Changing One's Mind: Philosophy, Religion and Science

Ariel Furstenberg*

From reflex to reflection: Moving from the space of causes to the space of reasons and back

<https://doi.org/10.1515/opphil-2020-0124>

received April 30, 2020; accepted October 9, 2020

Abstract: This article proposes to narrow the gap between the space of reasons and the space of causes. By articulating the standard phenomenology of reasons and causes, we investigate the cases in which the clear-cut divide between reasons and causes starts to break down. Thus, substituting the simple picture of the relationship between the space of reasons and the space of causes with an inverted and complex one, in which *reasons* can have a causal-like phenomenology and *causes* can have a reason-like phenomenology. This is attained by focusing on “swift reasoned actions” on the one hand, and on “causal noisy brain mechanisms” on the other hand. In the final part of the article, I show how an analogous move, that of narrowing the gap between one’s normative *framework* and the space of reasons, can be seen as an extension of narrowing the gap between the space of causes and the space of reasons.

Keywords: reasons, causes, decision-making, picking, choosing, impulsivity, neuronal noise, neuroscience and philosophy

1 Introduction

This article proposes to soften the philosophically acknowledged dichotomy between reasons and causes. Not by articulating some kind of representational medium in which reasons can meet causes, but by analyzing their phenomenological character. By articulating the standard phenomenology of reasons and causes, one can investigate the cases in which the clear-cut divide between reasons and causes starts to break down. Thus, substituting the simple picture of the relationship between the space of reasons and the space of causes¹ with an inverted and complex one. In this inverted picture, *reasons* have a causal-like phenomenology and *causes* have a reason-like phenomenology. In the final part of the article, I show how an analogous move, that of softening the distinction between one’s normative *framework* and the space of reasons, can be seen as an extension of the softening of the dichotomy between the space of causes and the space of reasons.

---

¹ I’m alluding here to Sellars’ (1956) classic paper “Empiricism and the Philosophy of Mind,” in which the phrase “space of reasons” was coined. It was further elaborated in Brandom, *Making it Explicit* and McDowell, *Mind and World*. “In a slogan, the space of reasons is the realm of freedom” (McDowell, *Mind and World*, 5). “McDowell also emphasizes the fact that since justifications are linguistic, the space of reasons should be regarded as a ‘conceptual’ space [...] The contrasting logical space is that which it is the job of the natural sciences to deliver. In recognition of the fact that such sciences yield descriptions, explanations and predictions based on natural laws, it is sometimes called the ‘realm of law’. On other occasions the specifically causal nature of these laws is emphasized by terming it the ‘space of causes’” (Pollard, “Naturalizing the Space of Reasons”).

---

* **Corresponding author: Ariel Furstenberg**, The Hebrew University of Jerusalem, Edmond and Lily Safra Center for Brain Sciences, Jerusalem, Israel, e-mail: ariel.furstenberg@gmail.com

To set the stage, it is useful to describe certain “freewill” behavioral impairments in patients with prefrontal cortex lesions. Through these impairments, one can learn about freewill behavior and the elements that behaviorally and conceptually take part in it. This will lead us to an analysis of the relationship between the space of reasons and the space of causes in impaired and healthy behavior and in other situations.

2 A short behavioral sketch

I wish to dwell here on two behaviorally impaired decision processes: *prolonged decision-making* and *impulsive decision behavior*, such as observed in patients with *orbitofrontal cortex lesions*.² These patients experience difficulties in making everyday simple decisions (involving picking between similar things; e.g., “which of these similar shirts to wear?”). On the other hand, faced with real-life situations, some make socially inappropriate, seemingly impulsive, decisions (e.g., making sexual insinuations, signing checks that bounce, inappropriately reaching to someone else’s food plate).³ At the base of these behaviors lie the notions of “conflict,” “conflict resolution” and “self-control.” These patients seem to have difficulty in resolving simple conflicts and lack a measure of self-control. These two impediments are connected. Self-control is applied mainly by an agent experiencing an impulsive resolution within a conflicting situation; ordinarily, without an inner conflict, there is no need for self-control.⁴

There are different types and levels of inner conflicts. The conflict can emerge between one’s evaluative judgment and an intentional action or desire; or between a prior intentional resolution and a current intentional action.⁵ If it is a complex high-level conflict, it typically involves a *choosing*-type selection, in which one can give *reasons* (e.g., in the form of evaluative judgments, a taste or a desire). However, a basic low-level inner conflict occurs within a *picking*-type selection, in which the alternatives make no difference to the agent (following the notions coined by Ullmann-Margalit and Morgenbesser).⁶ Time has an essential role here too. A *rapid* formation of an intention to act might lack self-control and express impulsive behavior. Empirically, one of the features of impulsivity and lack of self-control seems to be the early termination of the deliberation process in the face of a conflicting selection process.⁷

In a way, these patients with their impaired behavior exhibit an ancient philosophically described phenomenon, that of *weakness of will*, on two levels: (a) in picking situations, the *will* is very weak and the patients find themselves in a kind of paralysis (such as described in “Buridan’s ass” parable).⁸ (b) In a conflicting situation created by environmental cues vs good (social) *reasons* why not to act upon these cues – impulsive behavior and unwarranted intentions might arise. Whether *weakness of will* is best understood as action contrary to one’s better judgment, or as action contrary to some prior resolution,⁹ the impulsive behavior reflects, in these situations, a clash between the *space of reasons* and the *space of*

2 Szczepanski and Knight, “Insights into Human Behavior;” Manes et al., “Decision-making Processes;” Berlin et al., “Borderline Personality Disorder, Impulsivity, and the Orbitofrontal Cortex.”

3 These are impairments found in studies regarding certain type of patients. It does not mean that each and every patient possesses all of these impairments or any at all. However, it does give us a hint as to what kind of mechanisms might be in charge in avoiding such behavior.

4 Hofmann et al., “Dieting and the Self-control of Eating in Everyday Environments.”

5 Mele, “Weakness of the Will and Akrasia;” May and Holton, “What in the World is Weakness of Will.”

6 Ullmann-Margalit and Morgenbesser, “Picking and Choosing.”

7 In fact, frontal premotor – sub-thalamic nucleus pathways may be involved in conflict resolution by acting as a “brake” during decision conflict, “buying time” until the right decision can be made (Frank, “Hold Your Horses”).

8 For a discussion on “Buridan’s ass” see Weintraub, “What Can We Learn from Buridan’s Ass?”

9 Mele, “Weakness of the Will and Akrasia;” May and Holton, “What in the World is Weakness of Will.”

causes. For example, a patient comes into my office and sees *my* apple on my desk. Impulsively and socially inappropriately, he reaches out to my apple and bites into it. This agent has good *reasons* why to behave in a certain way (and refrain from reaching out to the apple), but an environmental cue (perceiving the apple) created a swift *causal* trajectory leading to the contradictory behavior of reaching out and eating the apple.¹⁰ This is the type of clash we observe in these patients between the two spaces of *reasons* and *causes*. I will return to these patients after analyzing the relationship between the *space of reasons* and the *space of causes*.

3 Causes and reasons

Articulating the relation between these two spaces – the *space of reasons*, with its social and normative aspects, and the *space of causes*, with its physical and deterministic aspects – is first and foremost a conceptual task. The challenge in drawing a line and examining the interaction between reasons and causes is of course a great one. Primarily, since it requires going to the background on which they are constructed and delineating the various directions and schools of thought regarding issues such as mind, body, representations, actions, intentions, desires, agency, dispositions, motivations and justifications. This is a lifelong project. However, a good starting point is Davidson's famous 1963 paper on "Actions, Reasons, and Causes," in which he concludes that "reasons are causes." Davidson decomposes reasons into *beliefs* and "*pro-attitudes*" (i.e., what it is about the action that is attractive to the agent, such as desires, wants or feelings of obligation). An action is explained when we come to see the agent's (reasoned) intention, which is explained in terms of the agent's beliefs and pro-attitudes. Davidson argues that explaining an action by eliciting the intention with which it was done is actually a causal explanation.¹¹ This line of thought – of belief–desire pairs as primary reasons for the (intentional) actions that they cause, embracing event causality – has been much discussed and criticized.¹² However, whether Davidson's line of argument is accepted or criticized, the discussion in philosophy of action mainly revolved around the axis from *reasons* to *causes*, asking: are reasons causes of action? This direction, from reasons to causes, is of course a reasonable one. Whenever there is a *reason* to do something and that something was done (i.e., there was a physical behavior), somewhere in the middle there was a causal chain ending with that physical behavior.¹³ However, there is a need to map the relationship between the *space of reasons* and the *space of causes* also in the reverse direction: from *causes* to *reasons*. Obviously, the issue is not symmetrical and one cannot simply argue that "causes are reasons" ("what would that even mean?"). Nevertheless, it is important to emphasize the way in which certain causal mechanisms do "make way for reasons." Moreover, there are cases of swift causal reasoned actions in which in a sense the cause for action precedes the reason for action.

4 Immediacy and regularity

Before moving in this direction, a few thoughts are in place regarding the character of these two spaces of reasons and causes. Practical reasons are attitudes (beliefs and desires) that can be

¹⁰ This is also known as "environmental dependency syndrome" (e.g., Boccardi et al., "Utilisation Behaviour Consequent to Bilateral SMA Softening").

¹¹ Risjord, "Reasons, Causes, and Action Explanation;" compare to Dretske, "Reasons and Causes."

¹² See for example Sandis, *New Essays on the Explanation of Action*.

expressed as propositions, whereas causes are understood as events. They are not of the same kind; they are categorically different. Moreover, in contrast to causes, practical reasons are part of a social construct:

It is the norms of a community that determine whether the desires and beliefs of an agent can count as reasons for action. It follows that whether an agent has a reason for acting does not depend solely on facts about that agent. The agent must also have a social status, an entitlement or commitment, and it is this social status that turns the facts about the agent into reasons.¹⁴

A particular intention may or may not settle how one *will* act, but its content determines how it is *appropriate* to act, and this is its *normative* pragmatic significance. And this of course does not deny having also causal significances. Thus, *normative* intentional explanations are more fundamental, they are presupposed and built upon by *causal* ones.¹⁵

In the twentieth century, the later Wittgenstein was a central advocate of the thesis that intentionally contentful states and acts have an essentially *normative* pragmatic significance. Anthony Kenny's *The Metaphysics of Mind* and Robert Brandom's *Making It Explicit* see Wittgenstein as their point of departure.

It is characteristic of psychological determinism to treat the reasons and motives of actions as if they were the causes of those actions—causes which can be brought under the covering laws constitutive of the structure of determinism. In fact, reasons are not causes, and the relationship between reason and action is quite different from that between cause and effect. The rules which govern practical reasoning are of a totally different form from those which govern the operation of physical causes.

One important difference between the explanatory power of reasons and the operation of causes is this. If there is present a perfectly adequate cause for an effect, then the effect cannot but follow: for a cause—at least on the determinist's view of the matter—is a sufficient antecedent condition for the effect, and if an effect does not follow when an alleged cause is present we know the cause is not a genuine one. On the other hand, there may be a perfectly adequate reason for performing an action and yet the action not ensue, without this fact casting any doubt on the adequacy of the reason.¹⁶

This, of course, rests on the basic difference between normative rules (i.e., rules governing behavior) and natural laws. It is possible that normative rules be violated in practice, as opposed to laws of nature which cannot possibly be violated (without a miracle). "If you find an apparent violation of a natural law you have an indication that the law has been wrongly stated. The occurrence of a violation of a [normative] rule, on the contrary, is no evidence that the rule has been wrongly framed."¹⁷ Without distinguishing between *being* correct and *seeming* correct:

there is no possibility of mistake or error, and without the possibility of being wrong one has no intelligible conception of normativity at all. This point is particularly pressing [...] for there is always the danger of 'ought' collapsing into 'is' and the distinction between seeming right and being right collapsing with it. A consequence of the distinction between being right and seeming right is that values cannot be conceived in individualistic terms.¹⁸

When we act *because* we want to or have decided to act, one should not mistake the "*because*" for a causal relation. Otherwise, the moment we "want to act" nature will take its course and the act will happen necessarily. Although "*because*" does not introduce a causal explanation of one's actions, it may actually serve to exclude certain kinds of causal explanations such as involuntary actions or twitches.¹⁹ The "*because*" is an invitation to dwell in the *space of reasons* not *causes*. In contrast, neuroscientific explanations express the space of causes. Neuroscientific explanations connect (in a causal or correlational manner)

¹³ Of course, "behavior" isn't the same thing as limb movements involved in that behavior, but it is the meaningful organizational feature of these movements (see Dretske, "Reasons and Causes," 4, footnote 5).

¹⁴ Risjord, "Reasons, Causes, and Action Explanation," 6.

¹⁵ Brandom, *Making it Explicit*, 15–6.

¹⁶ Kenny, *The Metaphysics of Mind*, 143–5.

¹⁷ Kenny, *The Metaphysics of Mind*, 154; compare to Brandom, *Making it Explicit*, 14.

¹⁸ Risjord, "Reasons, Causes, and Action Explanation," 5.

¹⁹ Bennett and Hacker, *Philosophical Foundations of Neuroscience*, 227–8.

between brain activity and some phenomenon that the animal or the human exhibit. Interestingly, in the case of human beings, neuroscience aims at explaining the neural conditions for the possibility of the mastery of a language. In a way, possessing language is an expression of rationality in both thought and action. However, as Bennett and Hacker stress,

neuroscience cannot displace or undermine the explanatory force of the *good reasons* we sincerely give for our behavior, or invalidate the *justifications* we give for *rational* behavior. The rationality of behavior that is motivated by good reasons is not given a deeper explanation by specifying the neural facts that make it possible for the creatures such as us to act for such reasons. *When we apprehend the propriety, adequacy or goodness of the reasons for which a person acted, then we fully understand why he did what he did.*²⁰

Language goes hand in hand with normativity. Specifically, the realm of linguistic “meaning” is in the heart of the normative system. Therefore, there is a philosophical attempt to articulate a theory of meaning that can help reveal the connection between the space of reasons and the space of causes. Dretske, for example, aims at articulating a theory of meaning which is based on a certain notion of *representation* at its center.²¹ This notion of representation is a causally relevant property in explaining behavior on the one hand and, on the other hand, is the vehicle of “meaning” and thus takes part in justifying behavior. The general structure of justifying behavior is usually in the form of inferential relations. This is Dretske’s attempt to explain the Davidsonian idea of “reasons are causes.” However, this isn’t the only way to go about a theory of meaning. In opposition to this stance, Brandom’s theory of language results in the reversal of this traditional relationship between *representational* properties and *inferential* properties. The traditional view was that the meaning or content of concepts had to be *fixed* in order to articulate an inferential relation as premises and conclusion between them. Therefore, when meaning and content are acquired by some notion of *representation*, we get that *representational* properties lead to *inferential* properties. However, Brandom, following others, questions this semantic commitment and claims that meaning and content are acquired by the inferential role of a concept. Thus, *inferential* roles and not *representations* are at the foundation of conceptual content. This approach “sees issues of what is a reason for what as essential to the identity and individuation of the conceptual contents that stand in those inferential relations.”²² Accordingly, *inferentialists* define representational properties in terms of inferential ones.²³

According to Brandom,²⁴ when one utters a sentence and thereby makes an assertion, one is committing oneself to defend that assertion against whatever objection or challenge might be raised by a hearer. The defense would take the form of giving *reasons* in support of that assertion, typically by *inferring* it from some other sentence (whose uttering might not be so readily open to challenge).²⁵ In making the assertion, one also confers on oneself the *entitlement* to make further inferences from it. In this way, one reveals the web of material inferences that his assertions are imbedded in. This process of revelation comes through the social game of *giving and asking for reasons*. Representations in this account are not the basis for a theory of meaning but rather one of the tools of communication.²⁶

²⁰ Bennett and Hacker, *Philosophical Foundations of Neuroscience*, 365; my emphasis.

²¹ Dretske, “Reasons and Causes.”

²² Brandom, *Tales of the Mighty Dead*, 4. Brandom’s pragmatism is a very detailed elaboration of the Wittgensteinian idea that “the meaning of a word is its use.” His approach is radical, however, in the sense that *meaning* is a result of the position held by a concept or an assertion in the web of inferences. Concepts and assertions acquire their meaning solely by their role within the web of inferences (for analysis and expansion of Brandom’s approach see Furstenberg, “Tradition and Conceptual Dynamics”). It is important to notice what creates the “pragmatic communal core.” In Brandom’s case, it is the use and role of concepts in the web of inferences. However, there are other possibilities, of course. An interesting possibility is to look at the pragmatic core, not of the use, but of *avoiding misuse* (such as developed in Kazimierz Ajdukiewicz’s *Directival Theory of Meaning*. A critical exposition of this stance can be found in Grabarczyk, “Directival Theory of Meaning Resurrected”). This can result in an alternative relation between inferentialism and representation, but this is beyond the scope of the article.

²³ Brandom, *Making it Explicit*, 94.

²⁴ Ibid; Brandom, *Tales of the Mighty Dead*.

²⁵ MacFarlane, “Future Contingents and Relative Truth.”

²⁶ For Brandom’s explanation of Davidson, see Brandom, *Making it Explicit*, 253–71.

Whichever side you hold with regard to a theory of meaning and the representation–inferential hierarchy dispute, a central aspect of language is the move from the concrete to the symbolic and opening the possibility of going beyond the immediate in pursuing a goal. Normativity enters, according to Kenny, through the notion of the “mind,” which he defines as the *capacity* for behavior of symbolic kinds which constitute the linguistic, social, moral, economic, scientific, cultural, and other characteristic activities of human beings in society.²⁷ Since minds are capacities, they are obviously not physical objects, as opposed to human beings and their brains.²⁸ The capacity for symbolic activity is central to this line of thought.

The pursuit of self-selected goals that go beyond the immediate environment in space and time is not possible without the use of symbols for the distant, the remote, and the universal. And on the other hand, the use of symbols itself involves purposes which go beyond the temporal and spatial present. Secondly, *to use something as a symbol and not as a tool is to use it in such a way that any effect which it may have on the environment lacks the immediacy and regularity characteristic of physical causality.*²⁹

The second point is central. It connects between language and goals which go beyond the temporal and spatial present. It claims that the symbolic *goes beyond* immediacy and regularity within the actual causal world. Thus, “practical reasoning,” defined as reasoning we use in planning how to achieve our goals within a normative framework, can have an effect on the physical environment, but it lacks *immediacy and regularity*.

Up to this point, it seems that we have a clear divide between the characteristics of the normative space of reasons and the physical space of causes, mainly with regard to notions such as *immediacy* and *regularity*. The causal seems immediate and creates a chain-like reaction according to laws of nature that cannot but be realized, whereas the reasoned and normative lack the immediacy and regularity characteristic of physical causality.

It is important to stress that the abovementioned description of physical causality and practical reasoning is a paradigmatic one and captures a very central aspect of them. However, it is limited in scope. It does not capture the character of *immediacy* and *regularity* in “swift reasoned actions” and in “causal noisy brain mechanisms.” In the former case, *reasons* are immediate and automatic; and in the latter case, *causes* lack immediacy and regularity; thus, substituting the simple picture of the relationship between the space of reasons and the space of causes with an inverted and complex one. In this inverted picture, *reasons* have a causal-like phenomenology and *causes* have a reasoned-like phenomenology. Sections 5 and 6 describe these additional important relationships between the space of reasons and the space of causes.

5 Do reasons have to be rehearsed “online”?

The capacity for intentional action, according to Kenny, is the same thing as the capacity to act for reasons. To have reasons for action it is necessary, though not sufficient, to have the ability to recognize actions as falling under linguistic descriptions (typically, “propositions”). Thus, the connection between the linguistic *symbolic* and the *actual causal world* can take the following form:

To act for a reason, it is not necessary that one should actually rehearse the reason, even in momentary silent soliloquy. There are countless cases where one acts for reasons and yet acts immediately without deliberation or reflection. For instance, a physician examining me says ‘take a deep breath’ and I do so; or, seeing a child running in front of my car,

²⁷ Kenny, *The Metaphysics of Mind*, 7.

²⁸ The claim that the mind is not a physical object is, of course, a conceptual claim as it cannot consist of length, breadth and location (Kenny, *The Metaphysics of Mind*, 73). Although Kenny and Brandom seem to have similar sensibilities their entering points are different. Brandom enters from the pragmatic “doing,” whereas Kenny’s entering point is from the side of the “mind.” It is interesting to compare them, since, in a way, the notions *reasons* vs *causes* reflect the notions “mind” vs “doing.”

²⁹ Kenny, *The Metaphysics of Mind*, 21; my emphasis.

I swerve to avoid him. If these actions are done for a reason then there will be a pattern of reasoning which can be exhibited after the event ('I obeyed the doctor because [...] 'I turned the steering wheel to the right because [...]'). But the reasons which would appear in the later formulation need not have formulated themselves in the agent's consciousness at the time in order to have been his genuine reasons.³⁰

The reasons are not deliberated and reasoned "online" in such swift cases. It even seems that the order of things is reversed here and the *cause* for action preceded the articulated *reasons* for action. But maybe the child running in front of the car is a *cue* for the *reasoned process* done *earlier and elsewhere in life*, expressed as a causal bias toward avoiding the child.³¹ Moreover, the modes of action are understood linguistically and can be thought of in an abstract symbolic way; therefore, the reasoned process done earlier and elsewhere in life does not have to be case-specific but can even be formulated in abstract terms. All this leads to the fact that practical reasons can have (in specific settings) a deterministic causal-like phenomenology.

But this phenomenology goes deeper. If we ask: where was the reasoned process (e.g., resulting in the bias toward avoiding the running child in the street) done earlier *during one's life*? The answer might not be obvious. However, it seems that many of these processes fall under the Wittgensteinian "inherited background" or "normative framework."

[...] I did not get my picture of the world by satisfying myself of its correctness; nor do I have it because I am satisfied of its correctness. No: it is the inherited background against which I distinguish between true and false.³²

Wittgenstein in this small passage stresses the background and the framework of knowledge as a kind of an untouchable *given*, but this is only part of his larger thesis of the untouchability of the normative *framework* emphasized in the (second) linguistic turn of the twentieth century, as Fisch and Benbaji put it:

[M]eaningful discussion of and reflection on one's own normative vocabulary (or language game, "system of belief," "form of life," or "final vocabulary" as such frameworks are variously termed) is necessarily *determined* by and *contained within* it to the extent that, as Rorty rather forcefully puts it, "all we can allow ourselves" is to "limit the opposition between rational and irrational forms of persuasion to the *interior* of a language game, rather than try to apply it to interesting and important shifts in linguistic behavior." It is only "within a language game, within a set of agreements about what is possible and important, [that] we can usefully distinguish reasons for beliefs from causes for belief which are not reasons."³³

The main claim is about the *constitutive* role that the normative framework holds. The normative framework is supposedly untouchable by reason. It is the *background* within which the game of reasoning takes place but not part of the game of reasoning. In our context, the important thing is that since one's normative framework is an "untouchable background framework" it plays a causal-like role and not a reason-like role. One of the characteristics of an agent's normative framework is that the agent acts *automatically* and *deterministic-like* with regard to his/her normative framework. There is no reasoning or deliberation done while one is relating to his/her normative framework. One might deliberate *within* the normative framework but not *with regard* to the framework itself.³⁴ Another characteristic is the agent's difficulty to articulate the set of propositions of one's *own* normative framework. Going back to our driver avoiding the child, one might suggest that practical reasoning behind such an act is a reflection of one's own normative framework and, therefore, not part of an online reasoning process but rather an *automatic, deterministic-like, causal-like* process.

³⁰ Kenny, *The Metaphysics of Mind*, 42.

³¹ Furstenberg et al., "Change of Intention in 'Picking' Situations." An important comparison is McDowell's notion of "second nature" (McDowell, *Mind and World*, 84; see discussion in Pollard, "Naturalizing the Space of Reasons").

³² Wittgenstein, *On Certainty*, 94.

³³ Fisch and Benbaji, *The View from Within*, 9; my emphasis. Rorty's quote is from Rorty, *Contingency, Irony, and Solidarity*, 47–8.

³⁴ Fisch and Benbaji take the challenge to show that it is possible to modify rationally even one's normative framework. As they show nicely in their book (Fisch and Benbaji, *The View from Within*), although the normative framework creates strong constraints to modifications it is a possibility using a unique process (which I will return to in the last section).

6 “Make way for reasons”

Here I want to go to the other extreme and claim that the *causal* activity of “neuronal noise” in the brain can have characteristics that fit the normative realm. “Neuronal noise” is a causal mechanism that creates *lack of immediacy* and *lack of chain-like reactions*; thus, the *space of causes* can have a *reason-like* phenomenology. In general, this is a causal mechanism that can “make way for reasons” and create a void for the normative to enter.

A fairly detailed account of the notion of neuronal noise and some philosophical implications are given by Shadlen and Roskies.³⁵ Noisy neuronal activity generally means that a neuron behaves variably even in repeated (seemingly) identical conditions. The source of this variability is not known for sure; however, we can assume that it reflects deterministic processes.³⁶ The origin of the noise in the neocortex probably has to do with synaptic integration, a manifestation of a chaotic mechanism that balances excitation and inhibition.³⁷ Delicate balance explains the very rapid response of neurons to a change in their input. Yet this balance also leads to highly variable responses by individual neurons.³⁸ On the one hand, this noise is inseparable from functional brain activity; on the other hand, the function of the brain is affected by the noise. For example, noise can affect simple decisions and be the source of errors and uncertainty in these decisions. Noise limits the perceptual sensitivity and motor precision. Thus, one clear effect of noise in behavior has to do with the accuracy and speed of decisions (which creates the so-called “speed-accuracy trade-off”). In light of this, Shadlen and Roskies claim that there are philosophical implications of this noisy chaotic character of the brain (even if deterministic). It implies a fundamental epistemic break in the flow of information since one cannot reconstruct the causes by knowing the effects, i.e., by knowing the spikes of some set of output neurons. In other words, given that there is noise in the system, even if one knows the conditions of the world, one cannot be sure what outcome they will cause. The presence of ineliminable noise implies that there is a level of uncertainty involved in every calculation of the brain. “Because the brain operates on noisy data with noisy mechanisms, it must enact *strategies* or *policies* to control accuracy. For example, it must balance the speed of its decisions against a targeted accuracy.”³⁹ Establishing strategies or policies are a high-level commitment one takes upon herself in order to gain the level of control desired in making decisions. “Noise puts a limit on an agent’s capacities and control, but invites the agent to compensate for these limitations by high-level decisions or policies.”⁴⁰ Shadlen and Roskies seem to understand the neuronal noise as an inevitable feature of the brain; however, a feature that is somewhat “negative;” i.e., a feature that is the source of errors and inaccuracies. A feature that one can *overcome*, at least partially, by adopting for example a policy of trading speed for accuracy. I agree with Shadlen and Roskies; however, it seems that there is another aspect of noise, a “positive” aspect which is ignored.

In order to appreciate the “positive” aspect of neuronal noise, let’s look into decision selection processes. As pointed out earlier, an agent encounters in general two types of free-choice selections within a conflicting situation: a *picking*-type selection, in which the alternatives make no difference to the agent and a *choosing* type, in which one can give a reason (in the form of an evaluative judgment, a taste or a desire) for the selection of an alternative.⁴¹ A basic approach for explaining the selection process in a *picking*

³⁵ Shadlen and Roskies, “The Neurobiology of Decision-making and Responsibility.”

³⁶ It is debatable whether quantum mechanics, with its alleged indeterminacies, is relevant within the spatial and temporal realm of brain activity (e.g., Tegmark, “Importance of Quantum Decoherence in Brain Processes;” Hepp, “Toward the Demolition of a Computational Quantum Brain;” Roy and Llinás, “Relevance of Quantum Mechanics on Some Aspects of Ion Channel Function”). However, for the purpose of this article, it is not necessary to decide on this issue and I will assume here a deterministic albeit chaotic activity.

³⁷ Shadlen and Roskies, “The Neurobiology of Decision-making and Responsibility,” Shadlen and Newsome, “Noise, Neural Codes and Cortical Organization;” “The Variable Discharge of Cortical Neurons,” Van Vreeswijk and Sompolinsky, “Chaos in Neuronal Networks.”

³⁸ Van Vreeswijk and Sompolinsky, “Chaos in Neuronal Networks.”

³⁹ Shadlen and Roskies, “The Neurobiology of Decision-making and Responsibility,” 8; my emphasis.

⁴⁰ Ibid., 9.

⁴¹ Ullmann-Margalit and Morgenbesser, “Picking and Choosing.”

situation is that although on a cognitive reason-based level (“space of reasons”), there is symmetry between the alternatives, on a relevant neuronal level (“space of causes”) – symmetry does not obtain.⁴² The source of this neuronal asymmetry can be an *external* subliminal bias, as stressed by Leibniz: “we are never indifferent, even when we appear to be most so, as for instance over whether to turn left or right at the end of a lane. For the choice that we make arises from these *insensible stimuli*.”⁴³ Alternatively, the neuronal asymmetry can be a result of some *internal* bias. Whatever may be the source of this causal bias, after the symmetry is broken in favor of one alternative, there is no room for change of mind, qualms or second thoughts, as Ullmann-Margalit and Morgenbesser rightly claim:

Often enough, or perhaps typically, what occurs in a selection situation you identify as a picking one is that you haphazardly focus your attention on some one of the available alternatives. Once you do that, however, then – by hypothesis – none of the other alternatives attracts you more, and there is no room for qualms or second thoughts. So, given the absence of either detracting or distracting factors, there is nothing to prevent you from going ahead and grabbing (or doing) that focused-on alternative.⁴⁴

Nevertheless, through behavioral and electrophysiological measurements, it was found that the asymmetry in a rapid *picking* selection process is often complex and dynamical and may include also *change of mind*. Although an early intention has been formed in favor of one alternative as a result of some external “*insensible stimuli*,” it does not necessarily persist; there might be a swift change of mind even in simple *picking* situations.⁴⁵ A possible neuronal mechanism for generating this type of dynamics and change of mind might be the presence of *continuous neuronal noise* that is injected into the system. Such neuronal noise, the claim would be, has the ability to swiftly flip the direction of an early intention that has been formed in favor of one (*picking*) alternative into another alternative and creating an apparent change of mind.⁴⁶ Thus, one might hypothesize that a selection process among alternatives is actually an interplay between symmetry-breaking *biases* (such as external sensory cues, whether consciously accessible or inaccessible, context, inner biases or motivations) and continuous neuronal *noise*. This leads us to the following picture: if an agent encounters a free-choice *choosing* selection situation, reasoning plays a role and typically there will be a bias toward one alternative over the other.⁴⁷ On the other hand, in a free-choice *picking* selection situation, the biases are weak by definition, and the choice is driven mainly by the underlying neuronal noise. Moreover, if an agent enters a *picking* situation, it might be beneficial to amplify one’s internal neuronal noise, since such amplification facilitates reaching a timely decision, otherwise the agent might stay “locked” or “paralyzed” within the symmetry. Nevertheless, as empirical models show, neuronal noise amplification might lead also to a *change* in the symmetry break direction; and although there is no room for regret or change of mind in *picking* situations, there still might be an apparent change of mind.⁴⁸

Here I propose⁴⁹ a further hypothesis that the capacity to amplify one’s internal neuronal noise actually improves one’s ability to act “freely,” first, by avoiding paralysis in case of a *picking* symmetry, and second, by enabling to override rapid intentions that are externally cued by the environment. As we saw in Shadlen and Roskies,⁵⁰ neuronal noise is usually taken as a negative feature which the system has to overcome. However, there are studies that find a central role for noise in a decision-making process as the main force of *exploration*

⁴² Furstenberg et al., “Change of Intention in ‘Picking’ Situations.”

⁴³ Leibniz, *New Essays on Human Understanding*, II, xx, 6. Other terminology used by him is: “insensible impressions” and “minute perceptions.”

⁴⁴ Ullmann-Margalit and Morgenbesser, “Picking and Choosing.”

⁴⁵ Furstenberg et al., “Evidence of Change of Intention in Picking Situations;” Furstenberg et al., “Effect of Aging on Change of Intention.” Justification for the use of “intention” in these situations can be found in Furstenberg, “Proximal Intentions, Non-executed Proximal Intentions and Change of Intentions.”

⁴⁶ Furstenberg et al., “Change of Intention in ‘Picking’ Situations;” Brass et al., “Why Neuroscience Does not Disprove Free Will.”

⁴⁷ The case in which the reasoned deliberation leads to a symmetrical tie is currently work in progress.

⁴⁸ Furstenberg et al., “Change of Intention in ‘Picking’ Situations.”

⁴⁹ In collaboration with Haim Sompolsky and Leon Deouell.

⁵⁰ Shadlen and Roskies, “The Neurobiology of Decision-making and Responsibility.”

in the landscape of alternatives.⁵¹ Moreover, a moderate level of noise is also beneficial in avoiding the system from being locked in a local minimum representing a suboptimal option. Therefore, we can articulate the following claim: *an agent is able to amplify his/her internal noise when challenged with a conflicting free-choice decision; thus, resolving the conflicting situation while avoiding a too-fast (impulsive) non-optimal resolution.*⁵²

Going back to the prefrontal lesion patients exhibiting behaviorally impaired decision processes, mainly *prolonged decision-making* and *impulsive behavior*, one might assert in light of the above claim that these patients exhibit an impairment in their neuronal noise generating mechanism. On the face of it, *prolonged*, *hesitant* decision-making and *impulsivity* seem contradictory behavioral phenomena. However, by hypothesizing that the selection process between alternatives results from the balance between *internal* or *external biases* on the one hand, and *system noise* on the other, prolonged decision-making and impulsivity become two sides of the same coin. If a free-choice decision has to be made upon a *symmetrical* or close to symmetrical situation (typically a *picking* situation) – response times will be longer in these prefrontal patients, given that their noise generating mechanism is impaired, since they are lacking the noise needed for breaking the relevant symmetry. On the other hand, given an inner cue or external stimulus to act (restating the above-mentioned example, a patient comes into my office and sees *my* apple on my desk), the system may *rapidly* converge on a local suboptimal state representing inappropriate behavior (sending his hand to my apple and biting into it) and will have difficulty “escaping” from it to explore a better option. The result may be an *impulsive* suboptimal reaction. In other words, in normal situations *the noise mechanism drives action when “locked” in symmetry and avoids unwarranted action when driven by cue/stimulus asymmetry.*

Avoiding unwarranted action when driven by cue/stimulus asymmetry is achieved in a twofold manner: first, the noise “dilutes” the environmental cues (and my apple loses its irresistibility); second, it opens a space in which the reasons can penetrate and take hold (“hmm [...] there are good reasons not to take the apple from the table [...] It’s not socially acceptable”). This mechanism of neuronal noise enables the move from “*reflex*” to “*reflection*.” Neuronal noise acts as a nonspecific causal mechanism diluting environmental cues (“*reflex*”) in order to create a temporal void in which the “space of reasons” (“*reflection*”) can enter. Put differently, the *deterministic causal noise* mechanism “makes way for reasons.”

In Sections 5 and 6, I tried to depict an inverted picture of the common dichotomy between the “space of reasons” and the “space of causes,” one in which *reasons* have a causal-like phenomenology and *causes* have a reasoned-like phenomenology. This is a general philosophical claim: that there are nontrivial interactions between the space of causes and the space of reasons. Although science in its method and understanding sees the space of causes as a reflection of the space of reasons, we detect here a more complex picture. One which makes a concrete demand upon our moral and normative stance. The clear-cut divide between the space of reasons and the space of causes, or more generally between the conceptual and the empirical, between the philosophical and the scientific, should be substituted with a softer divide.

7 Softening the dichotomy

The Wittgensteinian idea – that the normative framework is the *background* for giving and asking for reasons but supposedly does not take part in rational self-modification and change – challenged many

⁵¹ These studies suggest models of an attractor-based neural network type, whose dynamics is described as “jumps” between discrete states. In such models, cell populations tuned to different options compete through mutual inhibition and are biased by various factors. A decision is said to be made when the activity of one population becomes strong enough to suppress the others, and the system exhibits a phase transition. In these models, the decision does not involve any explicit threshold detection mechanism but instead emerges from the dynamics of the system (Thura and Cisek, “Deliberation and Commitment;” Wang, “Probabilistic Decision Making”). See also interesting work on neural fluctuations (“noise”) that underlie free and creative behavior in Broday-Dvir and Malach, “Resting State Fluctuations.”

⁵² An amplification of neuronal chaotic noise can be achieved by strengthening synaptic connections in a recurrent neural network (Sompolinsky et al., “Chaos in Random Neural Networks”).

thinkers in explaining radical revolutions in science and generally in normative systems. In this final section, I want to look specifically at the efforts of Fisch and Benbaji in explaining such revolutionary moves as *rational* and as a result of *self-criticism*.⁵³ The reason I wish to dwell on this aspect in the current article is that as claimed above the *normative framework* has a causal-like phenomenology and from this perspective seems to fit into the *space of causes*. In the Wittgensteinian view, there is a clear distinction between the *normative framework* and the *space of reasons* although the former constitutes the latter. The Fisch and Benbaji effort to penetrate the fixed normative framework with their theory of self-criticism is an attempt to soften the distinction between the space of reasons and the causal-like normative *framework*. This is a complementary attempt to the dichotomy softening endeavor of this article.

As Fisch frames it, the constitutive function of our linguistic frameworks, on the one hand, and their susceptibility to change, even radical change, on the other, create one of the most challenging philosophical problems. This is the challenge of cultural relativism, or as Fisch and Benbaji put it, the problem of the rationality of framework replacement. One's inability to stand outside one's own normative framework ("the view from nowhere") and compare it to a critic's radically different normative framework in order to rationally choose the better one leads Fisch and Benbaji to offer the following analysis and suggestion. Starting with the question of external criticism – can it stimulate a normative framework transformation? – they conclude that although *interpersonal* deliberation is central in attempting to change one's mind, the "site of rational normative change is the arena of *intrapersonal* deliberation: the ultimate discourse of rationality is that of the self."⁵⁴ In other words, the initial transformative act is when external criticism is endorsed as self-criticism. The transformative power lies in the disturbing picture it implicitly paints of us. "Its effect resembles that of a recording device that allows us a disturbing glimpse of what we can never see ourselves, namely, how others think we think and should be thinking, and how they judge the way we judge and should be judging."⁵⁵ A successful critical account is not a straightforward rational persuasion, since one's normative framework is not accessible to this type of deliberation, nevertheless it creates a disorienting sense of self-estrangement, it creates discrepancies between how we appear to ourselves and appear to others. In the trusted normative framework criticism, we do not rationally deliberate and reject the alternative picture (i.e., the alternative normative framework). However, even though it is incongruous with our own, there is a moment in which we "hold" both side by side. This is a moment in which one can experience a familiar but meaningfully different version of oneself, creating *mixed feelings* and *ambivalence* regarding one's own norms and standards. Norms rendered ambivalent lose their force as foundations in one's self-identity. Ambivalence dilutes the force of one's commitments.

In this way, I submit, deep reaching and trusted normative criticism can give rise to a sense of inner-discordance and self-estrangement capable of creating the inner leeway necessary for truly transformative normative self-criticism [...]. The transformative rational moment is not one of enlightened discovery in the light of criticism, but one of deeply disturbing ambivalence; a moment of inner discordance fraught with tortured dithering and painful indecision. Ambivalence, self-estrangement and indecision are, as a rule, not the most inspiring and motivating states of mind. But in moments of normative crisis, if I am right about them, they become reason's very driving force.⁵⁶

I expanded on Fisch and Benbaji's thesis in order to show that the distinction between one's normative *framework* with its fixed deterministic-like character and one's space of reasons is softened, in their account, by letting disturbance, ambivalence and inner discordance penetrate the supposedly unchangeable space of the normative framework. This is parallel to the idea we sketched earlier that inner neuronal noise might make room for the space of reasons. What we observe in all these examples is a kind of "letting go" from the deterministic causal-like trajectory, which enables a more *optimal (reasoned) self* to enter. Inner noise, ambivalence, indecision and discordance "become reason's very driving force." From the neuronal low level up to the highest normative framework level, a basic condition for one being free and

⁵³ Fisch and Benbaji, *The View from Within*.

⁵⁴ Ibid., 278.

⁵⁵ Fisch, "Taking the Linguistic Turn Seriously," 617.

⁵⁶ Ibid., 618–9.

fulfilling oneself is the *ability* to create noise and ambivalence. Noise and ambivalence are not the same thing, of course, but they do share an aspect of liberating the system from its core deterministic causal-like grip. Those who lose the *ability* to create noise and ambivalence seem to lack a part of their *self-identity*, either by being paralyzed in the space of choice alternatives, falling into impulsive and nonoptimal behavior, or by being locked within a non-fulfilling normative framework.

This way of looking at things, I suggest, is a conceptual shift regarding the notions of *freewill* and *self-control*, since inner noise, ambivalence, indecision and discordance are usually understood as standing in opposition to a controlled expression of oneself. This article offers to take these processes and mechanisms as a central part of what makes us reasoned and rational human agents.

8 Summary

The main aim of the article was to show the complex relation between the *space of reasons* and the *space of causes* by articulating their phenomenology and thus narrowing the gap between these spaces. It seems that there is a clear divide between the characteristics of the normative *space of reasons* and the physical *space of causes*, mainly with regard to notions such as *immediacy* and *regularity*. The causal seems immediate and creates a chain-like reaction according to the laws of nature that cannot but be realized, whereas “practical reasoning” (planning how to achieve goals within a normative framework) can have an *effect* on the physical environment, but it lacks *immediacy and regularity* characteristics of physical causality. The article attempts to show that this phenomenological description is limited in scope. It does not capture the character of *immediacy and regularity* in “swift reasoned actions” in which *reasons* are immediate and automatic, such as in the case of a driver swiftly avoiding a child running in front of the car. On the other end, this phenomenological description does not capture “*causal noisy brain mechanisms*,” in which *causes* lack immediacy and regularity. The neuronal noise mechanism drives action when “locked” in symmetry and avoids unwarranted action when driven by cue/stimulus asymmetry. As explained, the noise “dilutes” the environmental cues and it opens a space in which the reasons can penetrate and take hold, enabling the move from “*reflex*” to “*reflection*” (a step which orbital-frontal patients may lack). The *deterministic causal noise* mechanism “makes way for reasons.” Analogously, the distinction between one’s normative *framework* with its fixed deterministic-like character and one’s space of reasons is softened, according to Fisch and Benbaji, by letting disturbance, ambivalence and inner discordance penetrate the supposedly unchangeable space of the normative *framework*. What we observe is a kind of “letting go” from the deterministic causal-like trajectory, by means of inner noise, ambivalence, indecision and discordance, which enables a more *optimal (reasoned) self* to enter. As stressed, inner noise, ambivalence, indecision and discordance “become reason’s very driving force.” A basic condition for one being free and fulfilling oneself is the *ability* to create noise and ambivalence, thus liberating the system from its core deterministic causal-like grip.

Acknowledgments: I wish to thank Leon Deouell, Avishai Margalit and Haim Sompolsky for sharing their deep scientific and philosophical knowledge.

References

- Bennett, Maxwell R., and Peter Michael Stephan Hacker. *Philosophical Foundations of Neuroscience*. Vol. 79. Oxford: Blackwell, 2003.
- Berlin, Heather A., Edmund T. Rolls, and Susan D. Iversen. “Borderline Personality Disorder, Impulsivity, and the Orbitofrontal Cortex.” *American Journal of Psychiatry* 162:12 (2005), 2360–73.
- Boccardi, Edoardo, Sergio Della Sala, Cristina Motto, and Hans Spinnler. “Utilisation Behaviour Consequent to Bilateral SMA Softening.” *Cortex* 38:3 (2002), 289–308.
- Brandom, Robert. *Making it Explicit: Reasoning, Representing, and Discursive Commitment*. Harvard University Press, 1998.

- Brandom, Robert. *Tales of the Mighty Dead: Historical Essays in the Metaphysics of Intentionality*. Harvard University Press, 2002.
- Brass, Marcel, Ariel Furstenberg, and Alfred R. Mele. "Why Neuroscience Does not Disprove Free Will." *Neuroscience & Biobehavioral Reviews* 102 (2019), 251–63.
- Brodav-Dvir, Rotem, and Rafael Malach. "Resting State Fluctuations Underlie Free and Creative Verbal Behaviors in the Human Brain." *bioRxiv* 2020.
- Davidson, Donald. "Actions, Reasons, and Causes." *The Journal of Philosophy* 60:23 (1963), 685–700.
- Dretske, Fred. "Reasons and Causes." *Philosophical Perspectives* 3 (1989), 1–15.
- Fisch, Menachem. "Taking the Linguistic Turn Seriously." *The European Legacy* 13:5 (2008), 605–22.
- Fisch, Menachem, and Yitzhak Benbaji. *The View from Within*. Notre Dame, Ind: University of Notre Dame Press, 2011.
- Frank, Michael J. "Hold Your Horses: A Dynamic Computational Role for the Subthalamic Nucleus in Decision Making." *Neural Networks* 19:8 (2006), 1120–36.
- Furstenberg, Ariel. "Proximal Intentions, Non-executed Proximal Intentions and Change of Intentions." *Topoi* 33:1 (2014), 13–22.
- Furstenberg, Ariel. "Tradition and Conceptual Dynamics According to an Inferentialist Theory of Meaning." *European Journal for Philosophy of Religion* 8:2 (2016), 221–41.
- Furstenberg, Ariel, Leon Y. Deouell, and Haim Sompolsky. "Change of Intention in 'Picking' Situations." In *Surrounding Free Will*, 165–83. Oxford, UK: Oxford University Press, 2015.
- Furstenberg, Ariel, Assaf Breska, Haim Sompolsky, and Leon Y. Deouell. "Evidence of Change of Intention in Picking Situations." *Journal of Cognitive Neuroscience* 27:11 (2015), 2133–46.
- Furstenberg, Ariel, Callum D. Dewar, Haim Sompolsky, Robert T. Knight, and Leon Y. Deouell. "Effect of Aging on Change of Intention." *Frontiers in Human Neuroscience* 13 (2019), 264.
- Grabarczyk, Paweł. "Directival Theory of Meaning Resurrected." *Studia Semiotyczne* 31:1 (2017), 23–43.
- Hepp, Klaus. "Toward the Demolition of a Computational Quantum Brain." In *Quantum Future from Volta and Como to the Present and Beyond*, 92–104. Berlin, Heidelberg: Springer, 1999.
- Hofmann, Wilhelm, Marieke Adriaanse, Kathleen D. Vohs, and Roy F. Baumeister. "Dieting and the Self-control of Eating in Everyday Environments: An Experience Sampling Study." *British Journal of Health Psychology* 19:3 (2014), 523–39.
- Kenny, Anthony. *The Metaphysics of Mind*. Clarendon Press, 1989.
- Leibniz, Gottfried Wilhelm. *Leibniz: New Essays on Human Understanding*. Cambridge University Press, 1996.
- MacFarlane, John. "Future Contingents and Relative Truth." *The Philosophical Quarterly* 53:212 (2003), 321–36.
- Manes, Facundo, Barbara Sahakian, Luke Clark, Robert Rogers, Nagui Antoun, Mike Aitken, and Trevor Robbins. "Decision-Making Processes following Damage to the Prefrontal Cortex." *Brain* 125:3 (2002), 624–39.
- May, Joshua, and Richard Holton. "What in the World is Weakness of Will?" *Philosophical Studies* 157:3 (2012), 341–60.
- McDowell, John. *Mind and World*. Harvard University Press, 1996.
- Mele, Alfred. "Weakness of Will and Akrasia." *Philosophical Studies* 150:3 (2010), 391–404.
- Pollard, Bill. "Naturalizing the Space of Reasons." *International Journal of Philosophical Studies* 13:1 (2005), 69–82.
- Risjord, Mark. "Reasons, causes, and Action Explanation." *Philosophy of the Social Sciences* 35:3 (2005), 294–306.
- Rorty, Richard. *Contingency, Irony, and Solidarity*. Cambridge University Press, 1989.
- Roy, Sisir, and Rodolfo Llinás. "Relevance of Quantum Mechanics on Some Aspects of Ion Channel Function." *Comptes Rendus Biologies* 332:6 (2009), 517–22.
- Sandis, Constantine, (ed.), *New Essays on the Explanation of Action*. Springer, 2008.
- Sellars, Wilfrid. "Empiricism and the Philosophy of Mind." *Minnesota Studies in the Philosophy of Science* 1:19 (1956), 253–329.
- Shadlen, Michael N., and William T. Newsome. "Noise, Neural Codes and Cortical Organization." *Current Opinion in Neurobiology* 4:4 (1994), 569–79.
- Shadlen, Michael N., and William T. Newsome. "The Variable Discharge of Cortical Neurons: Implications for Connectivity, Computation, and Information Coding." *Journal of Neuroscience* 18:10 (1998), 3870–96.
- Shadlen, Michael N., and Adina L. Roskies. "The Neurobiology of Decision-making and Responsibility: Reconciling Mechanism and Mindedness." *Frontiers in Neuroscience* 6 (2012), 56.
- Sompolsky, Haim, Andrea Crisanti, and Hans-Jürgen Sommers. "Chaos in Random Neural Networks." *Physical Review Letters* 61:3 (1988), 259.
- Szczepanski, Sara M., and Robert T. Knight. "Insights into Human Behavior from Lesions to the Prefrontal Cortex." *Neuron* 83:5 (2014), 1002–18.
- Tegmark, Max. "Importance of Quantum Decoherence in Brain Processes." *Physical Review E* 61:4 (2000), 4194.
- Thura, David, and Paul Cisek. "Deliberation and Commitment in the Premotor and Primary Motor Cortex During Dynamic Decision Making." *Neuron* 81:6 (2014), 1401–16.
- Van Vreeswijk, Carl, and Haim Sompolsky. "Chaos in Neuronal Networks with Balanced Excitatory and Inhibitory Activity." *Science* 274:5293 (1996), 1724–6.
- Ullmann-Margalit, Edna, and Sidney Morgenbesser. "Picking and Choosing." *Social Research* 44 (1977), 757–85.
- Wang, Xiao-Jing. "Probabilistic Decision Making by Slow reverberation in Cortical Circuits." *Neuron* 36:5 (2002), 955–68.
- Weintraub, Ruth. "What Can We Learn from Buridan's Ass?" *Canadian Journal of Philosophy* 42:3–4 (2012), 281–301.
- Wittgenstein, Ludwig. *On Certainty*. Vol. 174. Oxford: Blackwell, 1969.