Towards an interdisciplinary 'science of the mind': a call for enhanced collaboration between philosophy and neuroscience

Abstract

In recent decades, the neuroscientific community has moved from describing the neural underpinnings of mental phenomena – as characterized by experimental psychology and philosophy of mind – to attempting to redefine those mental phenomena based on neural findings. Nowadays, many are intrigued by the idea that neuroscience might provide the 'missing piece' that would allow philosophers (and, to an extent, psychologists, too) to make important advances, generating new means that these disciplines lack to close knowledge gaps and answer questions like 'What is Free Will? and 'Do humans have it?'. In this paper, we argue that instead of striving for neuroscience to *replace* philosophy in the ongoing quest to understanding human thought and behavior, more synergetic relations should be established, where neuroscience does not only inspire philosophy but also draws from it. We claim that such a collaborative co-evolution, with the two disciplines nourishing and influencing each other, is key to resolving long-lasting questions that have thus far proved impenetrable for either discipline on its own.

Keywords: Philosophical theories, neural data, scientific paradigm, inference, history.

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Introduction

In recent decades, neuroscience has introduced substantial changes in the way we study and understand cognition (Bor, 2015; Diamond & Amso, 2008; Nichols & Newsome, 1999).[1] Perhaps most importantly, the neuroscientific community has moved from describing the neural underpinnings of mental phenomena – as characterized by experimental psychology and philosophy of mind – to attempting to redefine those mental phenomena based on neural findings. Empowered by new tools and methodologies, alongside the inclination to assign more weight to

[1] Some claimed that this change will go beyond academic practices (e.g. Underwood, 2016), and also affect everyday language and concepts (Churchland, 1985; Dennett, 1991).

data-driven answers grounded in neural findings over conceptual work, neuroscience started branching out into the domains of those neighboring disciplines, as well as other fields such as economics (Camerer et al., 2005; Glimcher et al., 2009), law (Jones et al., 2013; Vincent, 2013), and even aesthetics (Huston et al., 2015; Wald, 2015). Though these new subfields have generated interesting findings and research directions, they also attracted criticism. These were largely centered around the risk that the 'neuro' prefix might obscure some of the methodological specificities, important background assumptions, and contextual factors influencing the examined behaviors (e.g. Aharoni et al., 2008; Chandler, 2018; Harrison, 2008; Nadal et al., 2012; Vassiliou, 2020). Nevertheless, many are still intrigued by the idea that, in the case of philosophy of mind (and, to an extent, psychology, too), neuroscience might somehow provide some 'missing pieces' that would allow these disciplines to finally solve their puzzles, close knowledge gaps, or at least make important advances (e.g., Filley et al., 2020; Piccinini, 2020, 2022; Tarlacı, 2023).

In this paper, we argue that to reach its full potential, the overall positive trend of 'augmenting' philosophy of mind with neuroscientific resources, which naturally also has some less favorable side-effects (e.g. Mudrik & Maoz, 2015), should undergo another transition. Instead of striving for neuroscience to *replace* philosophy[2] in the ongoing quest to understanding human thought and behavior, more synergetic relations should be established, where neuroscience does not only inspire philosophy but also draws from it. We claim that such a collaborative co-evolution, with the two disciplines nourishing and influencing each other (Francken et al., 2022), is key to

[2] Or psychology; but for the sake of the simplicity of the argument, we will focus on philosophy here.

resolving long-lasting questions that have thus proved impenetrable for either discipline on its own.[3]

Before making that case, however, it is important to make our motivations explicit. We think that the need for the 'paradigm shift' we advocate for can be best appreciated by first looking at how, historically, the relationship between neuroscience and philosophy developed. The brief historical overview in the next section provides insight into why this relationship developed to be what it is, and how these disciplines originally positioned themselves with respect to each other. We see a clear trend emerging from what might prima facie look like a series of scattered anecdotes: neuroscience has gotten increasingly interested in 'big questions' that are traditionally discussed in philosophy, such as, for example, 'Why are human beings conscious?', 'What is agency?' or, more directly connected to the discussion that follows, 'What is Free Will? And do humans have it?'

To demonstrate this trend, we examined the number of publications on the Web of Science database, which belong to the "Neurosciences" category and containing the keywords "free will", "agency", or "consciousness" (for simplicity, we will term these *neurophilosophical studies*, though this should not be taken as anything more than a shorthand term to describe studies in this category). As shown in Figure 1, the last 20 years saw a dramatic increase in the number of neurophilosophical studies. Importantly, this increase is much steeper than the overall increase in the number of annual publications in neuroscience in general.. In particular, the subset of neurophilosophical studies has grown more than five-fold over the past 20 years, going from

[3] It is worth mentioning that there have been other, somewhat analogous proposals for a 'paradigm shift' in the past. In philosophy, a lively and dynamic discussion focused on its relationship with science. Perhaps the most significant past attempt to 'integrate' philosophy and the special sciences into a common research paradigm was the Positivist movement in the first half of the 20th century, especially thanks to what is historically known as the 'Vienna Circle' (Uebel, 2022). However, Positivism had a broadly reductionist attitude towards philosophy. On the contrary, our proposed 'paradigm shift' assigns a primitive and irreducible role to philosophy (alongside neuroscience) and calls for collaboration while preserving each discipline's methodological specificities.

constituting a 0.0007% of all neuroscience publications in 2003 to 0.0036% in 2023: an impressive 428.5% increase. Another way to describe this trend is to examine the change in the normalized amount of neurophilosophical studies vs. neuroscientific studies across time .Figure 1 represents this change by depicting the number of neuroscientific studies (in blue) and neurophilosophical studies (in red) published each year divided by the overall number of studies over that 20-year period in that category. As is apparent, the increase in the neurophilosophical studies is substantially greater than that in the neuroscientific studies in general. This trend seems to rely, at least in part, on the (nontrivial) assumption that questions like those about free will and other, similarly 'high-level' notions like agency or consciousness, are answerable based on neural data or, in some cases, that neurally-based answers are preferrable to non-neurally-based ones (e.g., those provided by philosophy), as we demonstrate below. But is this the case? Is there really so little room left for philosophical views of the mind in an age of unprecedented access to the brain? As we discuss later on, some ongoing interdisciplinary collaborations between philosophers and neuroscientists suggest that the answer is a clear 'no'.

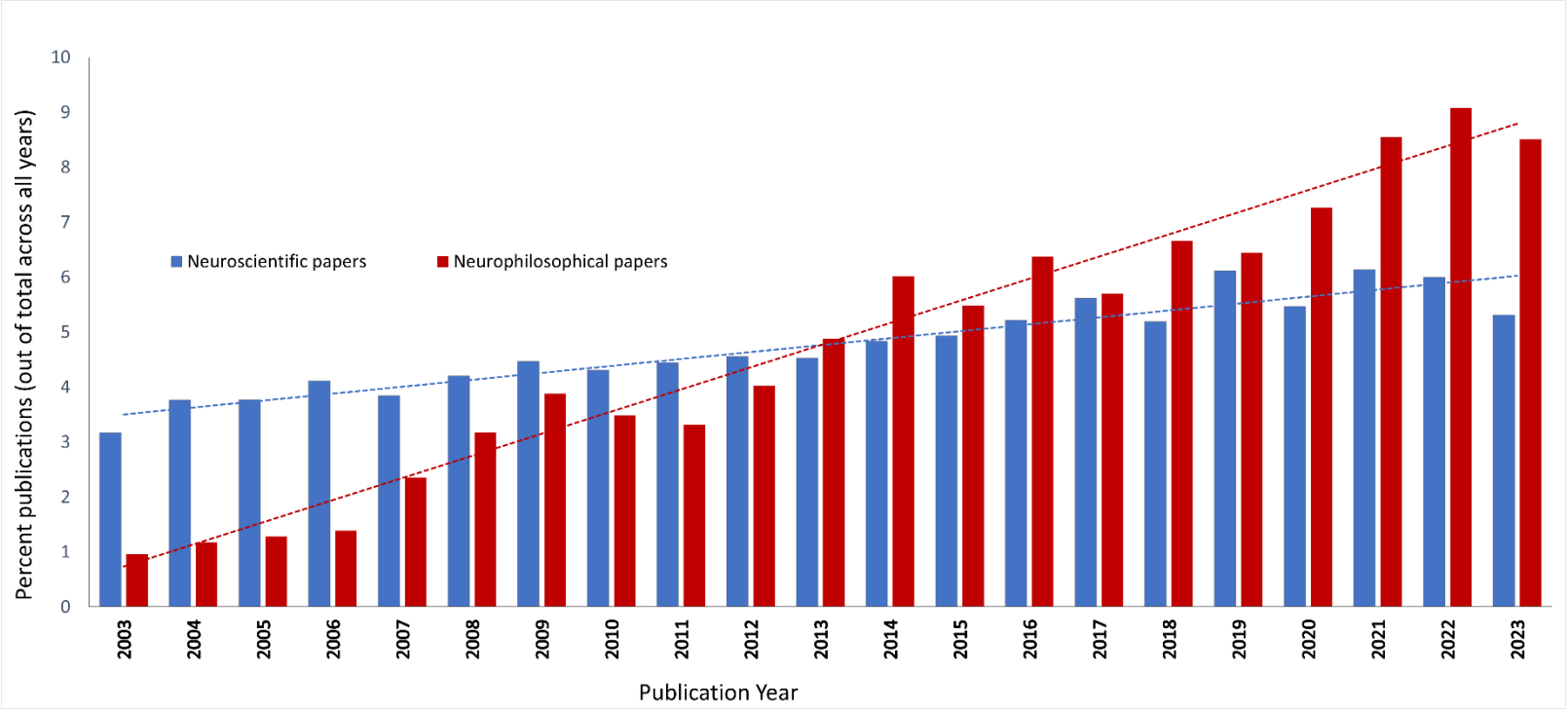

Figure 1. Each bar represents the percentage of papers published in a given year within each category (neuroscientific papers in blue and neurophilosophical papers in red) from the overall number of papers published in that category across the entire timespan (2003-2023). Neuroscientific papers were those categorized as "Neurosciences" by Web of Science. Neurophilosophical papers were those that Web of Science categorized as "Neurosciences" and that further contained at least one of the keywords "free will", "agency", or "consciousness". The blue bars show a moderate increase in neuroscientific publications over time (slope of X), while the red bars demonstrate a clearly steeper increase (slope of Y) (Source: Web of Science Core Collection).

Philosophy meets neuroscience: the shift from the 'how' to the 'what'

Though the brain has been the focus of scholarly interest for centuries, dating back to antiquity (Clarke & Jacyna, 1987; May, 1968; Potter, 1988), the early precursors of what is today termed neuroscience can be traced back to at least the seventeenth and eighteenth centuries (Gross, 2009; Wickens, 2014).[4] At that time, the term *neuroscience* had not yet been coined, as the so-called 'neuron doctrine' was not introduced until the 19th century (Gold & Stoljar, 1999; Golgi, 1967). So, we use the term 'brain sciences' to refer to pre-19th century precursors of modern

[4] Regrettably, our expertise is mostly limited to the Western history of neuroscience. For descriptions of the contributions made to modern neuroscience by Eastern (including Arab and Muslim) traditions, see for example (Finger, 2001; Mohamed, 2008).

neuroscience. Back then, the main problem that captured the focus of scientific investigation was the nature of the nerve impulse, or nerve conductance (Brazier, 1984). Deciphering how nerves conduct information and cause muscular contraction was one of the greatest challenges of that era: "every writer, whether physician, scientist, or philosopher, searched for the solution, and many gave up trying for a material explanation, granting the accolade to the soul" (Brazier, 1984, p. 6). Though some of the suggested solutions to this problem were indeed non-physical (e.g., that the immaterial soul is the cause of nerve impulses), the problem was nevertheless neurophysiological in nature;[5] it is *about the brains and bodies of human beings (or nonhuman animals), and the means by which they operate*. These investigations cannot teach us about what the organism is or what it does (or why). They can only reveal *how* the structures or organs of the organism operate. And they are surely not focused on explaining the mind. They are all about explaining the workings of the brain as an organ.

Investigating the brain as an organ without venturing or hoping to answer questions about the mind or the psyche remains an important and active line of neuroscientific research.[6] Yet, two centuries ago it was the mainstream of brain-scientific investigation. Most (though not all) brain scientists completely ignored the relations between the brain and the mind. And even those who

[5] Our use of the word 'neurophysiological' is not aimed at negating some form of spiritualist solution, or assuming a materialistic point of view. In this context, 'physiological' is not synonymous with 'physical'. Rather, 'physiological' refers to something that pertains to the human body (and more specifically in this context, 'neurophysiological' refers to the nervous system) and its processes. For a more specific description of the origin of term 'physiology', and its shift from denoting the science of all natural things to that of living things only, see (Fulton & Wilson, 1966).

[6] In fact, cognitive and Behavioral Neuroscience, i.e. the subfields of neuroscience to which we mostly refer here when using the term 'neuroscience', are only 2 of the 13 'major branches' of neuroscience (listed by Medical News Today). This alone seems to suggest that most of neuroscientific research today is still concerned with the brain as an organ—i.e., with its biology and physiology, and with the brain as a 'physico-chemical' system rather than as a window to the mind or the psyche. (URL: https://www.medicalnewstoday.com/articles/248680#major-branches). Yet they receive substantial attention from the academic community and from public media, making them highly salient and influential.

did refer to the mind, typically did so mainly to clarify that questions about the mind are outside the scope of the brain sciences. In the words of English neurologist John Hughlings Jackson:

> Neural physiology is concerned only with the varying conditions of the anatomical arrangements of nerve cells and fibers – with the physics of the nervous system…Sensori-motor processes are the physical side of, or, as I prefer to say, form the anatomical substrata of, mental states. It is with these substrata only that we, in our character as physicians and physiologists, are directly concerned with" (Taylor, 1931).

Similarly, distinguished French physiologist Francois Magendie wrote:

> The most sublime features of the human character are intelligence, thought, the passions and that admirable faculty by which we are enabled to direct our movements, and communicate by speech…we do not pretend to explain the acts of the understanding or the instincts; our object is to study them, and to demonstrate the physiological connexion they may have with the brain generally, or with its parts (Magendie, 1844).

Magendie explicitly states that high-level cognitive phenomena, which are to him the "most sublime features of human character"[7], should not be the target of investigation in the brain sciences. According to Magendie, the most brain scientists can do is describe the relations between these cognitive phenomena and neural events, without any attempt to draw insights from neural data to explain these phenomena or shed new light on them.

Still, there were also brain scientists who did spend time and effort trying to explain mental and cognitive phenomena, and not only the brain in isolation. Take for example William Cullen, an 18th century Scottish physician, chemist and agriculturalist, who was "more anxious to explain *what* happens than to explain *how* it does happen" (Wightman, 1973, p. 141).[8] This was one of the earliest formulations of the new definitions of goals of brain scientists: from wishing to reveal the

[7] See, for example, Leibniz's concept of apperception (Leibniz, 1989), or Locke's focus on introspection throughout his "Essay Concerning Human Understanding" (Locke & Fraser, 1894).

[8] These quotes are taken from the notes of one of the students who attended the lectures, so one should take into account that they might not be accurate.

physiological nature of the nervous system to using these data to unravel some of the *psychological* attributes of human beings.[9]

Researchers like Cullen thus began to envision a methodological shift and a new paradigm that governs investigations of the mind. Instead of being considered distinct from, or even irrelevant to, psychological (i.e., at the time, philosophical) claims, neural findings gradually began to be regarded as the 'authority' that determines which mental states and processes there are, how they relate to each other, and how they connect to behavior. In this 'brain-o-centric world order', neural data have the power to, first, disprove or confirm claims about the mind (classically made by philosophers), and second, to *add new knowledge* to existing philosophical theories. Additionally, neural data-driven science is held to produce more rigorous, more objective – in a word, *better* – knowledge than any knowledge ever produced from the armchair.

This new approach then flourished in the 19th century, when the work of 'anatomy-focused' scientists—like Broca, Wernicke, Lichteim, and Gershwind—facilitated the linking of mental phenomena (especially pathological ones) to brain lesions observed during autopsies. This work contributed to the creation of a model of the brain's functional anatomy, characterized by high modularity and localization (e.g. Broca, 1861; Nasios et al., 2019; Wernicke, 1974).

A notable and clear-cut example of this new approach (though also of how it was not always justified) is the work of Franz Josef Gall, the founder of phrenology. Historians describe Gall as being obsessed from an early age with the question regarding different talents or faculties[10] that individuals have. To answer this question, he relied on anatomical findings, pathologies, his

[9] At the time, the terms "psychology" or "psychological" referred to the subject matter of philosophical theories. It was not until the late 19th century that psychology officially became an experimental science and a discipline independent from philosophy.

[10] The idea that human psychology could be divided into 'faculties' had been discussed among philosophers long before Gall, dating back to Aquinas and the 9th-10th century Arab philosopher known in the West as Razi (Ivry, 2012; Lonergan, 2004).

clinical work as a physician, and twin studies (Ackerknecht, 1973). His conclusions were fourfold: (a) faculties are innate (i.e., hereditary); (b) faculties depend on organic structures; (c) the brain is the organ of all faculties, tendencies, and feelings (but not of all sensory and motor functions); and (d) the brain is composed of as many organs as the persons' faculties, tendencies, and feelings (Gall, 1818). It is thanks to these ideas that Gall is widely held to be the father of brain localization (i.e., the ascription of different functions to different brain areas). Yet his poor methods, relying mostly on palpation of the cranium[11], drew much criticism and even ridicule, which in turn led to phrenology not being considered scientific (van Wyhe, 2004).[12] In that respect, Gall's ideas about the differences between human beings were based more on the shape of their skull than on neural data. Yet, the shape of the skull was for Gall a proxy for the shape of the brain: differently developed brain areas supposedly caused corresponding places on the skull to take different shapes to accommodate the brain (Mountcastle, 1995). So, Gall used differences among brains to explain differences among persons.

Gall's phrenology was endorsed by a considerable number of scholars, who either practiced it or based their investigations on it (Cooter, 1976; Young, 1990). Thus, this version of the 'neuro-centric' paradigm gained prominence. In the words of historian of science Robert Young, "Gall combined a principle of analysis into behavioral and anatomical units with a requirement that we

[11] It should however be noted that Gall excelled in anatomy, introducing new techniques for dissecting the brain which were far superior to the traditional slicing procedure. This enabled him to differentiate between grey and white matter (though, interestingly, he considered the latter to be a matrix of nerves).

[12] It should be noted that, even though phrenology enjoyed some degree of popularity in the 19th century and then had a resurgence later on, it was never widely accepted among scientists. In particular, it is worth mentioning how the controversial and unscientific claims made by phrenology were adopted in the early 20th century by European Nazi and Fascist regimes to advance political goals and justify their race-based discrimination policies.

actually look to external nature rather than rely on introspection alone for our classifications of mental and behavioral phenomena" (Young, 1990, p.12).[13]

However, some of Gall's contemporaries, who observed this methodological shift in real time, criticized him for it. One of his greatest opponents was physiologist Pierre Flourens, who attacked Gall's self-proclaimed goal of deciphering human character based on anatomical features: "Men will always be looking out for external signs by which to discover secret thoughts and concealed inclinations: it is vain to confound their curiosity upon this point: after Lavater came Gall; after Gall someone else will appear" (Flourens & Meigs, 1846). Indeed, Flourens was right to detect the growing trend to rely on external signs, in the current case neural findings, in order to unveil the true nature of human beings.

To demonstrate, let us turn to the English physician and physiologist William Carpenter. The title of his influential book *Principles of Human Physiology, with their chief applications to Psychology, Pathology, Therapeutic, Hygiene and Forensic Medicine* (Carpenter, 1860) is enough to reveal the writer's ideas about what can be derived from neurophysiology: insights for many fields, including psychology.[14] Moreover, in the first chapter, called "Of the Distinctive Characteristics of Man", he infers the superiority of intelligence over the senses based on anatomical findings. Even more radical is Carpenter's reliance on neurophysiology to claim that not all intellectual acts are conscious, or are consciously performed (*Ibid.*, p. 536).

So, neurophysiology turned from either distancing itself from philosophy or explaining what was already known about human behavior and thought in neural terms to *inferring from*

[13] See also the words of renowned evolutionary psychologist George H. Lewes: "Gall rescued the problem of mental functions from metaphysics and made it one of Biology. In his vision of Psychology as a branch of Biology, subject therefore to all biological laws, and to be pursued on biological methods, he may be said to have given the science its basis" (Lewes, 1871).

[14] See footnote 9 regarding the use of the term "psychology" in this context.

neural findings and discoveries what human behavior and thought (or consciousness, in the paragraph above) are. This has led other disciplines to also seek to introduce neuroscientific discourse into their theory and practice. In psychiatry, for instance, diagnosing patients according to their behavioral symptoms started to seem insufficiently scientific to some of the leading researchers of the time, moving from the 19th to the 20th century (Shorter, 1997). An example of this trend can be found in an unpublished note to Carpenter's mentor, Camillo Golgi, widely known for his contributions to the discussion around the neuron doctrine (Golgi, 1967), which stated: "The research methods applied in psychiatry are often inappropriate, because they are based on pseudo-philosophical systems rather than on biological issues."[15] Indeed, by the time the first edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-I) came out in 1952, explaining mental illness in terms of neurobiological dysfunctions was commonplace (Kawa & Giordano, 2012).

Similarly, psychologists were inspired by the progress of neurophysiology. In an 1851 letter to the British philosopher John Stuart Mill, psychologist and philosopher Alexander Bain (founder of the journal *Mind*,) wrote:

> …although I neither can, nor at present desire to, carry Anatomical explanation into the Intellect, I think that the state of the previous part of the subject will enable Intellect and Emotion to be treated to great advantage and in a manner altogether different from anything that hitherto appeared. There is nothing I wish more than so to unite psychology and physiology that physiologists may be made to appreciate the true ends and drift of their researchers into the nervous system…In fact I feel pretty confident of being up with the nervous physiology in its Psychological *bearings*, as it stands at present, although I am satisfied that if I had that familiar and perfect grasp that belongs to a professional Anatomist, I might do a vast deal more in the way of pushing forward my own subject. (Young, 1990, pp. 102-103. Italics ours)

[15] The note is preserved at the Institute of Pathology of the University of Pavia and quoted in (Liberini & Spano, 2000).

Despite the cautious opening, Bain's message is clear: experimental psychology will be better off if it relies on neurophysiology as a means to infer the "psychological bearings", as he puts it, of the nervous system.[16]

In 1949, psychologist Donald Hebb, who laid the grounds for the neural underpinnings of learning, published his book *The Organization of behavior: a Neuropsychological Theory* (Hebb, 1949). There, he set forth to present "a theory of behavior that is based as far as possible on the physiology of the nervous system" (*Ibid*, p. 1). Many then followed his assertion that "the problem of understanding behavior is the problem of understanding the total action of the nervous system" (*Ibid*, p. xiv). It is through this conception of the relationship between neuroscience and experimental psychology that neurophysiology gradually began to turn into 'humanology', culminating with (some) contemporary neuroscience claiming superiority over other disciplines that study human cognition and behavior. The latter shift has become even more evident with the development of neuroimaging techniques during the twentieth and twenty-first centuries. In the words of Posner and Raichle:

> The microscope and telescope opened up unexpected vast domains of scientific discovery. A similar opportunity has now been created in the study of human cognition by the introduction of methods to visualize the brain system involved as we think…the bulk of the impact will come when new theories are developed that take advantage of these previously unavailable tools. (Posner & Raichle, 1994)

This quote refers to functional neuroimaging (fMRI)[17], but the same approach applies to Electroencephalography (EEG)—i.e., recording electric activity from the brain—which was first

[16] In that respect, see also William James's claim that "Bodily experiences, therefore, and more particularly brain-experiences, must take a place amongst those conditions of the mental life of which Psychology need take account…Our first conclusion, then, is that a certain amount of brain physiology must be presupposed or included in Psychology" (James & Wilshire, 1971).

[17] Interestingly, about forty years prior to this scientific development that enabled obtaining of information from the living brain, the philosopher Herbert Feigl envisioned an 'autocerebroscope' that would enable people to examine the activity of their own brain. For him, such examination could serve to realize the identity between mind and brain (Feigl, 1967).

carried out on human subjects in the mid-1920s (Berger, 1929). Given its much higher temporal resolution compared to fMRI, EEG allows researchers to non-invasively examine neural activity in the living brain with a temporal precision of milliseconds, which to a large extent is the timescale of neuronal activity (the width of a single action potential is ~1 ms). This naturally strengthened the hope and expectations, and with it the claims, that neuroscience will unveil the mysteries of the mind. One example where EEG was used as a tool to understanding the mind is the creation of personality profiles (Becker-Carus, 1971; Lindsley, 1944; Pawlik & Cattell, 1965; Rösler, 2005). This is, in a way, reminiscent of Gall's phrenology (albeit much more empirically sound).

Alongside fMRI, nowadays EEG has become one of the central tools in the scientific inquiry of mental phenomena, often based on the assumption that it is better – i.e., more accurate and rigorous – to learn about mental phenomena from electrophysiology than from introspection and behavioral observation. In the words of neuroscientists Michael Rugg and the psychologist Michael Coles:

> The conventional methodologies of cognitive psychology do not permit cognitive processes and representations to be observed directly. Instead, they must be inferred by a judicious selection of experimental manipulation, and by an analysis of the effects of these manipulations on overt behavior. Given that cognitive processes are implemented by the brain, it makes sense to explore the possibility that *measures of brain activity can provide insights into their nature* (Rugg & Coles, 1996, p. 27, Italics ours).

According to Rugg and Coles, the aims of cognitive psychology are not restricted to deciphering the neural mechanisms involved in human cognition. Rather, these mechanisms are suggested to be used as *tools that might explain what human cognition is*. This is thus another example of the consistent effort to consolidate the neuro-centric paradigm: neural findings are means towards a separate, 'higher' end; namely, to learn new truths about human thinking and

behavior. In the neuro-centric paradigm, neuroscientific findings have the power of enriching, improving, and sometimes even completely changing philosophical theories of the mind.

As an example of the new methodology, consider one of the most controversial (yet influential) neuroscientific studies of the twentieth century: the Libet experiment (Libet, 1985; Libet et al., 1983).[18] In a series of experiments, Benjamin Libet and his colleagues presented participants with a clock composed of a dot moving around a circle at constant angular speed and recorded their brain activity using EEG. Participants were instructed to move their hand whenever they had the urge to do so, and to note the position of the dot at the time when they first became aware of that urge. The EEG recordings revealed that ~500 ms (on average) before participants moved electrical brain activity known to precede voluntary action (i.e., the 'readiness potential', or RP) was already apparent over the supplementary motor area. However, participants reported their first urge to move only ~200 ms (again, on average) before movement onset. Hence, critically, RP onset preceded the reported time of the urge to move by ~300 ms.[19] Electrophysiology, thus, led to one of the most widely debated claims in the history of neuroscience; namely, that the decision to perform a motor act is *unconsciously* initiated, with consciousness appearing only post-factum. For those endorsing the neuro-centric framework, this carried profound philosophical implications about free will and agency. As Libet himself notes (Libet et al., 1983), since the presence of the RP might be taken as evidence that even spontaneous, voluntary actions are unconsciously initiated, individuals might not be able to exercise full conscious control over such

[18] The readiness potential was not discovered by Libet. Rather, it was first reported by two German scientists in 1965. This potential was negative over the motor projection areas and was found to occur in the lead up to self-initiated action (Kornhuber & Deecke, 1965, 2016). Libet was the first to use this potential to investigate the relation between the neural activity accompanying volitional acts and participants' conscious decisions to act.

[19] There are a few versions of the Libet experiment, carried out in different times. These experiments were replicated but also widely criticized on methodological and conceptual grounds. For a comprehensive review of this literature see (Dominik et al., 2023)

actions. This, in turn, casts doubt on the very existence of an individual-level faculty for intending, initiating, controlling and intervening on actions – or on free will.

The Libet experiment is especially interesting for us here because its whole premise is to directly put the introspective approach (asking participants to report when they first had the urge to move) against the neuro-centric one (recording an EEG component that precedes voluntary action). Libet's interpretation of the results clearly assumes an advantage of the neuro-centric approach. Put differently, Libet's interpretation of his experiment's results suggests that the onset of an objective measure of the preparation to move (the RP) should be favored over the onset of the subjective one (the report of the urge to move) as *the* moment at which an intention to move is formed.

Based on these neural findings, Libet draws insights about the way humans make decisions and exercise will. What is more, here these findings are used to *negate some of our strongest and most persistently held beliefs about ourselves*, namely that we are free-willed creatures who consciously choose to perform one action or another. Philosopher Adina Roskies explicitly refers to this new practice when she writes:

> … those things that once seemed to be forever beyond the reach of science might soon succumb to it: neuroscience will lead us to see the 'universe within' as just part and parcel of the law-bound machine that is the universe without. The decisions, choices and actions we take are generally thought to be freely willed. But science reveals them, or threatens to reveal them, to be mechanistically or physically intelligible, and some have argued that our intuitive notions of freedom are thereby mistaken. (Roskies, 2006), p. 420)[20]

[20] Notice, however, that even though most people nowadays accept that neuroscience has at least the potential to undermine our common-sense conception of free will, the extent or seriousness of such threat is still up for debate. For instance, in a later paper Roskies explains that "the mere fact that […] volition has neural underpinnings", and that such underpinnings can be described mechanistically, "is not a basis for denying freedom of the will." (Roskies, 2010). Furthermore, a recent paper argues that findings from psychology, demonstrating unconscious effects on decision making, also do not currently pose a threat on free will (Mudrik et al., 2022).

Taking stock, we might ask: has the neuro-centric paradigm rendered philosophical conceptions of the mind obsolete, or at least less relevant than before to answer key questions about the mind? And is neuroscientific reasoning blind to philosophical views, such that the data itself indeed dictates the conclusions? Not really, as Popper would have predicted (Popper, 2002). For instance, it seems that Libet himself was unwilling to fully commit to the conclusion that he drew from his own experiment—that human beings might not have free will. Later on, he suggested a theory that preserves free will to some extent, this time relying on introspection, to reconcile it with his findings. He argued that, because participants reported becoming aware of their urge to act ~200 ms before movement, there might still be an "opportunity for the conscious will to control the outcome of the volitional process…or, the conscious will could block or 'veto' the process, resulting in no motor act" (Libet, 2003). Then, Libet's language changes even further: "the existence of a potentiality to veto is not in doubt. *Everyone has experienced* having a wish or urge to perform an act but vetoed the actual performance of the act" (*Ibid.*, italics ours).

He talks about what "everyone experiences" to show that the existence of a conscious veto cannot be doubted. But, of course, everyone also experiences—arguably even more strongly—that their conscious intent *initiates* their action. Then, he presumes that such a veto must take place during the time window between the conscious urge to act and the actual action, though, as he himself admits, there is "no evidence for such a mechanism." (*Ibid.*) In other words, Libet seemingly *tweaked the interpretation of his empirical findings to fit his pre-existing, introspection-based assumptions about free will and the role of consciousness in agency*. Prima facie, Libet fully endorses the idea that neuroscience can finally provide the new, theory-free, objective facts about the mind that philosophy could not produce by itself. The whole premise of his experiment rests

on this endorsement. Yet his reasoning is in fact still grounded in pre-established, introspectively based beliefs.

Another, perhaps more striking, example of such grounding can be found in the writings of Charles Sherrington, one of the most accomplished and prominent neuroscientists of all times. When discussing perception, Sherrington resorted to anatomical observations to provide empirical support for ontological dualism—the view that the mind and the body are made up of different kind of substances, an immaterial substance and a material one, respectively (Descartes, 1641/2013)**.** His rationale was simple; as there is no area in which right and left information from the retina converges, there must be a mental, non-physical mechanism by which the two are integrated:

> There is thus no evidence that the nervous paths from two corresponding retinal points R and L reach a common mechanism in the brain. The corresponding right-eye and left-eye perceptions are, however, contemporary...That it is not so misread shows that the nervous channels themselves are no part of experience; the mind does not experience them at all. That the conjoined reports are not misread indicates *their conjunction is mental, not physical* (Sherrington, 1951).

However, nothing about the neural data warranted this conclusion. Clearly, Sherrington's inference resulted from his pre-existing philosophical views, which served as background assumptions. Being a dualist *already*, Sherrington found in the brain what he interpreted as objective evidence for dualism. Other scientists with different ontological stances would have probably provided a different interpretation of the observed data. Quite similarly, Nobel Prize laureate Sir John Eccles maintained that "no doubt to the great discomfiture of all materialists and physicalists …the fact remains, and is demonstrated by research, that non-material mind acts on material brain" (Eccles & Cousins, 1985).

Scientists like Eccles (and Sherrington) offer the opportunity to make explicit an important aspect of what we call the neuro-centric paradigm: that is, that the neuro-centric paradigm should

be kept distinct from the more widely discussed neuro-reductionist one (e.g. Bickle, 1998). Although the overlaps are undeniable—many people we mentioned as advocates of the neuro-centric paradigm had reductionist ambitions— Sherrington and Eccles do not fit that profile. The neuro-centric paradigm differs from the neuro-reductionist one in that it is mostly a methodological, rather than epistemological or ontological, approach. In other words, the neuro-centric paradigm, as we understand it, is a paradigm that concerns the 'direction' in which inferences are drawn: from observed neural events to philosophical concepts and theories, rather than from philosophical concepts and theories to the neural events possibly causally related to them. In this sense, Eccles fits in the neuro-centric paradigm while remaining an ontological dualist in virtue of his commitment to the brain-to-mind 'order of inference', and more specifically his claim that the fact that "non-material mind acts on material brain" is something that can be "demonstrated by [neuroscientific] research".

In sum, though the neuro-centric paradigm has clearly generated new insights into cognitive processes, it also suffers from some serious shortcomings (Adolphs, 2015; Marek et al., 2022). Mainly, the neuro-centric paradigm fails to properly recognize the still important role that existing philosophical stands play in neuroscientific practice. For neuroscience to fulfill its potential to enrich our understanding of the mind, these implicit influences must be rendered explicit. And the best way to do this is to have philosophy and neuroscience found another, different paradigm *together*. The illustration below (Figure 2) represents both our understanding of the past and our hope for the future. In the next section, we present a few examples that such a future is, perhaps, already here.

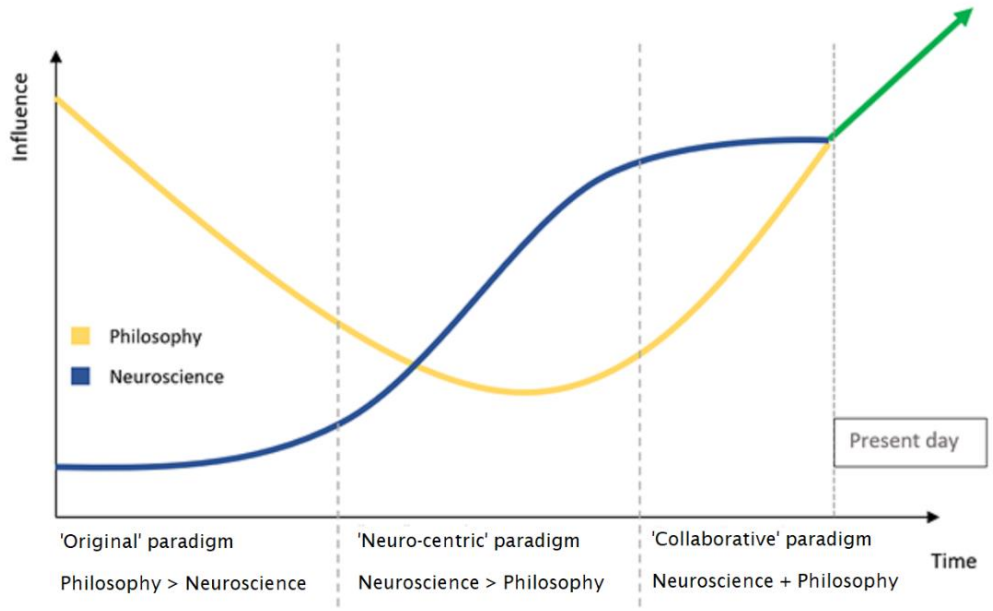

Figure 2. *A diagram illustrating the trend described in the paper. The explanation and understanding of the mind "shifted" from being mostly influenced by philosophy, to being a declared aim of neuroscience at the expense of philosophy, to finally being a joint focus of philosophy and neuroscience working together.*

The next paradigm shift: joining forces on more equal grounds

When neuroscientists and philosophers recognize the common ground among their investigations and come together to set the agenda, good things often happen. Drawing from our own experience, we focus on recent work on the same question that fascinated Libet: What is the role of the readiness potential and, more generally, of unconscious brain processes on volition and decision-making? Rather than attacking Libet's conclusions on empirical, methodological grounds, akin to important follow-up studies (Banks & Isham, 2009; Dominik et al., 2018; Haggard & Eimer, 1999), this group of scholars (some of whom are authors of this paper) started by turning to philosophy in an attempt to re-examine this problem on conceptual grounds.

In particular, philosophers differentiate between different types of decisions: *picking decisions*, which are arbitrary and non-reason based, and *choosing decisions*, which are meaningful

and reason-based (Ullmann-Margalit & Morgenbesser, 1977).[21] Philosophers[22] who examine Libet's experiment can accordingly ask: Why is it assumed that the spontaneous and, overall, meaningless picking decisions in that experiment should constitute paradigmatic instances of free will, which might be more relevant to choosing decisions? According to many prominent philosophical stances (for a review, see O'Connor & Franklin, 2022), free will is the ability to act for a purpose, make decisions with the intention of achieving specific goals, assign value to their options, and be responsive to reasons – which all pertain to choosing, not picking. None of that is reflected in the set up and theoretical assumptions underlying Libet's experiment or other subsequent experiments where the readiness potential was observed (Haggard, 2019). Accordingly, the group asked if the same RP finding would generalize to a situation where participants made choosing decisions that "matter", such as donating a large amount of money ($1000) to different charities. The results showed that the RP preceded arbitrary, picking movements but not deliberate, choosing ones, with real-world implications (Maoz et al., 2019).

Within a philosophically informed theoretical framework, the RP no longer constituted 'objective proof' that human decisions are determined by unconscious and uncontrollable brain

[21] There are reasons to think that Libet may have been aware of a version of this distinction (and its implications), as he explicitly mentions it in Libet et al. (1983), where he specifies cases in which consciousness might still play a causal role in voluntary actions: "In those voluntary actions that are not spontaneous and quickly performed, that is, in those in which conscious deliberation (of whether to act or of what alternative choice of action to take) precedes the act, the possibilities for conscious initiation and control would not be excluded by the present evidence". However, in a paper published just two years later, Libet (1985) stresses the potential importance of his work to the notion of moral responsibility and dismisses this distinction: "One might therefore speculate that the actual motor execution even of a deliberately preselected voluntary act may well involve processes similar to those for the spontaneously voluntary acts studied by us. The urge or intention actually to perform the voluntary act would then still be initiated unconsciously, regardless of the preceding kinds of deliberative processes." Indeed, some commentaries in that 1985 paper already took Libet to task on this generalization from arbitrary to deliberate decisions (e.g., Breitmeyer, 1985). Nevertheless, Libet's meshing of picking and choosing seems to have carried the day in the field, and the distinction got lost in most subsequent neuroscientific studies seeking to either replicate or expand on Libet's experiment (other than the one we discuss in this paper). To our knowledge, follow-up studies and commentaries on Libet mostly overlooked the picking-choosing distinction. When this was again introduced back into the literature (Maoz et al., 2019), it was indeed inspired by a philosophical paper, rather than by Libet's own comment. A detailed account of this issue can be found in (Dominik et al., 2024).

[22] See also a similar claim made by psychologist Bruno Breitmeyer (Breitmeyer, 2002).

activity. Though meaningful in the context of revealing *the first* neural correlate of subject-level action formation, the importance of the RP now appears somewhat diminished (Schurger et al., 2012, 2021). The neuro-centric paradigm, in which philosophy is held to only be informed by neural data, did not pursue these relatively fine-grained distinctions among types of actions and decisions.

We argue that such fine-grained conceptual distinctions, if properly operationalized, could lead to important differences in the functional profiles of cognitive capacities (and related mechanisms). Hence, the neuro-centric approach, in addition to being sometimes blind to these fine-grained conceptual distinctions, may also lead to straightforwardly contradictory hypotheses regarding such capacities. To determine which of these hypotheses is more plausible, then, it is crucial to look at the additional theoretical commitments and implications tangled up with them. For that, philosophical theories and practices can be extremely helpful. Maoz, Mudrik, and their colleagues are not an isolated case, either. Over the past decade, other neuroscientists have also been turning to philosophers as collaborators, for example to 're-engineer' their experimental practices (e.g. Schurger et al., 2021; Silva et al., 2013) and to refine their interpretations of empirical evidence.

Consider for instance the following approach to exploring the relationship between consciousness and attention. There seems to be neuroscientific evidence supporting both a tight and a not-so-tight relationship between these two cognitive capacities. The debate originated in part from philosopher Ned Block's famous distinction between 'phenomenal' consciousness, i.e. the 'what it is like' aspect of experience, and 'access' consciousness, i.e. what allows people to cognitively access and thus report their experiences (Block, 1995).[23] In a recent paper, Lopez

[23] According to some, a third type of consciousness, namely 'reflective' consciousness (Carruthers, 2000; Rosenthal, 1997), should also be kept conceptually distinct from the other two just mentioned.

(Lopez, 2022) argues that, despite contradictory conclusions drawn from neuroscientific and behavioral evidence, there are ways to reconcile the claim that attention and consciousness are highly independent capacities with the claim that we can learn something about the contents of consciousness by looking at what one attends to. By drawing more systematic, yet empirically justified, boundaries among different types of consciousness and different types of attention, more domain- and task-specific connections can be revealed, such as those between phenomenal consciousness and cross-modal attention (Haladjian & Montemayor, 2015; Montemayor & Haladjian, 2015). These examples invite us to take seriously the idea, central to the approach we advocate for in this work, that philosophers can contribute to concrete aspects of neuroscientific research, such as designing novel behavioral paradigms for exploring cognitive functions and interpreting the results of neuroscientific experiments, and not just to 'high-level' conceptual refinement.

As a final example, consider the framework known as '4E cognition' (the four Es stand for 'embodied', 'embedded', 'enactive', and 'extended'), which originated from the work of philosophers and scientists coming from quite different traditions and backgrounds (Chemero, 2009; Froese & Di Paolo, 2009; Gallagher, 2005; Gibson, 1979; Hurley, 1998; Synofzik et al., 2008; Varela et al., 1991). Over the years, clinical neuroscience and neighboring disciplines—such as occupational therapy, psychiatry, and neurology— have increasingly adopted methodologies and background assumptions consistent with that framework (Caspar et al., 2015; Foley et al., 2019; Haggard, 2017; Magnani et al., 2022; Synofzik et al., 2008), in addition to the broader 'biopsychosocial' model in medicine (Engel, 1977).

Conclusion

In this paper, we presented and discussed instances of different scientific paradigms that investigate the mind. These paradigms reflect different conceptions of the relationship between philosophy and neuroscience. While philosophy initially provided the basic assumptions and guiding concepts for neuroscience, the neuro-centric paradigm established neural data as the more accurate, more objective, and thus 'better', way to describe mental phenomena. However, despite its undeniably large influence on both neuroscientific and philosophical practice, the neuro-centric paradigm failed to completely transform these two disciplines and their relationship. Eminent neuroscientists—like Libet, Sherrington, or Eccles—who largely operated within the neuro-centric paradigm, were clearly still committed (albeit implicitly) to philosophical assumptions when interpreting data and drawing inferences from them. Yet, because the commitment was implicit, their claims gained the respectability of being based on 'objective data', potentially being favored over conceptually based work.

We think that an important lesson can be learned: the neuro-centric paradigm should give way to another one, in which philosophy and neuroscience *together* inspire and sustain a 'Cycle of kinds' (Francken et al., 2022) that iteratively increases our understanding of the mind. This collaborative paradigm may be our best chance at achieving a genuinely interdisciplinary, explanatorily powerful, and predictively fruitful science of the mind—combining the multiple perspectives that make us better philosophers and better neuroscientists. Though we are not oblivious of the inherent difficulties entailed by interdisciplinary dialogue, and the potential gap between scholars of the different disciplines (Laplane et al., 2019; Snow, 1993), we think that this is a challenge worth overcoming, given its prospects for establishing a more informed, conceptually grounded neuroscience (Buccella & Dominik, 2023; Maoz & Sinnott-Armstrong, 2022).

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