frontiers

A neural coarse graining theory of consciousness

Acer Y.C. Chang [1,*], **Co-Author** [2] **and Ryota Kanai** [1]

ARAYA, Inc., Tokyo, Japan

Correspondence*:
Corresponding Author
acercyc@araya.org

ABSTRACT

Neural systems process information through different levels of organisation in a hierarchical manner. Information at lower levels is finer-grained and can be coarse-grained for higher level computation. However, one is aware of information processed only at specific levels. Theorists have addressed this issue. For example, the intermediate level theory of consciousness suggests that the intermediate level seems to be privileged with respect to consciousness. It is true that we do not experience information processed by individual neurons which is always highly noisy. Besides, we have no conscious experience from interpersonal activities albeit massive interactions among individuals. Instead, neurophysiological evidence has been showing that conscious experience tends to covary with information encoded in coarse-grained neural states such as neural population codes. We hypothesise that, through coarse-graining, neural systems construct a non-trivial information closure representation which represents deterministic dynamics of external environments. Information closure characterises that future states of a system can be deterministically predicted by its past states without information outside the system. Therefore, coarse-grained information encoded within the representation is sufficient to deterministically determine its future states without accessing fine-grained information processed at lower levels. There are significant advantages to construct the information closure representation in neural systems including increasing robustness against noise within fine-grained information processing, providing reliable information for future prediction, and alleviating computational cost for computing sensory data. We argue that the neural states within the scope of the information closure determine the contents of consciousness and brain processes outside apart from the representations of that level remain unconscious. This argument suggests a distinction between conscious and unconscious processing and provides a generic computational framework. Finally, using the deep learning network, we can measure information closure in deep hidden layers. Our preliminary results show that information closure representation emerged after learning. We further decoded the information from the representation and compared it with human conscious perception.

Keywords: theory of Consciousness, information closure, neural coarse-graining, level of analysis, keyword, keyword, keyword, keyword

1 INTRODUCTION

2 INFORMATION CLOSURE

3 MATHEMATICAL DEFINITION

4 NEURAL COARSE-GRAINING

5 RELATIONS TO CONSCIOUS PERCEPTION PHENOMENA

6 COMPARISON WITH OTHER THEORIES

7 CONCLUSION

7.1 Equations

Equations should be inserted in editable format from the equation editor.

$$\sum x + y = Z \tag{1}$$

7.2 Figures

Frontiers requires figures to be submitted individually, in the same order as they are referred to in the manuscript. Figures will then be automatically embedded at the bottom of the submitted manuscript. Kindly ensure that each table and figure is mentioned in the text and in numerical order. Figures must be of sufficient resolution for publication see here for examples and minimum requirements. Figures which are not according to the guidelines will cause substantial delay during the production process. Please see here for full figure guidelines. Cite figures with subfigures as figure 2B.

7.2.1 Permission to reuse and Copyright

Permission must be obtained for use of copyrighted material from other sources (including the web). Please note that it is compulsory to follow figure instructions.

7.3 Tables

Tables should be inserted at the end of the manuscript. Please build your table directly in LaTeX.Tables provided as jpeg/tiff files will not be accepted. Please note that very large tables (covering several pages) cannot be included in the final PDF for reasons of space. These tables will be published as Supplementary Material on the online article page at the time of acceptance. The author will be notified during the typesetting of the final article if this is the case.

8 NOMENCLATURE

8.1 Resource Identification Initiative

To take part in the Resource Identification Initiative, please use the corresponding catalog number and RRID in your current manuscript. For more information about the project and for steps on how to search for an RRID, please click here.

8.2 Life Science Identifiers

Life Science Identifiers (LSIDs) for ZOOBANK registered names or nomenclatural acts should be listed in the manuscript before the keywords. For more information on LSIDs please see Inclusion of Zoological Nomenclature section of the guidelines.

9 ADDITIONAL REQUIREMENTS

For additional requirements for specific article types and further information please refer to Author Guidelines.

CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

The Author Contributions section is mandatory for all articles, including articles by sole authors. If an appropriate statement is not provided on submission, a standard one will be inserted during the production process. The Author Contributions statement must describe the contributions of individual authors referred to by their initials and, in doing so, all authors agree to be accountable for the content of the work. Please see here for full authorship criteria.

FUNDING

Details of all funding sources should be provided, including grant numbers if applicable. Please ensure to add all necessary funding information, as after publication this is no longer possible.

ACKNOWLEDGEMENTS

This is a short text to acknowledge the contributions of specific colleagues, institutions, or agencies that aided the efforts of the authors.

SUPPLEMENTAL DATA

Supplementary Material should be uploaded separately on submission, if there are Supplementary Figures, please include the caption in the same file as the figure. LaTeX Supplementary Material templates can be found in the Frontiers LaTeX folder.

DATA AVAILABILITY STATEMENT

The datasets [GENERATED/ANALYZED] for this study can be found in the [NAME OF REPOSITORY] [LINK].

REFERENCES

FIGURE CAPTIONS

Figure 1. Enter the caption for your figure here. Repeat as necessary for each of your figures

A

B

Figure 2. This is a figure with sub figures, **(A)** is one logo, **(B)** is a different logo.