



## Theoretical Integration

## Neuroscience, quantum indeterminism and the Cartesian soul



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## ARTICLE INFO

## Article history:

Accepted 21 November 2013

## Keywords:

Quantum theory  
Dualism  
Soul  
Determinism  
Heisenbergian uncertainty  
Cartesian interactionism

## ABSTRACT

Quantum indeterminism is frequently invoked as a solution to the problem of how a disembodied soul might interact with the brain (as Descartes proposed), and is sometimes invoked in theories of libertarian free will even when they do not involve dualistic assumptions. Taking as example the Eccles–Beck model of interaction between self (or soul) and brain at the level of synaptic exocytosis, I here evaluate the plausibility of these approaches. I conclude that Heisenbergian uncertainty is too small to affect synaptic function, and that amplification by chaos or by other means does not provide a solution to this problem. Furthermore, even if Heisenbergian effects did modify brain functioning, the changes would be swamped by those due to thermal noise. Cells and neural circuits have powerful noise-resistance mechanisms, that are adequate protection against thermal noise and must therefore be more than sufficient to buffer against Heisenbergian effects. Other forms of quantum indeterminism must be considered, because these can be much greater than Heisenbergian uncertainty, but these have not so far been shown to play a role in the brain.

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## 1. Introduction

From the very moment of its formulation in the mid 17th C, Descartes' conception of an immaterial *rational soul* (or just *soul*, or *mind*) interacting with the human body-machine has been controversial, but it remained a powerful force in philosophy until well into the 20th century.<sup>1</sup> It subsequently declined owing to serious challenges from both philosophy and neuroscience, but in recent years there have been numerous attempts to promote modified forms of Cartesian dualism (also called *interactionist dualism* or *Cartesian interactionism* or just *interactionism*), motivated often by paranormal phenomena (Kelly, Kelly, & Crabtree, 2006) such as near-death experiences (Carter, 2010; Van Lommel, 2010) or sometimes by metaphysical considerations (Goetz & Taliaferro, 2011; Swinburne, 2013). If the conventional physical forces at work in the brain exerted a control that was completely deterministic, there would be no scope for the postulated nonphysical soul to act, so modern versions of Cartesian interactionism often follow Eccles and Beck (Beck & Eccles, 1992; Eccles, 1986) in invoking quantum indeterminism as a solution to this problem. Such approaches have been cogently criticized (Smith, 2009; Wilson, 1999), but counterar-

guments are sometimes advanced as is discussed below. I here extend the arguments of Wilson and Smith so as to address the counterarguments, emphasizing quantitative considerations and the inherent resistance of neural function to minor perturbations.

Some writings relating consciousness to quantum theory focus on other aspects of the theory than indeterminism (Penrose, 1994). These are beyond the scope of the present paper, but they have been criticized elsewhere (McKemmish, Reimers, McKenzie, Mark, & Hush, 2009; Smith, 2009; Tegmark, 2000).

## 1.1. Cartesian mechanism and interactionism

Descartes believed that animals were mindless hydraulic (or more strictly pneumatic<sup>2</sup>) machines. He thought the driving fluids of these machines were the *animal spirits*, which had been invoked by many classical and mediaeval thinkers from Alcmaeon and Plato onwards as being a kind of volatile substance that flowed along nerves, considered (wrongly, of course) to be hollow tubes. Their flow was considered to be controlled by filaments that operated tiny “valvules” in the nerves and in the ventricles of the brain. Descartes attempted to explain reflex movements by the flow of animal spirits. External stimuli would move the skin that would in turn pull on the filaments and hence open valvules to release the flow, ultimately affecting the muscles and producing movement. His idea was not, however, limited to simple movements. He also tried to analyze

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<sup>1</sup> There have been two main notions of soul in western thought. The Platonic (and Augustinian) tradition postulated a separate, interacting soul, whereas the Aristotelian (and Thomistic) tradition postulated an embodied soul, which was thought to be an internal principle inherent in the body, not a separate entity. In postulating a separate, interacting soul Descartes aligned himself with the Platonic tradition. We are here concerned only with the interacting soul postulated by Descartes.

<sup>2</sup> Descartes' model is often described as “hydraulic” but the term ‘pneumatic’ would be more accurate because he envisaged the driving fluids (the animal spirits) as being more like a gas than a liquid.

sensation, and in *Passions of the Soul* (1649) even emotions, as being due to the way animal spirits were induced to flow from the periphery to the brain ventricles as a result of external events.

But Descartes held that *man* was more than a machine. Drawing on the dualistic philosophy that had been so important to many earlier Platonist thinkers on the mind-brain relationship including Galen, he proposed that man was a *soul in a machine*. Human reflex actions and emotions were explained on the same mechanical basis as in animals, but human voluntary thought and behaviour required an interaction between the material automaton and the immaterial, indivisible *rational soul* (or just *soul*), which Descartes considered to lack spatial extension and location. He maintained that the interaction occurred in the pineal gland, where the rational soul redirected small tissue movements so as to regulate the flow of animal spirits, and where the animal spirits could affect the soul. He chose the pineal gland as the site for body-soul interaction because it is a single, unpaired structure appropriate for interaction with a unique soul, and because he believed (incorrectly) that it protruded into the middle (3rd) ventricle and was thus well placed for influencing the movements of the animal spirits.

Descartes' conception of body-soul interaction was strongly critiqued from the very start. The pineal gland as site of body-soul liaison was soon abandoned, but other sites such as the corpus callosum were then proposed (Gaukroger, 1995). More important for our present concerns are early criticisms of the very notion that an immaterial soul could interact with a material body. One of the first protagonists in this debate was the brilliant Princess Elizabeth of Bohemia (oldest daughter of King James VI and I of Scotland and England), who maintained a long correspondence with Descartes. She argued that an immaterial soul could never interact with a material body, and wrote:

“... it would be easier for me to concede matter and extension to the soul than to concede the capacity to move a body and to be moved by it to an immaterial thing.” Princess Elizabeth of Bohemia to Descartes, June 10–20, 1643 (Shapiro, 2007).

This *interaction problem* is the main focus of this paper, but it is by no means the only criticism that can be raised against Cartesian interactionism. To avoid misunderstanding on this point, I now briefly mention other kinds of criticism.

## 1.2. Modern criticisms of Cartesian interactionism

### 1.2.1. Criticisms from philosophy

Interactionism has been strongly criticized by philosophers, especially since the 1950s. Linguistic philosophers in the Wittgensteinian tradition such as Gilbert Ryle argued that interactionism was an attempt to solve a non-problem. They claimed that it is an error to ask how mental and biological states fit together, because combining mind language and brain language in the same sentence is a source of confusion. Others, such as U.T. Place and Herbert Feigl argued in the 1950s that the mind and the brain were identical, and their *mind-brain identity* thesis has since become a major position in the philosophy of mind. Still others argue that mind and brain are not so much identical as *complementary aspects* of a single underlying entity (Chalmers, 1996; Murphy & Brown, 2007); this view has a variety of names including *neutral monism* and *dual-aspect theory*. Still others have chosen radical positions according to which either matter does not exist (idealism) or mind does not exist (eliminative materialism). In short, the philosophy of mind is as controversial as ever, but Cartesian interactionism is a minority view. It does however still have some supporters and their number seems to be growing (Goetz & Taliaferro, 2011; Madell, 2010; Swinburne, 2013).

### 1.2.2. Criticisms from neuroscience

A very strong attack on Cartesian interactionism has come from neuroscience. There is an enormous amount of relevant data, from many different levels of analysis. Cellular neuroscience is providing a detailed mechanistic understanding of how neurons function and communicate with each other. *In vivo* studies are showing how neural circuits analyze visual scenes, pre-programme movements and store memories. And computational studies are testing and refining our understanding of how neural circuits function. It would be beyond our scope to review this vast wealth of data, since most readers of this journal will be well acquainted with it, but it is worth emphasizing two conclusions that can be drawn:

1. Brain activity does not merely parallel mind activity, it causes it, as is shown by the results of brain stimulation.
2. In several cases, as in visual perception or memory storage and retrieval, we understand in some detail how the neural circuits perform operations underlying cognition, without any need for an interacting soul, and can confirm this by simulation.

It is difficult for an interactionist dualist to explain such findings if he believes, as Descartes did, that cognitive functions are performed by the soul and not by the brain.

## 2. Current day interactionism: a distributed and limited role for the soul or self

The most clearly formulated and most frequently cited modern model for Cartesian dualism is that of Nobel prize-winning neurophysiologist Sir John Eccles (1903–1997), especially the version that he elaborated with physicist Friedrich Beck (Beck & Eccles, 1992; Eccles, 1992, 1995). Recent supporters of Cartesian dualism continue to use this model or ones resembling it (Beck, 2008; Hari, 2008; Stapp, 2009). The model incorporates some but not all aspects of Descartes' original version. Like the latter, it postulates a separate nonphysical self (or soul or mind) interacting bidirectionally with the brain, but it rejects Descartes' notion of a unique site of soul-brain liaison, and instead posits a distributed array of liaison sites. These are postulated to occur in cortical modules, each containing a few thousand neurons, distributed through many parts of the cerebral cortex, particularly in the dominant hemisphere. Eccles generally called the supposed nonphysical interacting entity the “self” or the “mind”, because he felt that these terms were more metaphysically neutral than “soul”, but he did not object to the term soul. He speculated that the self interacts only with certain modules, which he called “open modules” (Eccles, 1979, 1980). He further suggested that the self is “microgranular”, being composed of multiple “psychons”, and that within the open modules each psychon would interact with the numerous synapses on a “dendron” consisting of a bundle of apical dendrites belonging to pyramidal neurons (Eccles, 1992). He argued that the open modules must be influenced by the self in situations of conscious volition, and could also be scanned by the self. Thus, the interaction would be bidirectional, self-to-brain and brain-to-self.

Another difference between this model and that of Descartes is that it postulates a much more limited role for the self or soul. To Descartes, almost the whole of cognition was performed by the separate, immaterial soul, not by the brain, but this strong claim is clearly untenable in the light of modern neuroscience. Eccles made only the weaker claim that the “self-conscious mind” (or “self” or “soul” etc.) exerted a “superior interpretative and controlling role...so that there is a unified conscious experience of a global or gestalt character” (lecture 2 in (Eccles, 1980)) and also for intentionality (Beck & Eccles, 1992).

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