PUTTING THE BUDDHISM/SCIENCE DIALOGUE ON A NEW FOOTING

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Integrating Buddhism and Neuroscience – Perspectives from a Contemplative Neuroscientist-practitioner Studying Compassion and Mind-body Medicine, and Field Notes from the Emory-Tibet Science Initiative

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Buddhism and Neuroscience: Incommensurable?

Gaelle Desbordes, PhD.

Gaelle Desbordes began by sketching her own multidisciplinary path as a scientist as well as a Buddhist practitioner in the Tibetan tradition. Having studied mathematics, physics, and engineering, and influenced by Francisco Varela's *Cognitive Science: A Cartography of Current Ideas*, she went into computer science motivated to learn about neural networks and artificial intelligence. Her interest shifted then to biological neural networks, leading to a PhD in neuroscience and postdoctoral work on the visual system of the cat brain. During this time she began exploring Tibetan Buddhism, which motivated her interest in contemplative neuroscience and work that aims for beneficial applications.

She presented an overview of the challenges of genuinely multidisciplinary work, referencing Eric Schwartz's five categories of disciplines that study brain and mind, with examples of different forms of conceptualization used by each:

1. theoretical physicists, mathematicians, computer scientists (symbols, concepts, information theory, graph theory, AI)
2. experimental physicists, engineers, computer programmers (computation, mapping, simulation, neural nets, spiking models, statistics)
3. biologists (neural biology including molecular biology, anatomy, electrophysiology, ethology, experimental psychology)
4. psychologists (concrete verbal concepts, e.g. clinical psychology, counseling psychology, behaviorism)
5. philosophers and the occasional theologian (abstract verbal concepts, e.g. introspection, phenomenology, philosophy of mind).

Desbordes described this complexity a true richness, not just a liability. There is no need to force-fit all approaches into a one-size-fits-all model; the right model instead depends on the question that one is pursuing. For instance, in any scientific approach, the scale at which investigation occurs—both the spatial and temporal scales, and the corresponding instrumentation and methods chosen—will influence what theory can be constructed. In current fMRI studies of the human brain, scientist may uncover patterns of functional connectivity between pairs of brain regions (or even more complex multi-voxel patterns), but these methods tend to impose an arbitrary scale of analysis (the "voxel") that is a feature of the current fMRI methods available, rather than an intrinsic feature of the underlying biology (where the relevant scales may be individual neurons, groups/networks of neurons, synapses, or neurotransmitters). Therefore, while these models are able to capture the fMRI data quite well, they really give us a very limited understanding of how the brain works, or how the different scales might relate to each other.

On top of these complicated maps of different theoretical silos and different scales, we are now trying to add Buddhist maps, with their own silos. Desbordes noted that Varela had ventured into this realm when he tried to map the Abhidharma concept of discrete moments of consciousness to phases of coherence in the dynamics of synchronous neural ensembles, and then used first person data to study the correlation of synchrony patterns and conscious states of preparedness in a simple visual task.[1] Michael

Sheehy later commented that there was never a singular Abhidarmic model of the mind: it was a multi-lineal and dynamic tradition in conversation with other systems of thought, and preserved in texts that are not based solely on phenomenological self-report but where any experiential report is strongly influenced by scholarly traditions.

Desbordes then described a neurophenomenological study she had been involved with that demonstrated problems characteristic of much neuroscientific research on meditation. The study, led by Jud Brewer at Yale University,[2] had subjects practice focused meditation with attention to the breath while fMRI activation was measured in the posterior cingulate cortex. Preliminary findings had indicated that higher activation was correlated with mind wandering, and de-activation with focus on the task. Those with meditation experience were more easily able to stay focused. By showing participants their own brain image with a minimal delay, the feedback allowed them to improve at the task. The claim was then made that the data was a marker for how well people were meditating, and could be used to train people in meditation, which Desbordes felt was problematic in that it reduced understanding of the brain's activity during meditation to a single binary signal (posterior cingulate activity going either up or down). Clifford Saron agreed, noting that his and Desbordes and Evan Thompson's inclusion as authors of the study was in the role of "adversarial collaborators." Desbordes added that this lack of consensus between scientific investigators was common in science, but that it was rarely recognized in the public perception of science, which tends to take published information as cast in stone without awareness of how the field itself in a dynamic process of constant contradiction and correction. A further concern she voiced was that fMRI data represents only increased metabolism in a brain region, with neuron activation inferred only indirectly, and no other mechanism, such as neurotransmitters, under consideration.

Saron added another reservation, that the study had described self-referential thinking or autobiographical memory as distractions that mapped categorically to the heightened activation, revealing a view of meditative experience derived from one limited set of Buddhist practices that was not universal, and that placed unwarranted emphasis on the contents of consciousness. Kalina Christoff raised the problem of how the baseline for measuring activation might be seen as arbitrary, given that meditation tends to change default modes of being and thinking. Even more fundamentally, both Saron and Christoff pointed to the lack of one-to-one relationship between any single brain region and processes in the default mode network. In effect, some skill the meditators possessed allowed them to better regulate a particular region, but another person might regulate the same region using different processes, and the success of biofeedback learning techniques tells us little about the mechanisms involved.

On a more positive note, the first person data collected in this study was rich, nuanced, and precise in a way that scientists have not yet correlated with brain activity, and suggests that neurophenomenology could offer a wealth of data that is already being simplified to fit existing assumptions. There is always a trade-off in any process of modeling, balancing how much richness to retain in your data with how to render it intelligible and useful to the problem being investigated.

Desbordes identified a problem in fMRI analysis that is analogous with DNA studies from the 1970s assuming that DNA not involved in coding for genes was meaningless "junk"—since found to be incorrect: current fMRI methods tend to discard as “noise” the brain activation patterns that differ in shape from the “canonical” activation, but these non-canonical patterns can be just as reproducible.[3] What is believed to be scientific fact at any given time is merely provisional; what endures is the scientific process. The book *Brainwashed: The Seductive Appeal of Mindless Neuroscience*[4] urges nonspecialists to maintain a critical eye when reading about brain imaging studies in the general media, because the editorial push for “hype” can turn a small, preliminary study into what seems like a major breakthrough.

One research challenge is the huge complexity of the qualitative data coming from first-person reports, and the difficulty of combining it meaningfully with brain imaging data except in very specific and limited ways. Mixed method research combining qualitative and quantitative data in the same model has been used in medical research and other fields, but any emphasis on first person data is likely to be met with resistance in funding or publishing neuroscientific studies. The culture of funding for science also discourages the time-consuming approaches and lack of manipulative interventions that are typical of neurophenomenological studies. Christoff added that this is why spontaneous thought is not considered a legitimate field of study, because by definition you cannot manipulate spontaneity.

Saron suggested the possibility of a middle path, using a model like the “mindfulness matrix” cube he had presented in his own talk as a way of registering the affective dimensions of experience at the level of micro-neurophenomenology. The value of intersubjective second person reports was also suggested, leading to a discussion of the role of a meditation teacher in evaluating a student’s progress, the influence of the teacher effect on neuroscientific studies of meditation, and the ethical challenges of the dual roles of Buddhist practitioners who participate in scientific research.

In the final portion of her presentation, Desbordes described her involvement with the Emory-Tibet Science Initiative, a large-scale program run from Emory University to teach science in Tibetan monasteries in India. The program was developed in response to a request from the Dalai Lama to give monks and nuns a sustained science education, focused in particular on cosmology, biology, neuroscience, and philosophy of science, and eventually was introduced as part of the standard monastic curriculum. Challenges included translating teaching materials into the Tibetan language which lacked a scientific vocabulary, and the lack of basic numeracy skills. Logic and debate skills, however, were very strong. Desbordes joined the program in 2008, contributing to developing and teaching the neuroscience curriculum.

A study of the program’s effects identified an interesting generational gap between the older monks in their thirties and forties currently in the science program who had no prior science education, and younger monks included as a control cohort who had been exposed to secular elementary and middle school education in the exile communities in India before joining the monasteries. Responses to the program by monastic leaders varied dramatically, including those who were enthusiastically supportive and those who experienced deep cultural conflict. At the same time, the adoption of technologies that depend on scientific knowledge, such as cell phones, has become widespread.

William Waldron and Martijn Van Beek both noted people’s ability to hold multiple world-views that may seem to be in conflict, or to use technologies that may conflict with stated world-views. In practice we all live our lives with such inconsistencies, and it is only the researchers who insist on consistency.

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[1] Lutz, Lachaux, Martinerie, Varela, *Proceedings of the National Academy of Sciences*, 2002.

[2] Garrison, K.A., Scheinost, D., Worhunsky, P.D., Elwafi, H.M., Thornhill, T.A. 4th, Thompson, E., Saron C., Desbordes, G., Kober, H., Hampson, M., Gray, J.R., Constable R.T., Papademetris, X., Brewer, J.A. (2013). Real-time fMRI links subjective experience with brain activity during focused attention meditation. *NeuroImage 81*, 110-8. doi: 10.1016/j.neuroimage.2013.05.030. Epub 2013 May 17.

[3] Gonzalez-Castillo J, Saad ZS, Handwerker DA, Inati SJ, Brenowitz N, Bandettini PA. Whole-brain, time-locked activation with simple tasks revealed using massive averaging and model-free analysis. PNAS 2012. https://www.ncbi.nlm.nih.gov/pubmed/22431587

[4] Satel, S. and Lilienfeld, S.O., *Brainwashed: The Seductive Appeal of Mindless Neuroscience*, Basic Books, New York, 2013.