Can Scientific Cognition Be Distributed?

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Abstract

The purpose of the paper is to examine critically Giere’s view of distributed cognition. Giere has treaded a tricky path between extreme ends in the disputes about the notion of distributed cognition and, as a result, two kinds of complains have been leveled against his view. On the one hand, conservatives like Vaesen criticized him for misusing the notion of distributed cognition. On the other hand, radicalists like Clark and me thought of him as a conservative for defending the traditional idea of the mind.

My argument unfolds as follows. In section two, I review briefly the typical cases of distributed cognition found in the works of Clark and Chalmers, Hutchins, and Knorr Cetina and extract a common characteristic of distributed cognition. In section three, I examine Vaesen’s response to Giere’s view of the distributed cognition around the debate between i-cog and d-cog. In section four, I show that Giere’s reply to Vaesen’s criticism is not appropriate for defending his version of distributed cognition and suggest a way towards the proper direction without breeding misunderstanding of the notion of distributed cognition.

Key words: distributed cognition, extended cognition, i-cog and d-cog, parity principle

1. Introduction

In cognitive science the notion of distribution is neither new, nor strange. Since 1980s cognitive scientists have used the notion of distributed processing as a salient feature of brain’s function. D. E. Rumelhart and J. L. McClelland (1986) imprinted the notion of parallel and distributed processing (PDP) on the mind of cognitive scientists. Recently, cognitive scientist E. Hutchins (1995) pioneered a theory of distributed cognition that cognitive process is distributed among artifacts as well as individuals beyond in the sense that they are parts of a cognitive system.

Nowadays, it is natural to talk about the distributed cognition even though there are still debates about whether cognition can be distributed or not, more specifically,

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whether the minds of scientists can be distributed over the instruments or physical objects, and whether scientific cognition can be distributed without accompanying the human agency. The idea of distributed cognition is intimately related to that of embodied cognition.\(^1\) Though embodied cognition is not the main topic of the paper, it is necessary to emphasize that embodied cognition theory is not well established yet and it subsumes various theories that are sometimes contradictory each other. We can see the expression, “4Es” (embodied, enactive, embedded, and extended cognition) in the literatures that stands for the core theoretical components of the embodied cognition theory.

However, the 4Es cannot represent the whole scope and contents of embodied cognition. They are neither exhaustive, nor exclusive. We can add more components to it such as distributed cognition and situated cognition such that we have the “4Es + D + S”.\(^2\)

- Embodied cognition
- Embedded cognition
- Extended cognition
- Enactive cognition
- Distributed cognition
- Situated cognition

As is shown, the notion of embodied cognition is more general and comprehensive than that of distributed cognition.

2. Types of distributed cognition

There are the two types of distributed cognition: Local distribution of cognition and global distribution of cognition.\(^3\) The local distribution of cognition concerns the distribution of a single person’s cognition in which cognition is distributed over the borderline of our bodies to external objects such as maps, telescope, computer, smart phone, and so on. The global distribution of cognition concerns the distribution of cognition in cognitive systems that are composed of individuals and instruments.

Human cognition can be distributed over a cognitive system. Consider a famous example given by A. Clark and D. Chalmers (1998). Otto suffers from Alzheimer’s disease that has caused the serious loss of his memory capacity. In order to compensate for the loss Otto carries always a notebook around with him. He writes newly acquired information down in his notebook and looks it up when any necessity arises.

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\(^1\) Here I use the name “embodied cognition” instead “embodied mind”, though it is necessary to separate them in some cases.

\(^2\) For introduction to 4Es, refer to M. Rowlands (2010) and L. Shapiro (2011).

\(^3\) I owe the above distinction to Giere (2007).
Now, consider Inga with normal capacity of cognition, especially normal memory. Inga hears the news that there is an exhibition at the Museum of Modern Art and decides to see it. She recalls the address of the museum and walks over it. Otto, too, hears the news and decides to go to see it. As usual, he consults his notebook, which shows the address, so he walks to the museum.

For some ways of filling in the story about Otto and Inga, Clark and Chalmers contend that Otto’s notebook plays the same role usually played by a biological memory. They argue that the cognitive cases of Inga and Otto are cognitively indistinguishable from a point of functionalism. Thus, if Otto’s notebook meets some conditions, we can think of it as a part of an unusual realizer of Otto’s belief that the museum is on its location, which is distributed between Otto’s brain and notebook. If so, we have to say that while Inga’s belief is entirely in her head, Otto’s is distributed between his head and notebook.

What is the condition that any external object meet for its being a cognitive component of a cognition? To answer the question Clark and Chalmers suggest the parity principle as follows:

If, as we confront some task, a part of the world functions as a process which, were it to go on in the head, we would have no hesitation in accepting as part of the cognitive/mental process, then that part of the world is (so we claim) part of the cognitive/mental process. (A. Clark and D. Chalmers, 1998, p. 8. Authors’ emphasis).

According to the above principle, Otto’s notebook is a part of the cognitive/mental process. So long as Otto consults his notebook, the notebook is really a part of his cognitive system which includes it as well as Otto’s brain and body. Clark and Chalmers call the resulting cognitive system as a coupled system and contend that the mind in a coupled system is extended over external components of the system. Because Otto’s mind plus his notebook comprise a coupled system, his mind extends beyond his skull and body to his notebook.

R. Giere cites Otto’s case as a typical example of distributed cognition and named it ‘locally distributed cognition’ in the sense that the range of distribution is local, i.e., to near around the person. Though Clark and Chalmers don’t use the notion of distributed cognition, there is a significant difference between the notions of extended cognition and distributed cognition and we can see later, contrary to Giere’s thought, that there is an insurmountable barrier between them.

Human cognition can be distributed globally over external components. The global distribution of cognition is the case that cognition is distributed into the ele-

ments of a global cognitive system such as navy ships, huge laboratories of the European Center for Nuclear Research (CERN), and the Hubble Space Telescope (HST). For the later discussion, let’s consider them briefly. The first example is E. Hutchins’ account of a traditional US Navy ship, the *Palau*, as an example of extended cognitive ethnography of navigation, which is presented in *Cognition in the Wild* (1995). Hutchins describes a cognitive process that takes place when steering a ship into harbor, by which a ship’s navigation team calculates the position of the ship over time by plotting a series of lines of position. The process involves several crewmen who use instruments in order to determine the bearings of certain landmarks, another who coordinates their work and records the bearings, and another who plots the bearings on a map and projects the ship’s future position. What Hutchins emphasizes are (a) that the cognitive process that aims to accomplish the task of steering the ship effectively is not only distributed over crewmen but also over artifacts such as alidade, gyrocompass, radar, maps, and so on, and (b) that the outcomes that mattered to the ship are not determined by the cognitive properties of any single navigator, but instead are the product of the interactions of several navigators with each other and with a complex suite of tools.

Now, consider another example for the global distribution of cognition. That is found in *Epistemic Cultures* (1999) by K. Knorr Cetina, where different scientific fields exhibit different epistemic cultures in the experiments done between 1987 and 1996 at CERN. CERN has a Large Hadron Collider coupled with a very large detector called ATLAS. Knorr Cetina contends that high energy physics experiments have a post-traditional communitarian structure as structures attempting to implement collective ways of working that downgrade the individual as an epistemic subjects and that emphasize instead such communitarian mechanisms as collective ownership and free circulation of work. One feature of such structures is that individual authorship conventions have disappeared and authority is distributed among a team or a group, or teams or groups. In high energy physics experiments, papers reporting experimental results have a list of all members of the collaboration that sometimes amounts to several hundred names. Here is an example. The number of authors of a paper with the title, “Combined Measurement of the Higgs Boson Mass in pp Collisions at $s\sqrt{ } = 7$ and 8 TeV with the ATLAS and CMS Experiments” (2015) is as many as 5154 but the length of research contents is only 7 pages among 33 pages. The subjectivity of participants is put on the line and quite successfully replaced by something like distributed cognition. According to Knorr Cetina, individual as an epistemic subject is erased and individual has been turned into an element of a cognitive system that functions as a collective epistemic subject. The only available

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7 Ibid., p. 25.
epistemic agent in such a system is the extended experiment itself.

3. *i-cog conservatism*

So far, we have examined two examples of distributed cognition: the local distribution of cognition and the global distribution of cognition. Now, let’s consider critical responses to the idea of the distribution of cognition. As shown in the previous discussion, the basic tenet of distributed cognition is that cognition can be distributed across the boundary line of the skull and the body to external objects, artifacts, and individuals.

There are strong resistance to the idea of distributed cognition. I use the word “conservatism” that comes mostly from the traditional view, referring to a position which sticks to individual subjectivity and limits the scope of cognition within the brain or one person. Conservatism can take various forms. We can see an example from J. Searle’s Chinese room argument (1980), especially in his view to the system reply. Another example is found in K. Vaesen (2011) who criticizes Giere from a conservative point of view. Before discussing Vaesen’s argument let’s summarize Giere’s (2007) view as follows:

- Cognition can be often distributed across individual and artifacts.
- A cognitive system consists of human agents and artifacts, but the locus of knowledge produced by the system is restricted to human agency.
- We should not accept the notion of the distributed mind, which leads finally to introduce a host of theoretical problems.

The strategy of Giere is to separate the notion of cognition from that of mind and to establish the distributed cognition without distributed knowing.

Vaesen, first, introduces the distinction between individual cognition (*i-cog*) and distributed cognition (*d-cog*). According to traditional accounts of cognition, cognition only takes place in the heads of isolated individuals. Hence, it is *i-cog*. Subsequently, Vaesen points out two important commitments of *d-cog*. The first commitment is the parity principle as a methodological principle, according to which human and artifact are equivalent in the sense that they play a same functional role in the realization of a system’s cognitive capacity. The second one is an extension of the traditional cognitive unit of analysis, i.e. the individual cognizer of *i-cog*. As we can see in Hutchins’ description of navigation, there is no central unit, blueprint, and crewman that organize the cognitive endeavor. Therefore, if we accept the two commitments, it is natural for us to admit that the artifacts comprising a cognitive system can be cognizing entities. This goes to a cognitive system that has *hybrid*

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components such as individuals as well as artifacts, as found in the Navy ship and the experiments in CERN.

The point of Vaesen is that $d$-cog has to be reduced to $i$-cog. Now, suppose we formalize the overall function of the Hubble Space Telescope ($\Phi_{HST}$) as follows.

$$(\Phi_{HST}: \phi_1 \to \phi_2 \to \phi_3 \to \phi_4)^9$$

Where $\phi_1$ is “data capture,” $\phi_2$ is “data transmission to planet earth,” $\phi_3$ is “delivering data in a format accessible to humans,” $\phi_4$ is “data to knowledge conversion,” and arrows indicate the ordering of the sub-functions. Vaesen recommends us to pay attention to the sub-function $\phi_4$ and argues, “Somewhere representations have to be promoted to knowledge, for if not the system’s overall function $\Phi_{HST}$ is not realized.” However, given Giere’s insistence on the non-parity between humans and artifacts in matters of knowledge, $\phi_4$ is carried out within human’s brain. As a result, we get the following formula:

$$(\Phi_{HST}: \phi_1 \to \phi_2 \to \phi_3) \to (\Phi_{scientists}: \phi_4)^{10}$$

Where $\Phi_{scientists}$ amounts to scientific knowledge production. The second formula has two parts. The left part is the process of instrumentation and the right is that of $i$-cog. The left part provides inputs or information to the right one, which knows the inputs, evaluates it, and produces scientific knowledge. In short, the first is about data and the send is about knowledge. Hence, knowledge is only in $\Phi_{scientists}: \phi_4$, which means that knowledge or cognition is not distributed to the whole function from $\phi_1$ to $\phi_4$. Therefore, it is impossible to espouse $d$-cog without distributing knowing agency to artifacts and external elements of a cognitive system.

Lastly, Vaesen suggests three options for escaping the dilemmatic situation as follows.\(^{11}\) The first option is to accept the $d$-cog’s parity principle, implying that scientific knowledge may be produced by artifacts (in principle, no humans needed\(^{12}\)), which Giere cannot follow. The second option is to make a revolution in our lexicon of scientific knowledge such that we can discuss $d$-cog without any theoretical problems “in alignment with $d$-cog”. But Giere is afraid that the supposed revolution leads to conceptual conflicts.\(^{13}\) Vaesen admits that there is a possibility (a) that scientific explanations based on the notion of $d$-cog performs better job than the case of $i$-cog or (b) that $d$-cog research program unifies “concerns of historians, sociologists and philosophers of science”. However, he recommends the third option: to preserve $i$-cog for the time being and to calculate empirically the payoffs of adopting $d$-cog, for there

\[9\] Ibid., p. 384.
\[10\] Ibid., p. 385.
\[11\] Ibid., p. 389.
\[12\] The original parity principle can imply that no humans is needed, but it is contrary to the view of Clark and Chalmers.
is no empirical evidence to validate for the precedent options. Anyway, there is no middle way which Giere’s view holds for.

4. Giere’s tightrope

As shown in the previous section, Giere is being criticized as a halfway radical without any admissible justification for \textit{d-cog}. Giere (2011) makes an immediate reply to Vaesen’s criticism. Let’s examine his reply. The core of Giere’s counter-argument is that Vaesen made misinterpretation of the parity principle as follows:

The first thing to note is that, as stated, it is a principle about cognitive \textit{processes}, not cognitive \textit{states}, and definitely not about the \textit{semantic content} of any content carrying state such as belief or knowledge. The second thing is that the principle gives only a \textit{sufficient} condition for regarding some process in the world as cognitive.\footnote{R. Giere (2011), p. 396.}

Giere’s counter-argument is neither strong, nor enough. It is true that the original version of parity principle contains the expression like ‘process’ or ‘cognitive/mental process’, but Clark and Chalmers extend it to the mind and the environment.\footnote{A. Clark and D. Chalmers (1998), p. 12.} Recall the case of Otto and Inga, where Otto’s notebook is a cognitive component of Otto, which means that the notebook is not just a causal component, but a real constituent one. According to the multiple realization principle, a single mental state or event can be realized by distinct physical processes or states. Hence, physically different processes can produce the same cognitive/mental content. What is important is not in the process, but the \textit{function}. For Giere, some processes of non-human objects can be \textit{cognitive} in that they are physical basis for producing knowledge, but they cannot have cognitive or mental states. But, Giere doesn’t give any admissible justification for excluding the possibility that the parity principle can be applied to non-human objects.

The debate between Giere and Vaesen concerns about whether we have to regard cognitive states in science as instances of \textit{d-cog} (Giere) or only as those of \textit{i-cog} (Vaesen). They think that the matter requires a methodological decision. Very interestingly, they have one strategy in common: methodological conservatism. Recall that Vaesen recommends the third option that leads us to try to demonstrate \textit{d-cog’s} payoffs empirically, but stick to \textit{i-cog} for the time being in the face of the low possibility of scientific explanation based on \textit{d-cog}. In a similar vein, Giere emphasizes that it is a matter of fairly \textit{high-level interpretation} to apply the concepts associated with human agency like mind, consciousness, and intentionality to extended entities involving both humans and artifacts, or to inanimate entities themselves. In other
words, the job is not empirical but conceptual basically, so we cannot justify the idea of the distributed cognition empirically. He is afraid of the situation that the application will lead to a revolution in our terminology, but he admits the revolution in our lexicon with the proviso that we have to adopt a new interpretation if it provides theoretical benefits of some sort, benefits that cannot be obtained without the revolution. In the situation of choice, however, Giere makes a pessimistic anticipation: “[T]hese extensions do not provide theoretical advantages for the study of science. On the contrary, they introduce a host of theoretical problems that confuse more than enlighten. We are theoretically better off rejecting these supposed innovations.”  

Giere is a well-known proponent of naturalized philosophy of science. What makes Giere reject the new interpretations? It is a worry about the kingdom of linguistic nonsenses. He raises the following questions: Does it make sense to say that the cognitive system of Otto with his notebook as whole “remembers” something? Does it make sense to say that the mind of HST extends from the Earth 2.2 billion light years out into space? For Giere, those questions do not make much sense. Why not much? It is because our giving affirmative answers to those questions is violating our language game in Wittgenstein’s sense. How can we decide whether a new interpretation is destructive or productive theoretically? According to Kuhn, any interpretation presupposes a paradigm, so a change of interpretation follows a change of paradigm. Giere is anxious about the “revolutions as changes of worldview” in the Kuhnian sense of revolution, which shows his shaky position: a conservative for i-cog as well as a (supposed) radicalist for naturalized philosophy of science.

In sum, Giere’s view of d-cog is somewhere between the two extremes: the conservatism found in Vaesen and the radicalism found in Hutchins, Knorr Cetina, and Clark and Chalmers. It is a kind of middle position. The fate of any middle position is that it can be the victim of criticisms from both extremes. In one hand, it is criticized as radicalism by conservatives and, in the other hand, it is criticized as conservatism by radicalists. In the dispute about d-cog it turns out that it will be a better strategy to follow Kuhn’s insight: There is no rational way of deciding between competing paradigms because a paradigm shift is a conversion experience like a Gestalt switch. We might decide between i-cog in the sense of Vaesen and d-cog in the sense of Giere, but it cannot be the case that they are decided as a conservative way as is supported by Giere.

5. Concluding remarks

It is an open question whether the d-cog view can give a unifying explanation

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17 Ibid., p. 317.
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over scientific cognition or knowledge. In the early stage of artificial intelligence there were intense debates about whether machine could think. Though there is no any single consensus among researchers who have their interests in the question, we can say that it has been answered already: machine can think. The reason we can answer affirmatively is not because that we have gathered empirical data favorable for it, but because that we are adopting a new interpretation. The notion of cognition is neutral in a sense that it can be applied to artifacts as well as humans. We can change our interpretation about scientific cognition relative to scientific evidence and as the amount of empirical data reaches to a critical level, a new interpretation starts as the gestalt switch. There are more emerging empirical data in cognitive science and neuroscience, especially from the embodied cognition theory that shows that \textit{d-cog} paradigm can replace \textit{i-cog} paradigm.

**References**

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