

Alterations in EEG connectivity in healthy young adults provide an indicator of sleep depth

Carolina Migliorelli, Alejandro Bachiller, Andreia G Andrade, Joan F Alonso, Miguel A Mañanas, Cristina Borja, Sandra Giménez, Rosa M Antonijoan, Andrew W Varga, Ricardo S Osorio ... [Show more](#)

Sleep, Volume 42, Issue 6, June 2019, zsz081, <https://doi.org/10.1093/sleep/zsz081>

Published: 04 April 2019 **Article history** ▼

Views ▼ Cite Permissions Share ▼

Abstract

Current sleep analyses have used electroencephalography (EEG) to establish sleep intensity through linear and nonlinear measures. Slow wave activity (SWA) and entropy are the most commonly used markers of sleep depth. The purpose of this study is to evaluate changes in brain EEG connectivity during sleep in healthy subjects and compare them with SWA and entropy. Four different connectivity metrics: coherence (MSC), synchronization likelihood (SL), cross mutual information function (CMIF), and phase locking value (PLV), were computed focusing on their correlation with sleep depth. These measures provide different information and perspectives about functional connectivity. All connectivity measures revealed to have functional changes between the different sleep stages. The averaged CMIF seemed to be a more robust connectivity metric to measure sleep depth (correlations of 0.78 and 0.84 with SWA and entropy, respectively), translating greater linear and nonlinear interdependences between brain regions especially during slow wave sleep. Potential changes of brain connectivity were also assessed throughout the night. Connectivity measures indicated a reduction of functional connectivity in N2 as sleep progresses. The validation of connectivity indexes is necessary because they can reveal the interaction between different brain regions in physiological and pathological conditions and help understand the different functions of deep sleep in humans.

[electroencephalography](#), [slow wave activity](#), [entropy](#), [functional connectivity](#)

© Sleep Research Society 2019. Published by Oxford University Press on behalf of the Sleep Research Society. All rights reserved. For permissions, please email: journals.permissions@oup.com

This article is published and distributed under the terms of the Oxford University Press, Standard Journals Publication Model (https://academic.oup.com/journals/pages/open_access/funder_policies/chorus/standard_publication_model)

Topic:

[electroencephalography](#)

[entropy](#)

[sleep stages](#)

[brain](#)

[sleep](#)

You do not currently have access to this article.

Sign in

Don't already have an Oxford Academic account? [Register](#)

Oxford Academic account

Email address / Username [?](#)

Password

[Sign In](#)

[Forgot password?](#)

[Don't have an account?](#)

Sleep Research Society members



[Sign in via society site](#)

American Academy of Sleep Medicine members



[Sign in via society site](#)

Sign in via your Institution

[Sign in](#)

Purchase

[Subscription prices and ordering](#)

Short-term Access

To purchase short term access, please sign in to your Oxford Academic account above.

Don't already have an Oxford Academic account? [Register](#)

Alterations in EEG connectivity in healthy young adults provide an indicator of sleep depth - 24 Hours access

EUR €36.00

GBP £28.00

USD \$45.00

Rental



This article is also available for rental through DeepDyve.

[View Metrics](#)

Email alerts

[New issue alert](#)

[Advance article alerts](#)

[Article activity alert](#)

[Subject alert](#)

[Receive exclusive offers and updates from Oxford Academic](#)

More on this topic

Sensory Stimulation Triggers Spindles During Sleep Stage 2

Relationship Between Cerebral Blood Flow Velocities and Cerebral Electrical Activity in Sleep

Functional determinants of enhanced and depressed interareal information flow in nonrapid eye movement sleep between neuronal ensembles in rat cortex and hippocampus

Influence of Hypoxia and Hypercapnia on Sleep State-Dependent Heart Rate Variability Behavior in Newborn Lambs

Related articles in

Google Scholar

Related articles in PubMed

[Analysis of sleep structure and related factors in children with severe obstructive sleep apnea-hypopnea syndrome].

Citing articles via

Google Scholar

CrossRef

Latest | Most Read | Most Cited

Characterization of the sleep disorder of anti-IgG disease

Actigraphic detection of periodic limb movements: development and validation of a potential device-independent algorithm. A proof of concept study

Simultaneous tonic and phasic REM sleep without atonia best predicts early phenotypic conversion to neurodegenerative disease in idiopathic REM sleep behavior disorder

Residual symptoms after natural remission of insomnia: associations with relapse over 4 years

Sleep duration and fragmentation in relation to leukocyte DNA methylation in adolescents

Looking for your next opportunity?

Chair of Pain Research
Boston, Massachusetts

PEDIATRIC EMERGENCY PHYSICIAN
Saskatoon Shines, Saskatchewan

Endowed Chair of Occupational
Health/Medicine
Saint John, New Brunswick

CHIEF OF THE DIVISION OF ALLERGY,
IMMUNOLOGY AND INFECTIOUS
DISEASE
New Brunswick, New Jersey

View all jobs

OXFORD
UNIVERSITY PRESS

[About SLEEP](#)

[Editorial Board](#)

[Author Guidelines](#)

[Facebook](#)

[Twitter](#)

[Contact Us](#)

[Purchase](#)

[Recommend to your Library](#)

[Advertising and Corporate Services](#)

[Journals Career Network](#)

Online ISSN 1550-9109

Print ISSN 0161-8105

Copyright © 2019 Sleep Research Society

[About Us](#)

[Contact Us](#)

[Careers](#)

[Help](#)

[Access & Purchase](#)

[Rights & Permissions](#)

[Open Access](#)

Connect

[Join Our Mailing List](#)

[OUPblog](#)

[Twitter](#)

[Facebook](#)

[YouTube](#)

[Tumblr](#)

Resources

[Authors](#)

[Librarians](#)

[Societies](#)

[Sponsors & Advertisers](#)

[Press & Media](#)

[Agents](#)

Explore

[Shop OUP Academic](#)

[Oxford Dictionaries](#)

[Oxford Index](#)

[Epigeum](#)

[OUP Worldwide](#)

[University of Oxford](#)

Oxford University Press is a department of the University of Oxford. It furthers the University's objective of excellence in research, scholarship, and education by publishing worldwide

Copyright © 2019 Oxford University Press

[Accessibility](#)

[Get Adobe Reader](#)

[Cookie Policy](#)

[Privacy Policy](#)

[Legal Notice](#)

[Site Map](#)