

Review of: “Towards an Ecology of the Brain:
Reassessing the Dominant as a Paradigm of
Organismic and Anthropological Physiology”
a PhD thesis written by Andres Kurismaa.

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1 Context for thesis review

To begin with, it would be useful to disclose my background and training in relation to the thesis that has been offered for review. The thesis has been generated in the Department of Philosophy and History of Science, Theoretical and Evolutionary Biology from the Faculty of Science, Charles University in Prague, and I am a clinician, neuroscientist and translational researcher located within the School of Biological Sciences at Victoria University of Wellington and in the Nelson Marlborough District Health Board, Paediatrics Department in New Zealand. Thus, it is important to note the apparent divide between these places, disciplines and their practical orientations.

Having declared that, however, there are several matters on which my knowledge and training are pertinent for evaluating the current thesis. My academic background is in neurobiology, behavioural sciences and clinical research so I am familiar with the theories and perspectives of figures such as Sechenov, Pavlov, Bekhterev, Ukhtomsky, Anokhin, Bernstein, Luria, Vygotsky, Leontiev, von Weizsäcker, Maturana, Varela, Rosen and other scholars referenced in this thesis. In regard to the theory of dominant by Ukhtomsky, I am fully aware of its crucial influence in the works of Vygotsky, Anokhin, Bernstein, Luria and Bakhtin. Indeed, all these authors have profoundly shaped my current theoretical and clinical thinking. I am also reasonably knowledgeable about the theories, methods and tools developed within the evo-devo complexity approach in neuroscience. Besides I do work in neurodevelopmental child psychopathology. In general, I have a major research interest in translational science, and in the use of the complexity sciences toolbox in translational research. I am especially interested in the application of multiscale fractal measures and machine learning techniques to identify markers for the early diagnosis of neurodevelopmental disorders (diagnostic accuracy studies). Moreover, I am a current member of the Advisory Board of the “Handbook of Anticipation” (2019) from The UNESCO Chair in Anticipatory Systems. Summing up, I am familiar with some of the topics discussed in this thesis, but I wish to acknowledge that my perspectives are rooted in different backgrounds.

2 Structure of the thesis

The thesis is constructed from an unpublished introduction and a series of published articles as inter-related case studies aimed to reexamine, from a modern perspective, the study of the dominant by the Russian physiologist A. A. Ukhtomsky. So I take this set of articles to ponder over the work of the PhD candidate.

The first article was published as Kurismaa, A. (2015). Perspectives on Time and Anticipation in the Theory of Dominance. In: *Anticipation: Learning from the Past* (pp. 37-57). Springer, Cham. I am familiar with the quality of the papers contained in the *Cognitive Systems Monographs* from Springer. To my knowledge, this article went through a rigorous and thorough review process, validating the quality of this scholar output. So I do not have difficulty judging the extent of the review and revision process that the candidate experienced to achieve this publication.

The second article is a co-authored paper published in a monograph volume from the *Annals of Theoretical Psychology* as Kurismaa, A., & Pavlova, L. P. (2016). The dominant as a model of chronogenic change: The relevance of A. A Ukhtomsky's and L S Vygotsky's traditions for systemic cognitive studies. In: *Centrality of History for Theory Construction in Psychology* (pp. 125-149). Springer, Cham. I am also familiar with this series of monograph and I assume the work of the candidate went to a similar process of review validating this particular outcome.

The last article was also published as a co-authored paper, i.e., Pavlova, L. P., Berlov, D. N., & Kurismaa, A. (2018). Dominant and opponent relations in cortical function: An EEG study of exam performance and stress. *AIMS Neuroscience*, 5(1): 32-55. As far as I know, this is an open access publication with a peer review process in place, but I do not know the details of it and I have no further comments to make in this regard.

2.1 Introduction

This is a very well written introduction that advance and parsimoniously summarises the whole content of the thesis. I read all the papers that form the body of the thesis at the time of their original publication. Now after a second reading, I acknowledge that adding this introduction greatly improves their intelligibility but also reveals new intriguing problems. Because of this, I will suggest the candidate seriously thinks about building on this piece of work to produce a new paper on the subject.

The candidate's research is topical and timely as the search for non-reductionist theories that can bridge the physiological, psychological and sociological dimensions of behaviour and cognition has become an important research concern. In

this context, the comprehensive assessment of Ukhtomsky's theory of dominant is a piece of work long waited by Westerns scholars. I share with alacrity the candidate's view that the exploration of the dominant framework could inspire new integrative research and eventually create an alternative road-map in neurosciences.

Notwithstanding that the dominant framework is presented by the candidate as an integrative and organismic paradigm for neuroscientific research and that he pointed to its "potentially wide implications for human neuroscience in particular, as a socially and culturally (anthropologically) oriented discipline", he does not review the important influence of Ukhtomsky concept of chronotope (which is closely associated to the notion of dominant) in the work of Bakhtin. I acknowledge that this particular task brings neuroscience to the boundaries with humanities, but following the integrative spirit of Ukhtomsky's theory, this relation needs to be explored and the link between these two scholars kept open to future research. The enquiry into the connections between dominant chronotopes, action, cognition and anticipation seems to be a promising line of research that could contribute in the directions anticipated by the candidate.

2.2 Study 1

This study focuses on the problem of anticipation in Ukhtomsky's theory of dominance and the works of his neurophysiological school, vis-à-vis recent developments in related fields, i.e., anticipation, neuronal homeostasis, and the interaction of graded and field effects with spike structured neural activity. In this chapter, the candidate engages mainly in a conceptual and theoretical discussion of the notion of dominant. He does a good job exposing and discussing the importance of the temporal variability (temporal dynamics) as a functional factor in the Wedensky-Ukhtomsky School. I agree with the candidate that the decision to focus on the temporal dynamics of phenomena was a visionary move made by Ukhtomsky which anticipated cybernetics and synergetics for many years.

Regarding the concepts of lability and parabiosis, both are clearly exposed and contextualised in the framework of dominance. I found particularly insightful the selection of quotes made by the candidate to illustrate the main points in this section. From a psychopathology vantage point, and stimulated by the material presented here, I would like to ask the candidate if he sees any relation between these ideas and Luria's concept of "the general dynamic of the nervous processes" (strength, balance and lability of the basic nervous processes of excitation and inhibition)?

The discussion of the problem of dominance is associated with the notion of anticipation in a suggestive way by the candidate. He rightly comments on the reg-

ulator role of dominants in the work capacity and in the sustained goal directed activity of the nervous system. Optimal lability and optimal excitability are recognized as paramount of dominant states. I agree with the candidate's opinion that the concept of criticality is convergent with the dominant interpreted as a non-equilibrium formation close to phase transitions.

As I noticed before, and despite the close relations between the concepts of temporal variability, dominance, anticipation and chronotope in the work of Ukhtomsky, this last concept is not presented or commented in this thesis by the candidate.

To finish with this chapter, I miss a more detailed discussion of the "experimental systems" (in the sense of Rheinberger), and the experimental paradigms related with the theory of dominant. In this post-Kuhnian times, the hegemony of theory analysis has long been challenged by historians and philosophers of science by shifting their attention to the study of experimentation. I think that this move may prove to be beneficial for the deep understanding and clinical translation of the dominant framework.

2.3 Study 2

In this study the candidate deals with the problem of chronogenic, systemic-dynamic organization of cognitive functions. He shows how this problem remains one of the most difficult and challenging for contemporary neuroscience.

The candidate's comments on the influence of Ukhtomsky in the work of Vygotsky are very illustrative and help to understand the deep thread that connect both scholars and other Soviet researchers. I share the views with the candidate regarding Vygotsky's "appreciation of the framework of the dominant should be understood first of all in a methodological light". Particularly evocative is the observation made by Kurismaa concerning the Ukhtomsky hypothesis that dominant-free states occur only in rare conditions or psychopathological states. Anokhin pointed in a similar direction, stressing the need to explore (in practical terms) the application of the dominant framework to the problems of higher nervous activity and its pathology; especially the role of the dominant motivation as a component of the "afferent synthesis".

Although the candidate does not mention the notion of "dissolution" (advanced by the English neurologist Hughlings-Jackson), he rightly states the importance of similar views in Vygotsky, i.e., the "upward transition of functions" during nervous system maturation and the corresponding "subordination" of lower (evolutionarily older) centers by newer ones, as well as the phenomenon of "emancipation of lower centers" from higher one's control if the latter are organically or functionally damaged".

The results presented from studies on human work dominants are intriguing. From a translational point of view, I found particular interesting the sections 7.4.2-3 in which measures for characterizing functional shifts in the brain's dominant physiological states are presented. Given the importance of this matter, I would like a more in depth discussion on the experimental paradigm from which these measures were obtained. I understand that this is a theoretical thesis, but if this work is going to stimulate translational research, is not a bad idea to describe and comment on the experimental systems that support the studies presented in this section. Sadly, not all the work of Pavlova is accessible to English speakers to fill in this gap.

2.4 Study 3

This last article is devoted to presenting the findings from a pilot study on electroencephalographic (EEG) analysis of human performance. The structure of this paper is *sui generis*, it was published by AIMS neuroscience as a “theory article” but it contains results from *de novo* empirical research. Due to this unconventional structure, the article is hard to read. The theoretical orientation of the paper is underpinned by two interrelated principles of systemic regulation of brain functions, i.e., the opponent process theory by R. Solomon, and A. Ukhtomsky's principle of the dominant.

During the presentation on the background of the research, the candidate does a good job summarizing the nuts and bolts of both the opponent process theory and the principle of dominant. The hypothesis of this pilot trial is that the “opponent motivational processes may be directly related to changes in hemispheric and prefrontal dominance indices”. The authors clarify this hypothesis stating that: “While this hypothesis has been proposed and is supported by other experimental paradigms and evidence, the current approach allows to extend and generalize these findings by applying a novel experimental and methodological framework for their neurophysiologically rigorous and ecologically valid investigation—albeit in a small-scale pilot study”.

I value the explanation of the methods used to get the statistical quantitative measures for characterizing functional shifts in the brain's dominant CAP states. The Appendix 1 is very informative in this former respect.

The material and method sections cover reasonably well all the procedures performed during the trial. However no sample size calculation was reported.

The results are presented and supported by a good choice of tables and figures, but the participants demographics are not reported. In a few places the presentation of these results follows an atypical scheme for a research paper, mixing the results with its discussion.

In a similar manner to the former section, the discussion section is blended with the conclusions of this research. Of note in this part, the authors mainly discussed the positive findings, despite this research being labeled as a pilot study by them, they do not report weaknesses and limitations of the methodology or the procedures trialed. Regarding this issue, I found just a couple of statements, one in the results section warning that “these results are preliminary and need careful replication on larger samples”, and another one in the discussion section saying, “Besides questions of methods and modeling, however, also ethical concerns should be further addressed in this line of research”. Moreover, the authors do not discuss possible improvements to the methodology or future research directions from this pilot stage.

In my opinion, the wording and the tone of the discussion are overly optimistic when suggesting the practical usage of the approach taken in this research; these comments should be more balanced according to the nature of the study and the level of evidence. Notwithstanding that the results of this research are very suggestive and deserve further exploration, they are just at the beginning of the translational research pipeline.

3 Conclusion

The thesis as a whole fulfills its purpose in presenting a series of inter-related case studies aimed at re-examining from modern perspectives the study of the dominant framework by Ukhtomsky and gives the chance to Western scholars to become acquainted with the principle of dominant. Moreover, it clarifies the modern status and significance of this framework as an integrative and organismic paradigm for neuroscientific research. Besides, this work discloses the potential of the dominant principle for translational research.

Finally, I would like to congratulate the candidate for this fine work and I will be happy if my comments contribute to his future undertakings. On a personal side, this work contains many insights that impinges directly in my research program and, if the candidate is interested, I am open to a future collaboration with him.