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GOOD PRACTICES IN TEACHING COGNITIVE NEUROSCIENCE TO BIOLOGY STUDENTS IN HIGHER EDUCATION

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Abstract

Cognitive Neuroscience refers to the scientific study of the mind and the brain, mainly by means of neuroimaging techniques and psychophysics. This field is considered rather complex, often posing learning challenges for students, especially in terms of the terminology and technical jargon used, as well as due to its interdisciplinary, STEM (science, technology, engineering, and mathematics) nature. To address this issue, an active learning approach was implemented. The present report describes a repertoire of targeted educational activities, developed in the context of a Cognitive Neuroscience course at a Biology Department in Higher Education. To approach consciousness, the theatre analogy for the Global Workspace Theory, developed by Bernard Baars, was used. This refers to a parallelism between elements of a theatrical production and consciousness. To this end, students attended a theatre performance and subsequently physically engaged in a series of onstage exercises. Next, a Science Spring Picnic was held to foster an informal dialogue on newly established knowledge, in a relaxed environment over food, beverages and kite flying. Finally, outreach activities were organized in the form of an art & science communication exhibition on visual illusions, at a major Science festival. Student feedback, by means of anonymous questionnaires, clearly denoted that the activities promoted motivation for learning, learning, and engagement beyond the classroom.

Keywords: *Cognitive Neuroscience, good practices in education, higher education, active learning, science communication.*

1. Introduction

How is a mechanical or chemical signal transformed into higher cognitive functions? To unravel this enigma, the field of Cognitive Neuroscience studies the mind and the brain, via advanced neuroimaging techniques and psychophysics (Poeppel, Mangun, Gazzaniga, & Bassett, 2020; Vallet, van Wassenhove, 2023). This domain stands in the intersection of STEM: Science, Technology, Engineering and Mathematics (Basu, Mondoux, Whitt, Isaacs, & Narita, 2017). This fact, alongside niche terminology and methodology, present significant hurdles to students (Baars & Gage, 2010). To tackle this issue, innovative teaching approaches may be implemented, namely active learning (Santosh, & Nakarmi, 2023). Active learning is an experiential educational practice so to increase student engagement (Zepke & Leach, 2010). The aim is to mitigate the academic burden through participation in -outside the classroom- course activities. The purpose of this report is to present good educational practices, that took place in the context of a Cognitive Neuroscience University course, offered to Biology students.

2. Methodology

2.1. The Theatre Analogy

To treat consciousness as an observable variable (Baars, 2017), students participated in a theatrical workshop (Figure 1.a). For this purpose, Bernard Baars' Theatre Analogy of the Global Workspace theory was used, i.e., a metaphorical framework that compares parts of a theatre and the conscious and unconscious contents that form the brain's mental processes (Baars, 2017). According to this analogy, the theatre stage corresponds to the working memory, whilst the spotlight on the stage represents voluntary attention. The content of consciousness is limited to the materials on the stage; the rest of the theatre represents unconscious knowledge and processes. Students first attended a theatrical

performance, and then found themselves on stage and under the spotlight. Through a series of physical theatre exercises, students worked on drawing several parallels to the concept of consciousness through a functional framework of human cognition. By forming emotional responses to external stimuli, they recreated the bottom-up attentional capture and they progressed to focus on top-down voluntary attention; ultimately, selectively directing their attention.

2.2. Science spring picnic

This extra credit course activity is a Journal Club with a twist, inspired by a previously published project, namely Science Tea Party (Andreou, Aletra, Athanasopoulou & Psarropoulou, 2018). A neuroscience curation of topics from the Nautilus Journal (http://nautil.us/) was made available to the students, so to choose their paper between the following options: 1. How Your Brain Fills in the Blanks with Experience; 2. Neuroscience has a Race Problem; 3. I Feel, Therefore I Am; 4. Why your Brain's Sense of Time is so Elastic; 5. Unlocking Mom's Brain; 6. Our Mind-Boggling Sense of Smell; 7. How We Remember Last Weekend; 8. The Brain Uses Calculus to Control Fast Movements; 9. Get Lost in Parking Lots -You Might Have Developmental Topographic Disorientation; 10. Are We Wired to Be Outside?. For presentation guidelines see Andreou et al. (2018). Students gave 5-minute talks, over food, beverages and kite flying, followed by plenary discussion (Figure 1.b). They were instructed to drill down to the most fundamental aspects of the publication and to interact with the audience. The premise of the activity was to boost science communication skills, outdoors, in a lax atmosphere. This way, a safe learning space was established, that nurtured informal conversations, on neuroscience and its implications on current culture and vice versa.

2.3. Science festival

An interdisciplinary student team was built and achieved their participation to a prominent three-day Science festival. There, they presented an art & science communication exhibition, entitled "Illusory vision: the human brain & illusions". This was essentially a STEM group, in which female representation was encouraged. The Cognitive Neuroscience course students held a science and science communication role. The topic of the exhibition involved the concept of error. "Cognitive Neuroscience informs us that error is an integral part of the learning process; our brain, by default, is wired up to make mistakes. A visual illusion begins where our senses fail. The false perception of reality, that the brain constructs, reveals to us the mechanism by which it operates. So, by learning from our "mistakes", we draw useful conclusions about the meaning of error in science and society; since in science we rely on experimentation to explore the unknown, while in education we often risk making mistakes in order to learn" (Andreou, 2023). The art exhibition negotiated these ideas in an open discussion with audiences of all ages. Alongside optical art printouts, graphic designs, and everyday objects, it mainly included exhibits created through 3D (three-dimensional) printing (Figure 1.c); that is, it employed art & technology for neuroscience communication of the study of the human brain. Henceforth, in this activity, students communicated complex neuroscience ideas to a diverse audience of 15.000 visitors, including 30 schools.

Figure 1. Student engagement in Cognitive Neuroscience educational practises (a) The Theatre Analogy (b) Science Spring Picnic (c) Science Festival.

(a) (b) (c)

3. Results & discussion

Students were requested to reflect on the aforementioned educational practices via optional, anonymously provided, open-ended comments. The student feedback was unanimously positive; indicatively one student remarked, "*Cognitive Neuroscience is one of the most interesting courses of the semester. The professor implemented various outreach activities to establish knowledge. During the*

Science Picnic, we had the opportunity to present science articles and further understand the concepts, through a fun, outdoor activity!". The comments provide a significant insight to students' perspective and merit further qualitative and quantitative investigation.

The vast majority of the comments provided affirmation with regards to the mitigation of academic burden, student engagement and subject-matter learning; and are in line with studies employing active learning strategies (Freeman et al., 2014). Students had the opportunity to elaborate on the science involved, in controlled, safe settings. They promoted their collaboration, public speaking, and science communication skills, while maintaining and sharing their enthusiasm and curiosity with their peers, their instructor and the general public. The incorporation of multidisciplinary practices, as the theatre analogy, the science spring picnic, and the participation to a science festival, underlines the multidisciplinary nature of the Cognitive Neuroscience field. Novelty and creativity enhanced motivation for learning, knowledge acquisition and student engagement in and beyond the classroom. Thus, the active learning activities reported here are deemed effective.

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