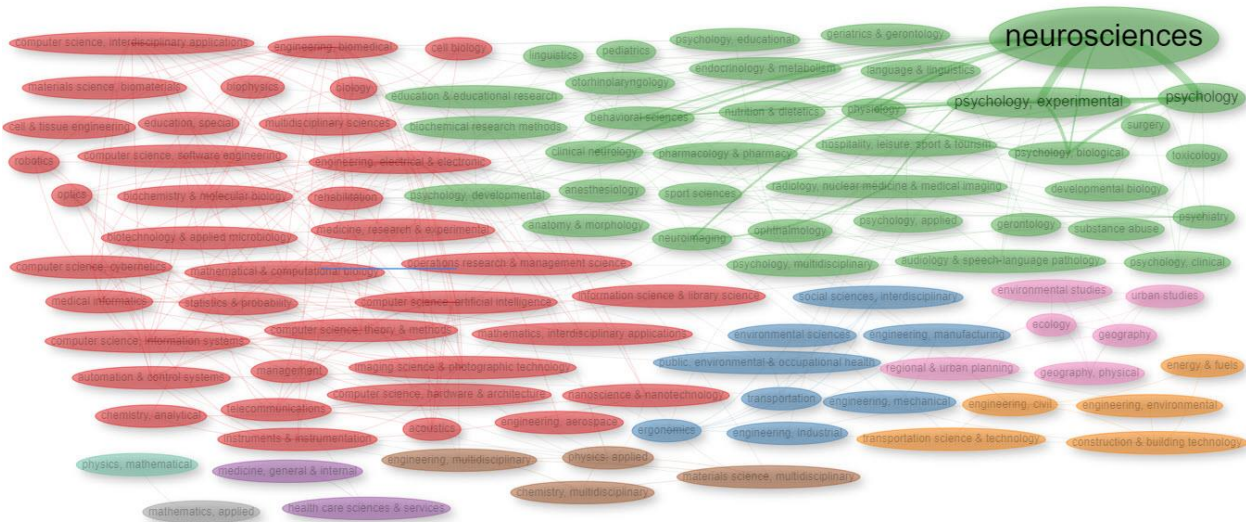


Figure 1. The co-occurrence network of WoS subject (9 clusters with different colors.).

3.6. The Co-Citation Network Papers

The co-citation network papers for all six regions are presented in Figure 2. The papers are : (Oldfield, 1971), (Makeig, 1993), (Bell & Sejnowski, 1995), (Benjamini & Hochberg, 1995), (Makeig & Jung, 1996), (Brainard & Vision, 1997), (Pfurtscheller & Da Silva, 1999), (Klimesch, 1999), (Lachaux et al., 1999), (Jung et al., 2000), (Pascual-Marqui, 2002), (Wolpaw et al., 2002), (Polich, 2007), (Maris & Oostenveld, 2007), (Faul et al., 2007), (Klimesch et al., 2007), (Rubinov & Sporns, 2010), (Tadel et al., 2011), (Mognon et al., 2011), (Oostenveld et al., 2011), (Klimesch, 2012), (Lopez-Calderon & Luck, 2014), (Luck, 2014) and (Pion-Tonachini et al., 2019). (Supplementary materials, Part F provides a separate analysis for each region)

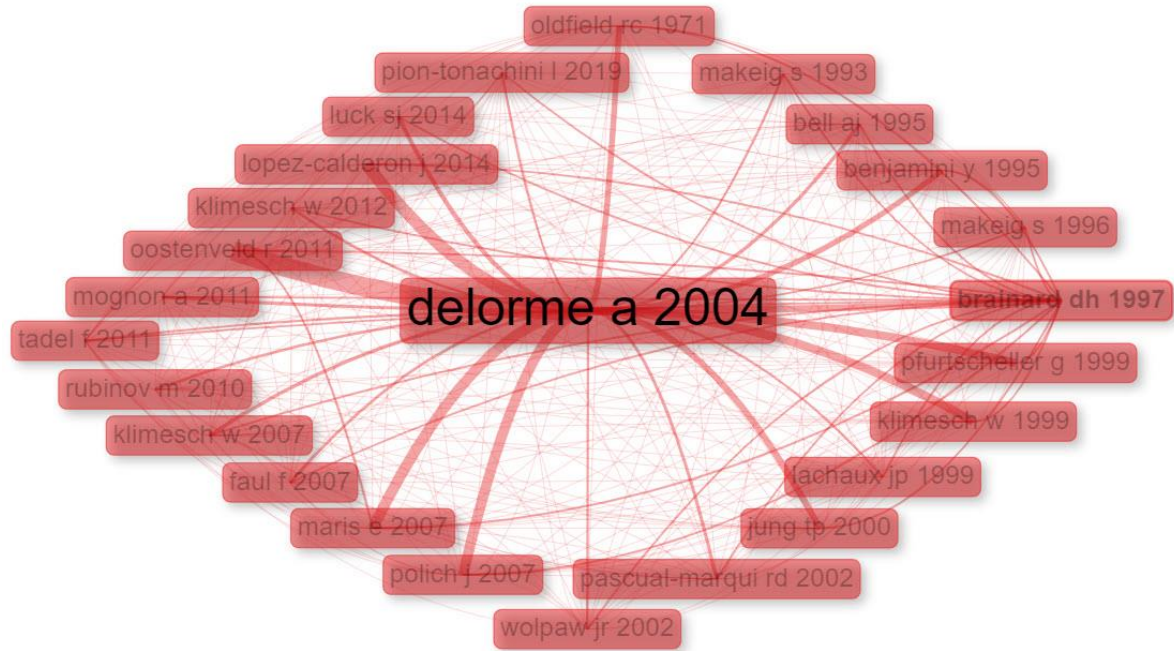


Figure 2. The co- citation network papers in Six Regions.

3.7. The Historiography

The historiography (historical co-citation network) are produced with `histNetwork()` and `histPlot()`. It has *node* (document cited by other documents) and the *edge* (direct citation) with the first author name and publishing year. (Ciavolino et al., 2022) The plots are presented in a layout with 6 plots for each subregions and one plot for all six subregions together in Figure 3.

In the ENEA subregion, there exists two clusters: The first one starts at 2010 “A novel approach for enhancing the signal-to-noise ratio and detecting automatically event-related potentials (ERPs) in single trials” (Hu et al., 2010) and at 2012 “Gamma-band oscillations in the primary somatosensory cortex—a direct and obligatory correlate of subjective pain intensity” (Zhang et al., 2012) and continues to the 2014 article “Single-trial time–frequency analysis of electrocortical signals: Baseline correction and beyond” (Li Hu et al., 2014) and it ended at 2019 article “Neural indicators of perceptual variability of pain across species” (Hu & Iannetti, 2019). The second cluster has two articles in 2017: “Temporal dynamics of reward anticipation in the human brain” (Zhang et al., 2017) and “Reward processing in gain versus loss context: An ERP study.” (Zheng et al., 2017)

In the NCA region, there is one cluster: it starts with a 2008 article “Anxiety and oscillatory responses to emotional facial expressions” (Knyazev, Bocharov, et al., 2008) and 2011 article “The default mode network and EEG alpha oscillations: an independent component analysis” (Knyazev et al., 2011) and ended at 2016 article “Anxiety, depression, and oscillatory dynamics in a social interaction model” (Knyazev et al., 2016).

In the PACIFIC region, there exists two clusters: In the first cluster, the 2008 article “Long-interval cortical inhibition from the dorsolateral prefrontal cortex: a TMS–EEG study” (Daskalakis et al., 2008) and 2009 article “Suppression of γ -oscillations in the dorsolateral prefrontal cortex following long interval cortical inhibition: a TMS–EEG study” (Farzan et al., 2009) are main references, in the middle there are two articles, the 2014 article “Removing artefacts from TMS-EEG recordings using independent component analysis: importance for assessing prefrontal and motor cortex network properties” (Rogasch et al., 2014) and the 2015 article “Cortical inhibition of distinct mechanisms in the dorsolateral prefrontal cortex is related to working memory performance: A TMS–EEG study” (Rogasch et al., 2015) and it ended with 2019 article “Characterizing and minimizing the contribution of sensory inputs to TMS-evoked potentials” (Biabani et al., 2019) and 2020 article “Source-based artifact-rejection techniques available in TESA, an open-source TMS–EEG toolbox” (Mutanen et al., 2020). In the second cluster: there exists two articles about Emotiv EPOC (Badcock et al., 2013; Badcock et al., 2015).

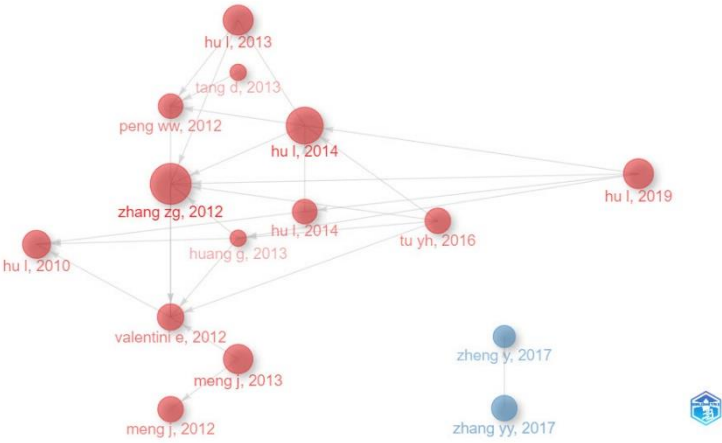
In the SEA region, there exists three clusters, The first cluster started at 2014 article “Hybrid fNIRS-EEG based classification of auditory and visual perception processes” (Putze et al., 2014). The second cluster started at 2014 articles “Discriminative analysis of brain functional connectivity patterns for mental fatigue classification” (Sun, Lim, Meng, et al., 2014) and “Functional cortical connectivity analysis of mental fatigue unmasks hemispheric asymmetry and changes in small-world networks” (Sun, Lim, Kwok, et al., 2014), in the middle is the 2018 article “Functional connectivity analysis of mental fatigue reveals different network topological alterations between driving and vigilance tasks” (Dimitrakopoulos et al., 2018) and it ended with 2020 article “Dynamic reorganization of functional connectivity unmasks fatigue related performance declines in simulated driving” (Wang et al., 2020). The third cluster start with 2017 article “Dynamic functional segregation and integration in human brain network during complex tasks” (Ren et al., 2016) and it ended with 2020 article “Towards machine to brain interfaces: sensory stimulation enhances sensorimotor dynamic functional connectivity in upper limb amputees.” (Ding et al., 2020).

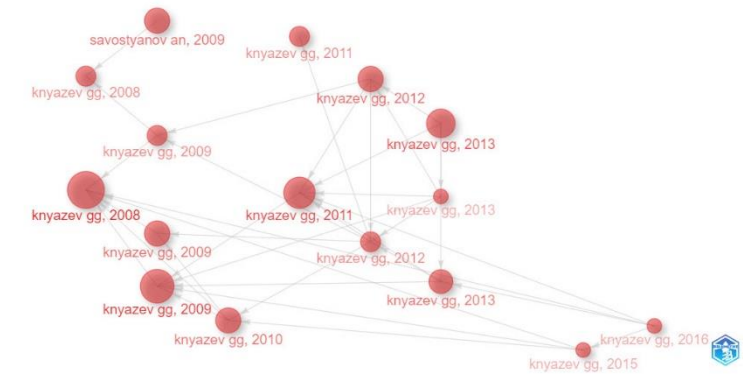
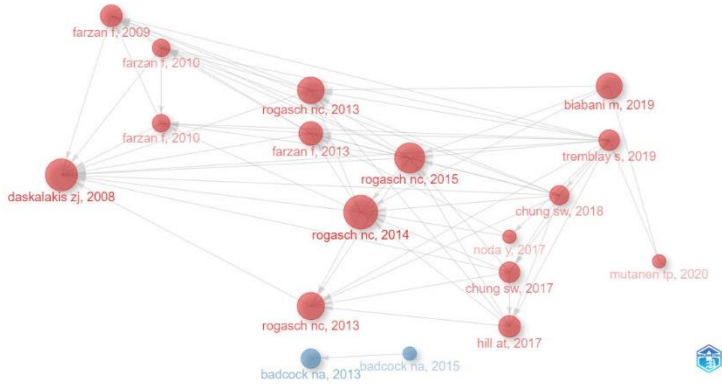
In the SSWA region, there exists six clusters. The first cluster started with the 2013 article “Sensitive periods for the functional specialization of the neural system for human face processing” (Röder et al., 2013) and ended with two 2018 articles “Evidence of a retinotopic organization of early visual cortex but impaired extrastriate processing in sight recovery individuals” and “Motion processing after sight restoration: No competition between visual recovery and auditory compensation” (Bottari et al., 2018; Sourav et al., 2018). In the second cluster, the 2015 article “Minimum connected component—a novel approach to detection of cognitive load induced changes

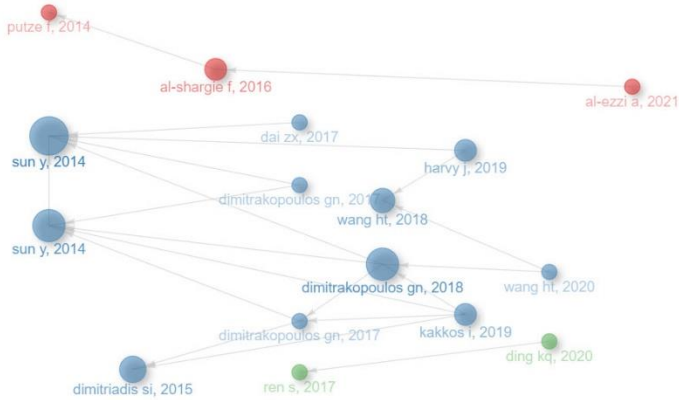
in functional brain networks” (Vijayalakshmi et al., 2015) exit. The third cluster is the cluster of Bahar Güntekin articles with some reviews (Gülmen Yener et al., 2013; Güntekin & Başar, 2014, 2016; Güntekin et al., 2019). The fourth cluster is Hamid Karimi-Rouzbahani articles(Karimi-Rouzbahani et al., 2017a, 2017b). The fifth cluster has two articles about automated detection of schizophrenia with EEG(Jahmunah et al., 2019; Shalbaf et al., 2020). The sixth cluster is Fatemeh Hasanzadeh articles (Hasanzadeh et al., 2019, 2020).

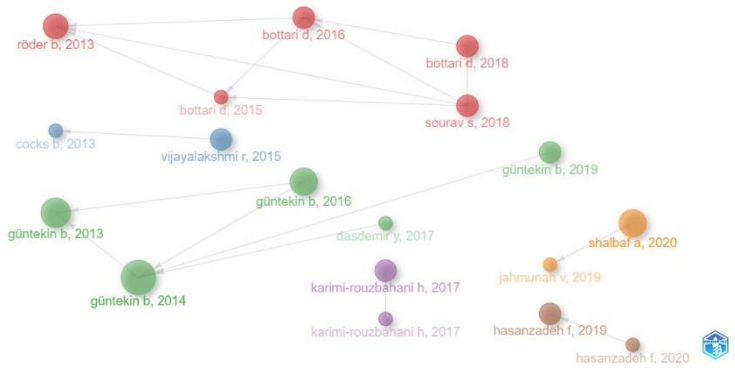
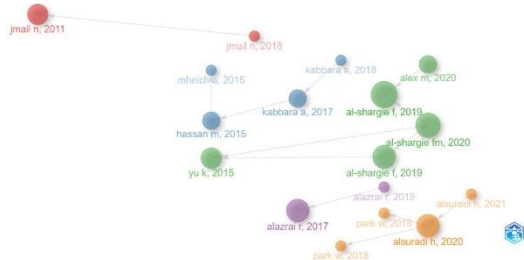
In the Arab states, there exits five clusters. In the first cluster there exited an 2011 article “A comparison of methods for separation of transient and oscillatory signals in EEG” (Jmail et al., 2011). In the second cluster a 2015 article, “EEGNET: An open source tool for analyzing and visualizing M/EEG connectome” (Hassan et al., 2015) exited. In the third cluster, Fares Al-Shargie articles exited (Al-Shargie et al., 2019; Alex et al., 2020; Yahya et al., 2019). In the fourth cluster, the 2017 article “Eeg-based brain-computer interface for decoding motor imagery tasks within the same hand using choi-williams time-frequency distribution” existed (Alazrai et al., 2017). The fifth cluster for 2020 article “Eeg-based neurohaptics research: A literature review” (Alsuradi et al., 2020) existed.

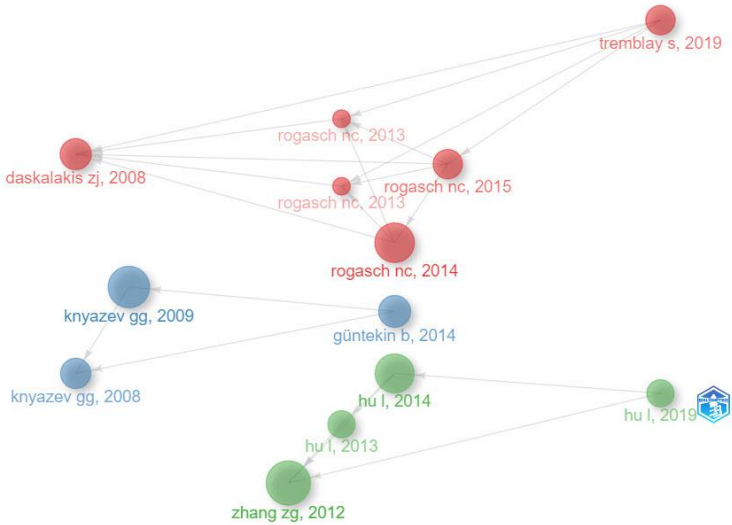
In these six regions overall, there exits three clusters. In the first cluster it started with a 2008 article “Long-interval cortical inhibition from the dorsolateral prefrontal cortex: a TMS–EEG study” (Daskalakis et al., 2008) and it reached 2014 article “Removing artefacts from TMS-EEG recordings using independent component analysis: importance for assessing prefrontal and motor cortex network properties” (Rogasch et al., 2014) and finally it reached the 2019 article “Clinical utility and prospective of TMS–EEG” (Tremblay et al., 2019). The second cluster have two articles from Gennady G Knyazev (G. Knyazev et al., 2009; Knyazev, Bocharov, et al., 2008) and an article from Bahar Güntekin (Güntekin & Başar, 2014). The third cluster contains 4 articles. It started with 2012 article “Gamma-band oscillations in the primary somatosensory cortex—a direct and obligatory correlate of subjective pain intensity” (Zhang et al., 2012) and three articles from Li Hu (Hu & Iannetti, 2019; Hu et al., 2013; Li Hu et al., 2014).

Subregion	Clusters
(a) ENEA	 Cluster 1 (Red): [2010: (Hu et al., 2010)], [2012: (Meng et al., 2012), (Zhang et al., 2012), (Peng et al., 2012), (Valentini et al., 2012)], [2013: (Huang et al., 2013), (Tang et al., 2013), (Meng et al., 2013), (Hu et al., 2013)], [2014: (L Hu et al., 2014), (Li Hu et al., 2014)], [2016: (Tu et al., 2016)], [2019: (Hu & Iannetti, 2019)] Cluster 2 (Blue): [2017: (Zhang et al., 2017), (Zheng et al., 2017)]
(b) NCA	

	[2008:(Knyazev, Bocharov, et al., 2008), (Knyazev, Levin, et al., 2008)], [2009: (G. Knyazev et al., 2009), (G. G. Knyazev et al., 2009), (Knyazev, 2009), (Savostyanov et al., 2009)], [2010: (Knyazev et al., 2010)], [2011: (Knyazev et al., 2011), (Knyazev, 2011)], [2012: (Knyazev, Savostyanov, et al., 2012),(Knyazev, Bocharov, et al., 2012)], [2013: (Knyazev, 2013a),(Knyazev, 2013b),(Knyazev et al., 2013)], [2015: (Knyazev et al., 2015)], [2016: (Knyazev et al., 2016)]
(c) PACIFIC	
	Cluster 1 (Red): [2008:(Daskalakis et al., 2008)], [2009:(Farzan et al., 2009)], [2010:(Farzan et al., 2010b), (Farzan et al., 2010a)] , [2013:(Farzan et al., 2013),(Rogasch et al., 2013),(Rogasch & Fitzgerald, 2013)] , [2014:(Rogasch et al., 2014)] , [2015:(Rogasch et al., 2015)] , [2017:(Chung et al., 2017), (Hill et al., 2017),(Noda et al., 2017)] , [2018:(Chung et al., 2018)] , [2019:(Biabani et al., 2019), (Tremblay et al., 2019)] ,

	[2020:(Mutanen et al., 2020)] Cluster 2 (Blue): [2013:(Badcock et al., 2013)] , [2015:(Badcock et al., 2015)]
(d) SEA	
	Cluster 1 (Red): [2014:(Putze et al., 2014)], [2018:(Al-Shargie et al., 2016)], [2021:(Al-Ezzi et al., 2021)] Cluster 2 (Blue): [2014:(Sun, Lim, Meng, et al., 2014), (Sun, Lim, Kwok, et al., 2014)], [2015:(Dimitriadis et al., 2015)], [2017:(Dimitrakopoulos, Kakkos, Dai, et al., 2017), (Dai et al., 2017), (Dimitrakopoulos, Kakkos, Vrahatis, et al., 2017)] , [2018:(Wang et al., 2018), (Dimitrakopoulos et al., 2018)], [2019:(Kakkos et al., 2019),(Harvy et al., 2019)] , [2020:(Wang et al., 2020)] Cluster 3 (Green):[2017:(Ren et al., 2016)], [2020:(Ding et al., 2020)]
(e) SSWA	

	Cluster 1 (Red): [2013:(Röder et al., 2013)], [2015: (Bottari et al., 2015)], [2016:(Bottari et al., 2016)], [2018:(Bottari et al., 2018; Sourav et al., 2018)] Cluster 2 (Blue): [2013: (Bernadine et al., 2013)], [2015:(Vijayalakshmi et al., 2015)] Cluster 3 (Green): [2013:(Gülmen Yener et al., 2013)], [2014:(Güntekin & Başar, 2014)], [2016:(Güntekin & Başar, 2016)], [2017: (Dasdemir et al., 2017)], [2019: (Güntekin et al., 2019)] Cluster 4 (Purple): [2017:(Karimi-Rouzbahani et al., 2017a, 2017b)] Cluster 5 (Gold): [2019:(Jahmunah et al., 2019)], [2020: (Shalbaf et al., 2020)] Cluster 6 (Brown): [2019:(Hasanzadeh et al., 2019)], [2020:(Hasanzadeh et al., 2020)]
(f) Arab Sates	
	Cluster 1 (Red): [2011:(Jmail et al., 2011)], [2016:(Jmail et al., 2016)] Cluster 2 (Blue): [2015:(Hassan et al., 2015),(Mheich et al., 2015)], [2017:(Kabbara et

	al., 2017)], [2018:(Kabbara et al., 2018)] Cluster 3 (Green): [2015:(Yu et al., 2015)], [2019:(Yahya et al., 2019),(Al-Shargie et al., 2019)], [2020: (Alex et al., 2020), (Yahya et al., 2020)] Cluster 4 (Purple): [2017:(Alazrai et al., 2017)], [2019: (Alazrai et al., 2019)] Cluster 5 (Gold): [2018:(Park et al., 2018)], [2019:(Park et al., 2019)], [2020:(Alsuradi et al., 2020)], [2021:(Alsuradi et al., 2021)]
(g) All six subregions together	
	Cluster 1 (Red): [2008:(Daskalakis et al., 2008)] , [2013:(Rogasch et al., 2013), (Rogasch & Fitzgerald, 2013)] , [2014: (Rogasch et al., 2014)], [2015:(Rogasch et al., 2015)] , [2019:(Tremblay et al., 2019)] Cluster 2 (Blue): [2008:(Knyazev, Bocharov, et al., 2008)] , [2009:(G. Knyazev et al., 2009)] , [2014:(Güntekin & Başar, 2014)] Cluster 3 (Green): [2012:(Zhang et al., 2012)], [2013:(Hu et al.,

	2013)], [2014:(Li Hu et al., 2014)], [2019:(Hu & Iannetti, 2019)]
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Figure 3: The historiography (historical co-citation network) plots, (a) ENEA, (b) NCA, (c) PACIFIC, (d) SEA, (e) SSWA, (f) Arab Sates and (g) All six subregions together.

3.8. The Further Analysis

The further analysis grouped by subregions such as : Collaboration Network Between Institute, Country Collaboration Network, Authors Production Over Time and Keyword Plus Trend Topic are in the Supplementary materials in Part G, H, I and J, respectively.

4. Discussion (359 words)

In the year of the 20th anniversary of EEGLAB (2004 through 2023), EEGLAB Newsletter issue 17 in February 2024 (Newsletter, 2024) and a bibliometric analysis of all 12,700 WoS citations of EEGLAB software until 8/27/2023 studied this software. (Fayaz, 2023) This new updated analysis with all 15,827 Scopus and WOS instead of only WOS citations of EEGLAB until 03/28/2024 showed that they were published in 2,072 sources, written by 33,070 authors, cited 763,160 references, and presented 21,384 keywords. And the annual growth rate is 18.63% and the international co-authorship is 34.8%.

In addition, the comparison between all citations of all World and ESCAP and ESCWA regions together showed that (Fayaz, 2023), about 35% of all WoS documents and 41% of authors came from these two regions while the average citation per doc in the world is doubled these two regions. Educational programs such as organizing conferences and training workshops, and supporting researchers in these regions (subregions) can be the basis for faster development and better quality of research. For example, A Virtual EEGLAB Workshop Pacific/Asia in 2021 was held with the hosting of Professor Tzyy-Ping Jung (鍾子平) from the Swartz Center for Computational Neuroscience, University of California San Diego, La Jolla, CA, USA and Department of Computer Science, National Yang Ming Chiao Tung University, Hsinchu, Taiwan and Professor Makoto Miyakoshi (宮腰誠) from Division of Child and Adolescent Psychiatry, Cincinnati Children’s Hospital Medical Center, Cincinnati, Ohio and Department of Psychiatry, University of Cincinnati College of Medicine, Cincinnati, Ohio (2021 Virtual EEGLAB Workshop Pacific/Asia, 2021)

One of the main direction for future research is bibliometric analysis of some specific topics in these regions and its relations with EEGLAB and EEG such as Traditional Chinese Medicine like Herbs and Acupuncture (Lim et al., 2021; Zhao et al., 2022) Islamic health-related topics (Kannan et al., 2022), and Yoga and meditation (Gaur et al., 2020). The main limitation of this research is that it only considers the papers that cited the EEGLAB main paper, therefore many more articles are not considered and other databases such as DOAJ indexed-only or articles with other languages are not provided.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

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