

Appointment of a reviewer of the qualification thesis Charles University
Faculty of Science Department of Philosophy and History of Science
Theoretical and Evolutionary Biology

Reviewer: Prof. Paola Palanza, Ph.D.

University of Parma (Italy)

candidate

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Study program: Theoretical and Evolutionary Biology

Thesis TITLE

HUMAN PERCEPTION IN CONDITION OF UNCERTAINTY: THE VISUAL, AUDITORY AND EMBODIED RESPONSES TO AMBIGUOUS STIMULI

The Summary Report

To start the report, I would like to acknowledge that I am aware of the work and approach that the research team is working on due to previous encounter on the workshop of the International School of Ethology in Erice, Italy – that I co-organize - where the research group publicly presented their research approach in detail for the first time as part of an invited talk.

The approach of the team is unique due to collaborative work of individuals from different fields and the use of the novel, quite revolutionary, approaches on evolutionary relevant topics. The outcomes of the collaboration are affected by a signature approach of the statistician and former physicist Prof. Hermann Prossinger who is consultant of the thesis, and they take into account typical topics that are relevant to evolution-oriented approach. The work of Dr. Jakub Binter as co-author and collaborator, and Prof. Jaroslav Flegr as supervisor helped the Ph.D. candidate Dr. Silvia Boschetti, a psychologist and neurobiologist by training, develop a set of unique research niche.

The presented thesis gave me an opportunity to take a deep dive into this novel approach and to appreciate the outcomes applied on specific problems, where the current methods

are often limited. In this regard the research approach here presented may open a new way of understanding human perception strategies in relation to environmental and psychological factors and in an evolutionary perspective.

The thesis itself is divided into five major parts.

In the first part Silvia explains the difference between the approach to signal in the two disciplines – ethology and physics – that are jointly affected by founding fathers and their inspiratory figures. The second of the two mentioned fields, physics, is more complex and has a possibility for enumeration of the phenomenon by using a formula – an approach rarely seen in classical ethology, as well as in medicine, neurosciences, and biology.

The theory of lived-world (Umwelt) is also discussed in combination with examples from the animal kingdom and from human perceptual world, which in my opinion it is relevant for any work related to the topic but rarely mentioned. The multimodal perception, pattern perception as product of Error Management Theory are described as well as perception of / communication of facial expressions.

In the following section Silvia describes in depth the current stimuli preparation for scientific research of perception. She is methodical in her description and ties the topics together to specifically point out the problematic issues of the laboratory oriented research and their limitations. In this view , one of the problems is related to the concept of the control that is considered high-standard, and demanded, by the reviewers, but that eventually can damage the experimental research when strictly followed. This is exemplified on stimuli preparation, namely affective state research.

Prossinger, H., Hladky, T., Binter, J., Boschetti, S., & Riha, D. (2021b). Visual Analysis of Emotions Using AI Image-Processing Software: Possible Male/Female Differences between the Emotion Pairs “Neutral”–“Fear” and “Pleasure”–“Pain”. In The 14th PErvasive Technologies Related to Assistive Environments Conference (pp. 342-346).

Binter, J., Boschetti, S., Hladký, T. & Prossinger, H. (2023a, submitted) Ouch!" or "Aah!": Are Vocalizations of 'Laugh', 'Neutral', 'Fear', 'Pain' or 'Pleasure' Reliably Rated? Human Ethology.

The student suggests replacement by evaluative tools that employ artificial intelligence to objectively assess the presence/absence of a pattern or difference between the affective states using picture processing algorithm. These principles are described in published work of other researchers but also in the research by Silvia and her collaborators. The articles, as well as dedicated sections of the thesis, provide detailed descriptions of the mechanisms used.

Prossinger, H., Boschetti, S., Říha, D., Pacovský, L. & Binter, J. (2023, In Press) From Stone Age to New Age Statistics: How Neural Networks Overcome the Irreproducibility Problems in Choice Based Profile Creation. In International Conference on Human-Computer Interaction.

These techniques are especially useful when the stimuli are ambiguous and uneasy to assess by the raters which makes the pre-testing uneasy or even impossible.

Prossinger, H., Hladký, T., Boschetti, S., Říha, D., & Binter, J. (2022a). Determination of “Neutral”–“Pain”, “Neutral”- “Pleasure”, and “Pleasure”–“Pain” Affective State Distances by Using AI Image Analysis of Facial Expressions. *Technologies*, 10(4), 75. doi: 10.3390/technologies10040075

The clustering methods are novel and allow to distinguish between multiple populations, in statistical sense, and heat-map-based visualization method, that allow for interpretation of characteristics typical for each cluster.

The student also included a total of 13 manuscripts published or submitted to highly respectable journals (some of which were shared with other students of the field). The ones focused on facial and vocal display evaluations also involve newly developed statistical method using Dirichlet (and Beta) distributions. Although the statistical analysis is not my main expertise, I have appreciated the efforts for developing robust Bayesian analytical methods.

Boschetti, S., Prossinger, H., Hladký, T., Machová, K., & Binter, J. (2022). “Eye can’t see the difference”: Facial Expressions of Pain, Pleasure, and Fear Are Consistently Rated Due to Chance. *Human Ethology*, Volume 37, 046-072. doi:

10.22330/he/37/046-072

This analysis is applied (in combination with the probability density function and off-diagonal matrix entries analysis) on the human ratings of the stimuli. The depth of the analysis is astonishing since the stimuli were created with an extreme control, each statistical sub-group (cluster) was found, and later outcomes were compared using the above mentioned statistical approach.

The project was very systematic, including also auditory, congruent combination of the stimuli, and incongruent stimuli, and has important implications for the field of perception and cognitive psychology.

Some of the produced publications on this topic are the first of its kind.

Boschetti, S., Binter, J. and Prossinger, H. (2023a, in press) Apoidolia: A New Psychological Phenomenon Detected by Pattern Creation with Image Processing Software together with Dirichlet Distributions and Confusion Matrices. Proceedings in Adaptation, Learning and Optimization.).

And confirmation study:

Boschetti, S., Prossinger, H., Hladký, T., Říha, D., Příplatová, L., Kopecký, R. & Binter, J. (2023b, In Press). Are Patterns Game for Our Brain? AI identifies individual Differences in Rationality and Intuition Characteristics of Respondents Attempting to Identify Random and Non-random Patterns. In International Conference on Human-Computer Interaction.

In my opinion the thesis is of very high level, original and able to stimulate new perspectives in the field. On the whole, it exceeds my expectation.

Some of the articles are written in Czech language and I am unable to judge their content, therefore I do not attempt to extend my rating on the topic. Otherwise, the language is excellent and I did not notice any formal mistakes.

The student also took part in translation and standardization of several questionnaires, some of which are frequently used in the field. This only extends on the multitude of work

that Silvia Bochetti achieved in her thesis. She also participated in several grant projects, and worked in international teams which increased her skills, and I am aware of the fact that her publications and presentations are well known with the scientific community. I have outlined below some small mistakes to be corrected, which do not alter the value of the thesis. Thus I am confident in recommending Silvia Boschetti's thesis for the defense and suggesting the highest rating.

Suggestions:

Sensory cross-talk (p. 12) is rather used in case of mixing of experiences known as synesthesia e.g., when one "tastes" blue color. The term should not be used in other context.

Chapter 5: Visual and Acoustic Stimuli (p. 40) the "A" should be capitalized

Attachment 12 and 13 bare the same name in the list (p. 10). The second one is Bimodal study, and the second the Vocalization study.

Questions:

In chapter 2.7 you mention that you wanted to avoid facial stimuli in pattern perception research to discuss the affective state perception involving facial expression in chapter 2.8. Are affective stimuli considered special case of patterns? If so, why?

This question exceeds the thesis but could you describe the CNS response that are related to the pattern presence, and facial expression of certain affect? Why do you think that this, on neuro-physiological level, is different to different groups of people as you suggest in the two papers?

Would this be different for an affect and basic emotion expression? Would the analytical approach be applicable to data from physiological measures?

In the papers related to the affective state perception the accuracy, consistency and due-to-chance outcomes are different, can you please give a closer explanation to the difference on a chosen example? Can a rating be inaccurate, consistent and due-to-chance?

What do you think is the application potential of the knowledge of the newly-found psychological mechanism? Can it be therapeutic or diagnostic?

Parma

12th April 2023

The reviewer

Prof. Paola Palanza, Ph.D.

A handwritten signature in black ink, appearing to read 'Paola Palanza', written in a cursive style.