

## Go Figure! A non-dual cognitive neuroscience perspective on the Möbius band.

Christopher B. Germann (PhD, MSc, BSc / Marie Curie Fellow)

Associated URL: <http://moebius-band.ga>

**T**HE *Möbius band* is an extraordinary geometrical figure. The band is eponymously named after the German mathematician August Ferdinand Möbius who described it in 1885, contemporaneously with another German mathematician named Johann Benedict Listing. It is a so called *ruled surface* with only one side and one boundary and it possesses the mathematical property of non-orientability (viz., a non-orientable manifold). A Gedankenexperiment is helpful to understand this property intuitively: Imagine walking on the surface of a giant Möbius band. If you would travel long enough you would end up at the very starting point of the journey, only mirror-reversed.

*A surface  $S$  is ruled if through every point of  $S$  there is a straight line that lies on  $S$ .*

The geometry of the Möbius band (also referred to as “Möbius strip”) has far-reaching interdisciplinary implications. The principles of its peculiar topology have been applied to a broad array of scientific disciplines including mathematics, cosmology, computer science, physics, chemistry, biology, psychology, et cetera. Practical applications include, for instance, superconductors with high transition temperatures, molecular engines, and bandpass filters (see exemplary references below). In addition to its scientific relevance, the Möbius band can be found as a leitmotif in multifarious artworks across various cultures (for an example see the ancient mosaic depicted below). Moreover, the abstract principles derived from its topological structure have been applied to music theory (e.g., the space of all two-note chords, referred to as dyads<sup>1</sup>, resembles the shape of a Möbius band). The Möbius band is a very interesting visual percept in the context of perceptual cognitive psychology and neuropsychology, as it helps researchers to investigate the cognitive and neuronal mechanism which undergird cognition and perception. (Besides, in the first half of the 20th century magicians used the Möbius band for “magical” tricks.)

Interestingly, a recent series of fMRI neuroimaging studies focused on the topic of ego-dissolution which is associated with non-dual states of consciousness in which the border between self and other (the dichotomy between inside and outside) temporarily dissolves. The default-mode network appears to be an important neuroanatomical correlate in this context. Next to its neuropsychological aspects, the Möbius band inspires profound philosophical contemplations concerning the relationship between mind & matter (e.g., the “Pauli-Jung conjecture” in the context of dual aspect monism). In the classical 17th century Cartesian framework (which is still highly influential), mind & matter (psyche & physis – or *res extensa* & *res cogitans*) are two separate phenomena (this dichotomisation is known as Cartesian dualism or the Cartesian split). However, alternative ontological theories postulate that mind & matter are

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<sup>1</sup>A dyad (or doad) is a set of two notes or pitches.

complementary with respect to each other (in the quantum physical sense of complementarity), i.e., they are different aspects of the same underlying “substance” (hence the term “monism” as opposed to “dualism”). Currently, a dualistic mind/matter conception is the (mostly implicitly accepted) reigning scientific paradigm (cf. Thomas Kuhn)<sup>2</sup>, particularly within the neurosciences (e.g., epiphenomenalism/emergence theories of consciousness). However, this dualistic working hypothesis can be challenged on various logical grounds and has not been empirically validated (e.g., correlation  $\neq$  causation; viz., the “*cum hoc ergo propter hoc*” logical fallacy of implied causality). Therefore, dual-aspect monism is a viable conceptual alternative worth considering – particularly given recent empirical data obtained in the domain of experimental quantum physics which deeply challenges our intuitive quasi-Newtonian notions of reality which are ubiquitously (*prima facie*) taken for granted without deeper critical reflection on their logical validity and empirical evidential foundation. The dual-aspect monism perspective is therefore iconoclastic towards the reigning dualistic psychological and neuroscientific status quo paradigm. It is argued that the Möbius band can be interpreted as a visual metaphor for chiasmic convergence a *coincidentia oppositorum* (Latin for “coincidence of opposites”; cf. C.G. Jung), i.e., the non-duality of psyche and physis, internal and external, subject and object, mind and matter, the knower and the known, the “seer and the seen” (Sanskrit: *Drg-Drśya*; as analyzed in the ancient Advaita Vedānta text *Drg-Drśya-Viveka*). William James eloquently summarized this non-dual view as illustrated in the following citation.

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<sup>2</sup>Cf. Kuhn’s seminal book “The structure of scientific revolutions”.

*The instant field of the present is at all times what I call the 'pure' experience. It is only virtually or potentially either object or subject as yet. For the time being, it is plain, unqualified actuality, or existence, a simple that. [...] Just so, I maintain, does a given undivided portion of experience, taken in one context of associates, play the part of the knower, or a state of mind, or "consciousness"; while in a different context the same undivided bit of experience plays the part of a thing known, of an objective 'content.' In a word, in one group it figures as a thought, in another group as a thing. [...] Things and thoughts are not fundamentally heterogeneous; they are made of one and the same stuff, stuff which cannot be defined as such but only experienced; and which one can call, if one wishes, the stuff of experience in general. [...] 'Subjects' knowing 'things' known are 'roles' played, not 'ontological' facts'.*

~ William James (1904)

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*The whole duality of mind and matter [...] is a mistake; there is only one kind of stuff out of which the world is made, and this stuff is called mental in one arrangement, physical in the other.*

~ Bertrand Russell (1913)

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*There is no such thing as philosophy-free science; there is only science whose philosophical baggage is taken on board without examination.*

~ Daniel Dennett (1995)

