



Marxism and Science from an Enactive Perspective

Ezequiel A. Di Paolo interviewed by Kyrill Potapov

ABSTRACT: This interview with Ezequiel Di Paolo explores the connections between biology, politics, and cognitive science through the lens of enactivism. Di Paolo discusses the origins and influences of enactivism, including the work of Francisco Varela and its potential dialectical underpinnings. The enactive approach is contrasted with approaches foregrounding the Free Energy Principle, emphasizing the importance of historicity and concrete embodied experience in understanding cognition and life. Di Paolo critiques reductionist approaches in cognitive science, arguing for a more nuanced understanding that incorporates social and material factors. He highlights the relevance of Evald Ilyenkov's work on the ideal and dialectics to contemporary cognitive science, suggesting that Ilyenkov's ideas could provide a theoretical frame to bring together some threads of work already being done in this area. The interview considers political implications of different approaches to cognitive science, and how some approaches implicitly replicate wider contemporary social arrangements and individualistic worldviews. Di Paolo advances a dialectical approach to science that remains open to revising concepts and boundaries when confronted with concrete reality. The emphasis here is on the historical context and value judgments inherent in scientific inquiry. He describes how a dialectical approach in science involves a constant circulation between abstract concepts and concrete experience, leading to a more integrated and self-critical form of knowledge production. The interview sheds light on what it might mean to work towards bringing together science and Marxism, as Ilyenkov argues for in *Dialectics of the Abstract and Concrete in Marx's Capital* (1982 – Progress Publishers). Di Paolo's own scientific inquiries are not only informed by Ilyenkov but serve as a model for how science can align with Marxist goals, ideas and methods.

KEYWORDS: Enactivism, cognitive science, dialectics, historicity, Francisco Varela, Evald Ilyenkov.

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- *Correspondence:* Kyrill Potapov, University College London.
 - e-mail: kyrill.potapov@ucl.ac.uk
 - ORCID: 0000-0002-3626-8485
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KYRILL POTAPOV: *Your work deals with some very technical areas of biology and related sciences. It's not obvious how biology and politics are connected. In fact, I think in many people's minds when you suggest that connection, they think of eugenics. Do you think of biology and politics as connected? Should they be?*

EZEQUIEL DI PAOLO: They're certainly connected, and they have been for a long time, at least in the sense that, inevitably, in biology we are always seeking answers about our own existence as humans, as part of nature. Since Darwin, there have been interpretations of the theory of evolution in terms of what it says about society. And to some extent, of course, there have been influences in the other direction too. The theory of evolution that we received was a particular theory that fit the time: in tune with the Victorian morality and the economics of the Industrial Revolution. You also had counter moves to these political influences that were not incompatible with the science, like Kropotkin's mutual aid approach, which is biologically quite interesting too as another way of thinking about evolution. Since the genetic revolution last century, biology has become even more political because of how the biotechnologies directly impact our lives.

Now, perhaps your question also implies whether doing biology, I mean performing research in biology, must be or somehow is inevitably influenced by politics. I think the answer is yes. But with the qualification that these influences are not necessarily always translated into an obvious representation of an ideology. The influences can be very subtle. The same happens in neuroscience. There's a kind of continuum between genetics and neuroscience, all of them generally reductive approaches. Let's put it this way: the approaches that tend to be reductive about their subject matter—life, mind, brains—are subtly influenced by a particular worldview that fits an individualistic perspective of human nature. There's also an idea that we should erase agency out of the picture, since agency is notoriously difficult to approach in reductionist terms. The message that people get from popular depictions of science is, well, it's your genes' fault that you're the way you are or this is your brain doing this stuff instead of you being in control, you can't do anything about it. Your agency is reduced, constrained, obliterated, and all these other biological and neural processes speak for you. The implication is that our own political agency should not be at the forefront of our discussions. We should accept not being able, or not having "real" grounds, to act. We should be like: "It's inevitable, you know, this is the

kind of world we live in, and we can change it a little, but not substantially, not really.”

This ideology influences the way in which research in the biological sciences is carried out, without meaning that if you have a different ideology, you will necessarily find very different results to your experiments. The data, however, is never uninterpreted and what it means, and the conclusions you draw from the data, are always influenced by how you orientate yourself towards it. And what you want to say with it. Scientific questions are never plainly of the form “Why X?”. Implicitly or explicitly, they take the form “Why X instead of Y?” or “Why X instead of Z?” and these choices are ideologically influenced.

KYRILL POTAPOV: *Your work draws heavily on the thought of Francisco Varela. Was his work informed at all by Marxist thinkers?*

EZEQUIEL DI PAOLO: Francisco Varela is definitely the founding figure of the enactive approach in embodied cognitive science. He was a very unusual scientist, very philosophically minded, very socially conscious. He saw a continuity between all of his interests. Between hardcore biological data from the lab, such as scientific measurements of color perception, and his more philosophically oriented analysis of experience, of consciousness, of the mind, of bodies, and other themes. Never in his writings do you find any direct reference to Marx, but he does have several references to dialectics, especially in his early work. He wrote a paper on dialectics called “Not One, not Two” (1976). I have my personal theory that he was a reader of Marx. He does reference Marxist literature such as Karel Kosík’s *Dialectics of the Concrete* (1976) or Sartre’s *Critique of Dialectical Reason* (2004), and others. I believe—this is my own interpretation—that he came from a time and a place in which, to openly declare yourself for Marx was dangerous. Remember he had to go into exile because of the coup that happened in Chile in 1973.

I suspect all this based on impressions from afar (I never met Varela in person and others will know more about these things) and from his way of speaking in various interviews (sometimes with roundabout, indirect references to Marx). And from personal experience too, though I am younger than him. In my childhood I lived through a similar atmosphere during the military dictatorship in Argentina. You knew that there were certain books you couldn’t have at home. You couldn’t be caught with Marxist literature at home because it could be dangerous, even if you were not Marxist, just by pure collateral damage; if somebody just saw it and mentioned it to somebody else the police might turn up. I remember my mother telling me that they had to bury, with her

friends, some of these books in the garden. That has still left a mark, a mark in the culture throughout the years in those countries. This is just my theory, I cannot really verify it, that Varela may not have been very openly a commentator on Marx, as a reflex, as a kind of like, “Okay, since I’m not doing political theory directly. I’m just doing this biology stuff, I will be subtle about this.” What makes me think this way is that he had no problem leaning strongly on the work of Marxist scientists such as Richard Lewontin as a pivotal way of thinking and expressing the enactive point of view that he introduced in the early 1990s (see chapter 9 of the book *The Embodied Mind*). He also continued to refer to dialectics in some of his other writings in that period, including an explicit call for cognitive science to move from the abstract to the concrete.

Maybe that was his way of doing it. I mean, his political orientation probably wasn’t Marxist. Maybe left-leaning and socially conscious, progressive. He had several dialogues with Cornelius Castoriadis on these topics (see Adams 2007).

So that was Varela. As I said, in his thinking you find many dialectical topics and ways of looking at things. Although he was very also much influenced by cybernetics and systems theory, he did not hold reductionist views. For him, it’s not all about just circuits and feedbacks in systems that are meant to describe everything. He knew that systems were embedded in other systems, that they would be changing according to their interrelations. And so he had to adopt a dialectical perspective to deal with such problems.

KYRILL POTAPOV: *There seems to be a shift from the kind of work that Maturana & Varela (1980) were doing to your own work, in that while the former remains with a kind of Spinozist view of nature, you take it to its Hegelian phase. Would that be fair to say?*

EZEQUIEL DI PAOLO: I do agree with that. Yes, I’ve always thought that Maturana was much more the conservative one, to put it in simple terms. He was a big fan of more traditional constructivism and the two had a split precisely at the end of the seventies when they started seeing things very differently, partly in regards to how their ideas connected with social processes. I believe that Varela had a much more ambiguous, dynamical, and indeed dialectical perspective on things. Whereas Maturana just saw clearly demarcated systems and hard, ahistorical distinctions. I think he was more of a Kantian. And I think Varela, at

least implicitly, was more of a Hegelian, even though one of his last papers (Weber & Varela 2002) precisely attempts to connect his whole enactive approach with Kant, but actually in the sense of connecting it to Kant's 3rd critique, *The Critique of Practical Reason*, which describes Kant's approach to life. This was done as a response to the Kantian view, rather than just saying: "oh, Kant is right." For him, Kant went only so far in talking about how we can conceptualise teleology in living organisms. Given that we have a mechanistic approach, this is all we can do according to him. So Kant says: therefore we cannot *really* know life in the same sense we get to know machines or other physical systems. But we have an intuition, a heuristics that we can use to talk about the self-organization of organisms. And Varela saw this last paper of his as a way of saying: no, we *can* do this, approach life and teleology scientifically, if we use all these ideas about autopoiesis from the enactive perspective. This went in the right direction, but I think something was missing there to properly naturalise teleology. He was caught halfway in that move, and then he passed away.

What was missing from this account of teleology was precisely bringing in a more Hegelian perspective. To speak of purposes and norms, you needed, in addition to autopoiesis, a concept in which all the hard boundaries between the systems, all of the distinctions, could become changeable, historized. His view *was* that that everything is historical and changes, but he had never articulated it theoretically in a workable manner. He claimed that there is a history of co-definition between organisms and environments. But he didn't give this claim the tools. And I think the beginning of my own work in this area had to do with precisely completing that move with the concept of *adaptivity* (Di Paolo 2005) to be put together with ideas of autonomy and autopoiesis, to bring all these asymmetries in time, in between agent and environment, and so on, into much more workable vocabulary that you can then theorize with. Gambarotto & Mossio (2024) explicitly discuss it as the Hegelian turn in the enactive perspective.

What's also Hegelian, if you like, about our work is the very fruitful and branching development of enactive perspectives on the social, which was only implicit in the earlier work. This began with our writings with Hanne De Jaegher on participatory sense-making (De Jaegher and Di Paolo 2007) and has evolved in several, sometimes unexpected directions, including engagements with practices connected with mental health, sports, and the arts, and our more recent enactive approach to language in our *Linguistic Bodies* book (Di Paolo, Cuffari, De Jaegher

2018). This is explicitly dialectical and broaches Hegelian themes such as the dialectics of recognition as well as hints at an approach to the ideal inspired by Evald Ilyenkov and others. Participatory sense-making, we didn't really notice this at the start, is an inherently dialectical idea, one that thematises the simultaneous tensions between the emerging dynamics of social processes and the personal autonomies of the participants. Navigating these tensions is constitutive of our social being, and the engine that drives the development of human forms of social agency.

KYRILL POTAPOV: *There's currently a lot of interest in approaches which see the brain as building predictive models of the environment that allow organisms to act so as to minimize surprise. This is often connected with what's called the Free Energy Principle. In your paper with Evan Thompson and Randall Beer (2022), you contrast this view with enactivism, even though this approach seems similar to enactivism. Both approaches focus on activity, focus on embodiment and self-organisation. You suggest that there are big differences and one of them is that these predictive processing approaches undervalue history. Can you say more about that and people like Hohwy and Seth (2020).*

EZEQUIEL DI PAOLO: Indeed, over the last 10 years or so there has been major interest in the idea of predictive coding and the Free Energy Principle. Looking at what these theories say, just to put it in context, we note that these are novel expressions of ideas that have existed for a while: the whole approach developed by Helmholtz about what you do in perception is to try to infer what's going to happen, what are the causes and the likely outcomes of the perceptual situation. And also in cybernetics we find similar ideas, such as the Perceptual Control Theory by William Powers, in which perception involves setting perceptual set points, and you move about in order to achieve these set points. For instance, I want to see over the horizon, or I want to see above that wall, so I move in such a way that I can see over it.

So these ideas are not new. There have been attempts to develop mathematical frameworks that relate these inferential ideas about active perception to the idea that the system is conserving itself, that is, maintaining its identity as the system that it is. If this is the case, under certain mathematical assumptions, you will obtain as a consequence, these predictive or modelling implications.

There's a lot to be said about this. You could just accept all the conditions and everything that makes this framework valid, and even then

question whether the implications are exactly what they say they are, or whether there is another interpretation of the mathematics. I'm not going to do that. But several researchers, such as Miguel Aguilera, who worked with me as a postdoc, have noticed that, even if the philosophy and the assumptions are ok, you still need to ask: What kind of systems will really behave like this? It turns out that there is a very limited set of sensorimotor configurations that will make the mathematics work (Aguilera et al. 2022). Once you assume a more realistic sensorimotor configuration, the mathematics don't apply so clearly. So there all kind of technical, as well as philosophical, problems. And yet, in spite of all that, the idea has been discussed for the last decade and keeps being discussed; a veritable academic publishing industry.

But from the point of view of relating these notions to an embodied, enactive approach, my first complaint in the paper you mention (op. cit.) is that the comparison with enaction is never very well done. It's often done quickly and sloppily, because they never really put the theories one against the other and then compare them. I mean, it's hard to compare theories, especially very different ones. But you can make an effort beyond noticing the mere resemblance of terms and ideas, and go a bit deeper, at least. Nobody does that, not really. So we tried to do this first, and then we found there were several tensions and incompatibilities, and one of the most interesting ones is the one you mentioned about historicity. So the whole idea of a Free Energy Principle rests on systems that maintain their own structure more or less invariant. Even though there can be randomness that can keep things changing, these changes occur with steady distributions of states. Essentially, these systems visit the same set of states indefinitely; they're not changing much.

There are other formulations that we didn't discuss in the paper which approach the question using trajectories of states, path integrals. So, instead of maintaining a structure, systems maintain certain paths, viable paths. But even this is not historical, as we discuss in the paper, in the sense of a system that is actually changing in some *fundamental* way and still maintaining itself as the system it is. There is no room in these theories for historicity and, so we argue, both autonomy and historicity are constitutive of living and minded systems. So that's the paradox. And this is where you need a more sophisticated, dialectical way of thinking that supersedes systems-based approaches, transforming them without fully abandoning them.

Historicity, in this sense, is inherent in the very idea of enaction. From an enactive perspective, cognition is no longer what happens in

your head. Cognition is what you *do*. And in actually doing you're changing your surroundings, and you're changing yourself, you're changing others, and their actions change you. These changes may be minute, they may simply reaffirm things as they stand, or they may be radical, throwing us into crises. This is summarized very nicely in that verse from Antonio Machado, that enactivists like so much: "There is no path, You lay down the path in walking."

This is the idea of bringing forth the world: that the world is being constantly changed in our actions. If you're going to take it seriously, it means that time is not simply a parameter, like in physics. Time emerges from the multiple, overlapping and sometimes contradicting temporalities of historical change. When the conditions are different from what they were before, and partly different because of what was before, you have history. There is a connection to the past which is not merely causal, because that past is still alive. It's not just a random change either. Living systems are like that.

There's a lot of interesting theoretical work comparing biology and physics. Physics is the science of invariances. You look for the conservation of energy, conservation of momentum, parity, symmetries, and so on. But in biology, invariances are being broken all the time. A cell splits in two. Something novel has happened! Even though these are cells from the same species, maybe even the same organism, and so something is conserved, this is no longer a mere *physical* invariant. So you need a different vocabulary. You need another way of thinking about it. And this is the radical historicity that you find in life, and of course, in mind and that enactive theory makes explicit.

The Free Energy Principle cannot capture this. I think you could say things like: well, for the most part, you can approximate a living system to be almost sufficiently invariant, and similar moves. That may be okay, like with any model. But it's no longer a *principle*. We're not talking about this general principle anymore. We're talking about a tool that may or may not be useful. Or maybe we are invariant only on much larger developmental scales (paths), and it is also true that to some extent there are similarities across developmental trajectories. But there are also many differences, particularly in the human case. Just because there are structural similarities, we cannot really conclude that nothing fundamental changes. You grow in a different culture, different social class, etc., then your developmental trajectories are different. This is why we say in *Linguistic Bodies* that the universal human body doesn't exist, it is an abstraction. There are billions of different human bodies.

Without taking historicity seriously, you could never understand why there's ever anything new, any radical change. A radical change could just be when you learn a new skill. You learn to play the piano, you become a pianist, then a concert pianist. That is a radical change in a developmental trajectory. Or you have an injury or a trauma, that curtails your possibilities for action. And so you adapt, you change, or you struggle to alter the conditions around you. Another radical change.

The enactive approach tries to say these are the more general cases. The cases in which you can simplify history, demarcate a timescale of observation in which the phenomena remains more or less stable and lawful, and then abstract similarities, these are the exceptional cases, exceptional situations in which you can remove all the changing variety and diversity to make these abstractions valid, but that is not the concrete reality. The move will be useful, like all abstractions can be useful, only in some limited sense.

KYRILL POTAPOV: *Great. That's great. It seems to be almost foreclosing revolution in some ways.*

EZEQUIEL DI PAOLO: Yes.

KYRILL POTAPOV: *It reminds me of the critique you have in Linguistic Bodies where you criticise the functionalism of traditional science.*

EZEQUIEL DI PAOLO: Yeah. Essentially, I find it interesting; and this was already something that Vygotsky comments on in the 1930s in this long essay on the history of psychology (2023). He says, as long as psychology doesn't have a core theory, every few years psychologists will just run and join the newest fashion, assume that with this new great idea you can explain everything. It happened with Gestalt psychology or the stimulus-response of Pavlovian psychology. One idea to explain everything. And this is what we're still doing! I mean, it's like psychology or cognitive science are still trapped in this early stage of intellectual development. Fifteen years ago or so, it was mirror neurons, the last decade it has been the Free Energy Principle. My impression is that if it has the shape of a core underlying theory and is interesting, maybe a bit hard to grasp, and if it has the authority of a great scientist behind it, then surely it must be true. You hear like a collective sigh of relief: we finally have a theory for our times! The theory that will unify all of this confusion. To put it very controversially, it's as if the sciences of mind are still at a pre-theoretical state. Vygotsky was also complaining about the same thing. For him, we had to have the equivalent of Marx's

Capital in psychology, an approach (more than a single theory) from which we can create a theoretical core, from which you can know when to apply what idea, in what way, and whether it is valid or not.

KYRILL POTAPOV: *Maybe this is something to talk about after this interview but I find it interesting how Thomas Metzinger (2010) has focused on how consciousness is an illusion we construct. All of this emphasis on illusion, hallucination from him, Anil Seth (2021) and Andy Clark (2023) is a very interesting thing. Like starting with the individual and being like: “oh, reality is serving me.”*

EZEQUIEL DI PAOLO: Yes. Well, to come back to the things you were hinting at earlier, there is also an implicit political implication or ideological framing in which these theories thrive, and which they in turn help justify. And it is this idea of the individual being a form of grounded existence that emerges from within itself and into the world.

In the case of Anil Seth, this shows up as the idea that perception is some sort of controlled hallucination, that you cannot really make sure what’s going on out there, a very Kantian view. At most, you are just building your own interpretation of it and the world only has an influence as error signals to help you adjust your predictive models. This is a sophisticated one-way arc of what we, enactivists, see as a richer cycle. The world also irrupts into your life and changes you. It enables and constrains certain actions and not others, it shapes the norms that guide your action, and it often puts obstacles in the way of your projects. You know what happens when you get hit by something, get soaked in the rain, or you fall because the surface is slippery? These are more than error signals, they’re material processes that shape and even constitute you as an agent and what you can and cannot do. We are worldly.

Worldly influences and breakdowns are patent in my experience and of what happens to my body and the processes of my body as the consequence. All of that means that such theories are neglecting this richer, material sense of the world. I want to emphasize: the enactive perspective is world-involving. All that is happening in the world is co-participating in what happens to you as well as what you can make happen, the changes you can produce as an agent. And of course, once you’re constitutively open to the world, you are open to society, you are open to others, a real relation that makes you. It has to be this two-way traffic between everything. I’m not denying that there are internal processes that are important in the brain, like processes of adjustment that you might construe as controlling your perception. Fine! Undoubtedly, that’s

how our bodies are made: they're made to attempt to stabilize our world and themselves. What we see doesn't look like a chaotic pattern where every little thing is distracting you, where every changing shade of light is a cause for altering your decisions. So, you attempt to stabilize, to control what you can control. But you cannot do it without the other side, without the world. And you cannot do it successfully all the time.

KYRILL POTAPOV: *So I'm hearing various resonances here with someone else who has influenced your work, and that is Evald Ilyenkov. Could you say a bit about why you find him interesting?*

EZEQUIEL DI PAOLO: I have an interest in dialectics as a way of thinking, and in the political perspectives that they enable, and in being able to more openly articulate these connections that we were talking about between science and politics. So I have a very broad interest in Marxist thinkers, thinkers from the left, who have engaged with some of the questions that I work with in my research, such as questions about perception, language, embodiment. And there have been several thinkers that are interesting in this way. But of course, most of the literature directly concerns politics, economics, and so on. That's fine. But then you find people precisely like Ilyenkov, who make like a sort of transversal move across all these concerns. And so these interests start to be braided together. That's what I find absorbing about him. That he could go from Marx's *Capital* to the critique of the abstract and the concrete (2008) and then from that to the ideal, to labour, to insights on personhood and psychological development. And suddenly *the ideal* is a question that you might well formulate as a question in cognitive science (Ilyenkov, 2009). Actually, very much an *open* question in cognitive science. So I principally like that about Ilyenkov, the protean thought patterns, and I think that also he was very open to engaging and connecting with the practical findings of science, like the deaf mute children in the Zagorsk special school. What I also like is this idea (Ilyenkov, 1974) that the sources of knowledge are not *just* science. Practitioners can also successfully solve problems and advance the knowledge of humanity, and he could engage with that, too, and from it he could reconnect it all to his philosophy.

In that sense, I see a very strong resonance with my own interests and the way I see things. You can have this rough division between theoretical knowledge and empirical knowledge, which is not a principled distinction. But the empirical knowledge is not just experiments. I think

the empirical knowledge is everyday life too, our practices, the arts, anything that is telling us something about the world. With our theories, we must engage with it or we simply become irrelevant. I think that Ilyenkov also had that attitude. One can see it in his writings.

KYRILL POTAPOV: It's interesting because you mentioned that it has implications for cognitive science. But it seems cognitive science is generally in line with what Ilyenkov in a derogatory sense called "cybernetics"—a first order cybernetics that is a mechanistic view of the world. What could it mean for cognitive science to take what Ilyenkov calls the ideal seriously?

EZEQUIEL DI PAOLO: Yeah, yeah. Well, I mean, I think it definitely can take it seriously. And there are hints here and there that there are moves that are, I wouldn't say going in the same direction as Ilyenkov, but maybe a similar one. For instance, studies of how children learn mathematical concepts (e.g., Abrahamson et al 2022, de Freitas and Sinclair 2014), and how they use their bodies and tools and movements and their participation in communities to develop ways of thinking (e.g., the works of Jean Lave and Barbara Rogoff, 1984). So there has been in cognitive science, if you like, an undercurrent of a more dialectical perspective on what cognition is; I say it again, a more concrete, more practice-oriented perspective. Ilyenkov could bring a very strong theoretical contribution that would help connect and develop those scattered pieces of work, scattered in time and in place.

Now, regarding the characterisation of cognitive science as mechanistic, Ilyenkov is writing at a time where at least the science that I believe he was most fully acquainted with was very reductive, mechanistic, and positivistic. None of the sciences that he knew were going to deliver the answers he wanted and, of course, they were also associated with a political project that was not the project that he defended.

I think today science has proven to be much more diverse. Even though most science is still quite reductionist, mechanistic, etc., there is always something going on at the margins, all kinds of interesting activity. People exploring novel theories, cross-fertilising disciplines, people developing more socially conscious projects about mental health for instance, and so on. I wouldn't have the same attitude that Ilyenkov had against science as I don't see it as this one unified whole. Today, I would essentially include all of these these fringe projects under the banner of science. We need to put the mainstream as just one of the many projects

and ways of doing science, I want to just put it in its place. Of course, there are major obstacles if you, as a scientist, choose not to go with the mainstream. But the mainstream is full of examples of fringe ideas that were at first rejected and later, in time, increasingly accepted. This happens a lot.

Most of science is still done in this mode Ilyenkov criticised and that's because of how we are organized as a society today. But this mode is not more valid intellectually, as a default, than fringe ways of doing science. Each contribution, each idea needs to be critically assessed, whether proposed by a few or by a majority. I must take them seriously, according to what they are and what they say. In turn, my attitude is not of one of blanket rejection of everything that comes from, say, a typical neuroscience lab where they're doing, say, some measurements of functional brain localization—an idea that I reject. My critical stance doesn't mean that I cannot read that paper and take something from it. It may be something different from what the authors intend or it may be a meta-reflection about how some experimental protocols are biased toward asking only some questions and not others. My interpretation would be probably very different, but there may be something interesting in that paper. The same will be the case for a more fringe perspective.

KYRILL POTAPOV: So finally, both you and Ilyenkov stress the importance of taking a dialectical approach to thinking about any phenomena. Just to kind of tie it up, what does it mean to take a dialectical approach if we're doing science?

EZEQUIEL DI PAOLO: It obviously does not mean the simple application of a formula. It starts with an attitude. It starts with an awareness of you as a scientist being there in a historical context with others. You're investigating a question that has some value to you or some interest to you, and on reflection it would be good for you to be able to answer why it has some value to you. All those aspects are going to be part and parcel of what you're going to say about it, how you're going to approach it, and what you think it will be good to say about it.

It starts with that broad attitude. Then, more specifically, if your subject matter concerns very complex systems like in life and mind and society, your general awareness of your situatedness becomes an awareness of where you draw your distinctions and boundaries, and a conscious call to for you to keep track of those. You definitely draw a distinction and boundary here, but from a dialectical perspective, you know

that it can be revised. It can be revised because of what you find out down the line. Therefore, you say: I'm going to make this definition, articulate this concept, that's a great starting move but at the next moment you have to confront this abstraction with the concrete. You have to be able to say how is that definition to be interpreted based on what's around you. It may be then that either your definition needs to change, or that you need to notice the potential misinterpretations of the definition. Say, "Careful, I do not mean it in this way. I mean it in that way," and such caveats. So you're doing all of this as a circulation between the abstract and the concrete. And I'm very aware now that this has been the way I've been approaching things maybe before I was conscious of it, because I knew that I had to use certain technical vocabulary to talk about concepts in the enactive approach such as the concept of autonomy that has a particular technical meaning. But the word *autonomy* is used in so many other contexts and the meanings are different. I have to consciously decide: do I want to stick to the word? Or do I want to change it? I stick with it as an conscious move because I suspect that eventually down the line the different meanings may somehow start relating to each other. But then the idea itself won't stay the same.

And so a theory grows dialectically. You make a decision. You might be wrong in the end. But you make a decision. Say, "I'm going to stick to this vocabulary" but more interestingly, I will try to be precise and rigorous. At the same time I need to be open to seeing what happens when I confront this decision with the concrete, and see whether I need to refine my definition, or say, "This is only applicable in in a certain context, and not always." We have to do all that conceptual decision-making and as scientists we're not very well trained to do that. Rather, as scientists, even as philosophers, we're trained to say: well, once you define the thing, you just stick to this definition, period. You move forward, you don't move backward.

The whole point of a dialectical approach in science is that you do move both backwards and forwards. You circulate. That's the way I see it. And that's why you keep approaching a better way of knowing, a more concrete version or resonance between your knowledge and the world. That's different from the way scientists usually think about what they do, the much more linear model of theory, hypothesis, and experiment, then drop the hypothesis if it's not supported, reformulate it, and so on. In this model, we just keep moving forward discarding whatever doesn't work. This abstract model is not a very accurate description of how science actually works. Dialectics also moves forward but does not assume

such a linear progression. It keeps our ways of knowing (self)critical and integrated by forcing us to engage with what might be true about the ideas we discard and how what's wrong about them can be superseded without losing this kernel of partial truth.

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