DOI: https://doi.org/ 10.56550/d.2.2.5		Original research article
Received on: March 30, 2023	Accepted on: October 4, 2023	Published on: December 18, 2023

Valentina Savojardo
University of Macerata
v.savojardo@unimc.it

SIMILARITY JUDGMENTS AND EXEMPLARS: FROM T.S. KUHN TO EMBODIED SIMULATION

Abstract

The paper takes up the complex Kuhnian concept of the "exemplar" through some key passages from the *Postscript-1969* and *The Essential Tension*. The term "exemplar" refers to the deeper philosophical meaning of the scientific paradigm: the "normal" scientist, with reference to the paradigm, can carry out his or her research by making similarity judgments between different problems. Such judgments are based on a perceptive ability that precedes any explicit rule and which is defined as both *learned* and *primitive.*
This paper intends to analyze this dual aspect of similarity perception from the point of view of Embodied Simulation Theory. The Kuhnian concept of exemplar can be clarified and deepened by considering the value of embodiment. The mechanisms of an "educated" perception can be identified in those automatic mechanisms of perceptual mirroring on which embodied cognition is based.

Keywords: Exemplars; Similarity judgments; Perception; Embodied Cognition; Embodied Simulation

ÄHNLICHKEITSURTEILE UND EXEMPLARE: VON T.S. KUHN ZUR VERKÖRPERTEN SIMULATION

Zusammenfassung

Der Beitrag greift das komplexe Kuhnsche Konzept des „Exemplars" anhand einiger Schlüsselpassagen aus dem *Postscript-1969* und *The Essential Tension* auf. Der Begriff „Exemplar" bezieht sich auf die tiefere philosophische Bedeutung des wissenschaftlichen Paradigmas: Der „normale" Wissenschaftler kann unter Bezugnahme auf das Paradigma seine oder ihre Forschung durchführen, indem er Ähnlichkeitsurteile

zwischen verschiedenen Problemen fällt. Solche Urteile beruhen auf einer Wahrnehmungsfähigkeit, die jeder expliziten Regel vorausgeht und die sowohl als *erlernt* als auch als *primitiv* definiert wird.
In diesem Beitrag soll dieser doppelte Aspekt der Ähnlichkeitswahrnehmung aus der Sicht der verkörperten Simulationstheorie analysiert werden. Das Kuhnsche Konzept des Exemplars kann durch die Berücksichtigung des Wertes der Verkörperung geklärt und vertieft werden. Die Mechanismen einer „gebildeten" Wahrnehmung können in den automatischen Mechanismen der Wahrnehmungsspiegelung identifiziert werden, auf denen die verkörperte Kognition beruht.

Schlüsselwörter: Exemplare; Ähnlichkeitsurteile; Wahrnehmung; verkörperte Kognition; verkörperte Simulation

Introduction

The notion of 'exemplar' assumes a central role in Kuhnian epistemology. In the *Postscript-1969* and in *The Essential Tension*, the author attempts to clarify the complex definition of paradigm, on which the central theses of *The Structure* are based, through reference to exemplars.

What are exemplars? What kind of knowledge do they produce? On what neural mechanisms is our ability to recognize one problem as similar to another based? And above all, what role does this capacity play in science? These are only some of the questions Kuhn raises in the above-mentioned texts. My attention will be particularly focused on the last two questions and their respective answers which Kuhn argues, both in the *Postscript* and in *The Essential Tension*, with the intention of defending himself against accusations of relativism and subjectivism.

The first part of this paper sets out to reconstruct the Kuhnian argument on the role of exemplars in the process of learning and acquiring meanings, with respect to the notion of the scientific paradigm. The claim that the recognition of similarities between two or more problems is prior to the application of correspondence rules is central (cf. Kuhn 1962; 1969; 1977). In the examined texts, Kuhn refers to this process several times as an automatism, based on certain neurocerebral mechanisms, prior to any definition or rule.

The exemplar as an example shared by the group constitutes the second, and more specific, definition of the term paradigm (cf. Kuhn 1969; 1977). Scientists, at the stage of "normal science", model the solution of one problem on that of another already known, and this similarity relationship becomes the main mechanism on which the work of the "normal" scientist is based. The ability to see certain similarities is related to an automatic process that the scientist can develop within the community of specialists. It involves using a perceptive capacity that Kuhn defines as both *learned* and *primitive* (cf. Kuhn 1977). The juxtaposition of these two terms is particularly problematic. This knowledge, embedded in similarity relations, appears to be founded on perceptual mechanisms that on the one hand are defined as innate and prior, as opposed to explicit laws or rules, but on the other hand must be educated.

How can a perceptual ability be both innate and learned or acquired? Recent studies on the perceptual mechanisms underlying Embodied Cognition, with particular reference to mirror neurons and Embodied Simulation Theory, can clarify how a perception precedes explicit rules or laws, but at the same time is learned and develops in the relationship between my body and that of the other, in a specific community context.

The second part of this paper will therefore return to the role of Kuhnian exemplars in science, considering the value of embodiment. The mechanisms of "educated" perception mentioned by Kuhn can be identified in those perceptual mechanisms upon which cognition is built, from an embodied perspective. Of central importance here is the thesis that marked the embodied revolution, starting as early as the 1980s, according to which nothing is abstract, but every idea, judgment, or decision makes use of the same system used to perceive, act, and feel (cf. Bergen 2012). In the embodied view, perception and action contribute to the development of cognition that is never purely theoretical or abstract, but always intertwined with a community context that outlines its main characteristics. In particular, the simulative mechanisms described in terms of Embodied Cognition can shed light on learning through exemplars, which constitutes one of the most complex and problematic aspects of Kuhnian epistemology.

1. T.S. Kuhn: Normal Science and Similarity Judgments.

The *Poscript-1969* constitutes Kuhn's attempt to clarify the many ambiguities surrounding the concept of paradigm as used in *The Structure of Scientific Revolutions*.

The purpose of this first part of the paper is to briefly reconstruct the main arguments through which Kuhn attempts to clarify the term paradigm through the notion of "exemplar", showing the connection between the scientist's ability to make similarity judgments and the practice of "normal science". In addition to the *Poscript-1969*, the second text I will refer to is *The Essential Tension*, in which once again Kuhn recognizes the need to return to the meaning of the term paradigm, in the face of the fact that numerous critics have been unanimous in recognizing the large number of meanings, at least twenty-two[1], in which the term is used in *The Structure* (cf. Kuhn 1977, p. 294).

As is well known, Kuhn, a few years after *The Structure*, distinguishes between two senses of the term paradigm; but both of these senses presuppose the idea, well rooted in Kuhnian thought, that the development of the basic sciences is not uniform, but goes through different stages: revolutionary periods alternate with phases of "normal science", defined as "the activity in which most scientists inevitably spend almost all their time" (Kuhn 1962, p. 5).

The first sense of paradigm is encapsulated in the expression "disciplinary matrix", within which all the elements shared by the group of researchers, from tools to beliefs to different techniques, must be placed. More precisely, Kuhn (1969, pp. 181-187) speaks of four main components: symbolic generalizations, models, values, and exemplars. The latter are understood first and foremost as "the concrete problem-solutions that students encounter from the start of their scientific education, whether in laboratories, on examinations, or at the ends of chapters in science texts" (Kuhn 1969, p. 187). According to Kuhn, the differences between sets of exemplars determine, more than any other component of the "disciplinary matrix", the community structure of science. Therefore, the second sense in which the paradigm is to be understood coincides with the concept of the exemplar itself and requires more attention.

If the paradigm as a disciplinary matrix takes on a sociological value, Kuhn reiterates how the significance of paradigms as exemplars remains philosophically deeper. The problem, and subsequent further confusion, may arise, however, when we find exemplars also among the elements of the "disciplinary matrix". It is then unclear whether the concepts introduced are to be understood in a sociological or philosophical sense. As has been rightly noted, in order to overcome this ambiguity, with respect to the concept of paradigm, these two dimensions, sociological and epistemological, must on the one hand be distinguished but on the other hand related to each

[1] Kuhn refers in particular to Masterman (1970).

other, bearing in mind the influence of the late Wittgenstein on the Kuhnian interpretation of exemplars[2]. Paradigms, in fact, possess at the same time a cognitive dimension, as they make scientific research possible, and an empirical-sociological dimension, as their meaning depends on the uses of terms and theories, intrinsically connected to observable behavior. Symbolic generalizations, models, and values, as components of the "disciplinary matrix", would have no determinate meaning if they were understood separately from the exemplars, the shared practical applications, which make so many different scholars a single community of researchers, specialized in a certain field[3]. For the late Wittgenstein, a term or phrase only makes sense, and is logically comprehensible within a precise linguistic context: every new use of words escapes the attempt to subordinate it to fixed rules. Similarly, according to Kuhn, scientific theories and concepts derive their meaning from their use and practical applications. It becomes impossible to establish, in a definitive manner, the rules by which theoretical laws are applied to the world (cf. Buzzoni 1986; 2005; 2010). In *The Structure*, the recourse to the theory of language games becomes functional in order to show the priority of paradigms over correspondence rules. The paradigm does not guide scientific research by means of explicit rules: "The determination of shared paradigms is not […] the determination of shared rules" (Kuhn 1962, p. 43). According to Kuhn, it is necessary to distinguish the paradigm from the set of laws that guide the activities of scientists; in fact, sharing a particular way of seeing the world with other individuals is much more than acting, mechanically applying the same theories to reality. In the *Postscript-1969* and in *The Essential Tension*, Kuhn reiterates the priority of paradigms over rules, referring to the role of exemplars, also in order to respond to accusations of subjectivism and irrationalism.

Just as the use of a term, within a certain context, requires the perception of a certain similarity between the objects observed (cf. Kuhn 1962, pp. 44-45), so there exist, and are easily identifiable, relationships of similarity between different research problems and techniques within a tradition of "normal science". What problems and techniques share is not simply a set

2 With respect to this thesis, see in particular Buzzoni 1986, pp. 51-53; 2005; 2010. Here, the author shows how Kuhn made Wittgensteinian philosophy of language the philosophical foundation of his epistemology and, more specifically, of his instrumentalism.

3 In Savojardo (2013), the Kuhnian concepts of "paradigm" and "normal science" are examined with reference to M. Polanyi's theory of personal knowledge, cited by Kuhn himself, in order to clarify the role of knowledge acquired through practice.

of explicit rules: "Paradigms may be prior to, more binding, and more complete than any set of rules for research that could be unequivocally abstracted from them. So far this point has been entirely theoretical: paradigms *could* determine normal science without the intervention of discoverable rules" (Kuhn 1962, p. 46).

This important passage would later be taken up and expanded upon by the author in the *Poscript-1969*, referring to paradigms as exemplars: exemplars precede the use of explicit rules or laws. To think that scientific knowledge is embedded in theories and rules and that problems only serve to apply these theoretical elements is utterly misleading. The student's learning process is simply the reverse. One does not learn the rules and then apply them, but learns from concrete cases or examples through similarity relations:

> The student discovers, with or without the assistance of his instructor, a way to see his problem as *like* a problem he has already encountered. [...] The resultant ability to see a variety of situations as like each other, [...] is [...] the main thing a student acquires by doing exemplary problems, whether with a pencil and paper or in a well-designed laboratory (Kuhn 1969, p. 189).

Normal science develops in the relationship between students and teachers and resembles the practice of solving puzzles (cf. Kuhn 1962, pp. 35-42): the answers to problems are already given, the scientist's skill lies in applying them to the individual cases that come to his or her attention, always in a community context. Just as in the attempt to put together the pieces of a puzzle, the work of the individual is coordinated and develops in relation to the movements and choices of all those who collaborate together in the enterprise; so, in science, the researcher cannot isolate himself or herself from the rest of the group; each work acquires significance in the interpersonal relationship with the other scientists, specialized in the same field. But how do scientists solve puzzles? The process that is put in place is the same as the one that allows students to solve a complex problem at the end of a chapter in a textbook. The scientist solves a puzzle by modeling previous solutions of known problems and thus making similarity judgments; only to a minimal extent do scientists resort to symbolic generalizations (cf. Kuhn 1969). The description of the mechanism through which we become able to discern similarity relations constitutes a central passage in Kuhnian argumentation on exemplars and shows, once again, the priority of paradigms over correspondence rules.

In the *Postscript*, Kuhn makes it clear at once that the knowledge of nature learned in similar relations is incorporated in the way physical reality is seen, rather than in rules or laws (cf. Kuhn 1969, pp. 190-191). The process through which this knowledge is acquired seems not to be resolved exclusively on a verbal or explicit level. But what is even more important to emphasize is Kuhn's need to specify that although there is an ineliminable tacit aspect within scientific knowledge, scientific insights "are not in principle unanalyzable" (Kuhn 1969, p. 191). Knowledge through shared concrete examples is no less systematic or analyzable than knowledge of laws or rules. In this way, Kuhn not only attempts to answer criticisms of subjectivism and irrationality but also suggests a way of identifying a type of knowledge that seems to precede the explicit search for rules or definitions:

> When I speak of acquiring from exemplars the ability to recognize a given situation as like some and unlike others that one has seen before, I am not suggesting a process that is not potentially fully explicable in terms of neuro-cerebral mechanism. Instead I am claiming that the explication will not, by its nature, answer the question, "Similar with respect to what?" That question is a request for a rule, in this case for the criteria by which particular situations are grouped into similarity sets, and I am arguing that the temptation to seek criteria (or at least a full set) should be resisted in this case (Kuhn 1969, p. 192).

The perception of similarity is understood as "logically and psychologically prior" (Kuhn 1997, p. 308) to all those criteria that accompany that identification: faced with a problem, the students of science seek a solution by looking for aspects in common with other problems they have already encountered; certainly, if they know the rules, they will try to apply them, but their basic criterion remains the perception of similarity (cf. Kuhn, 1977, p. 308). One should resist the temptation to look for criteria before identifying the similarity relation because this relation precedes any explicit judgment or law. The precedence, from a logical point of view, concerns the necessity of a visual and mental apparatus without which it would be impossible to define criteria or judgments of similarity; from a psychological point of view, on the other hand, the precedence of the perception of similarity over explicit criteria is exemplified by the author with reference to the neurological mechanisms that accompany and make possible the perception itself on the part of the subject (cf. Kuhn 1977, p. 308). The ability to see a problem as similar to another already known is "the result of neural processing, fully governed by physical and chemical laws" (Kuhn 1969, p. 194). Once we have learned this, it becomes an automatic mechanism that accompanies us always, like the beating of the heart: we no longer exercise any control over it, no power of choice. The fact that we are dealing with an entirely involuntary mechanism allows Kuhn to define the implicit processes that drive this mechanism as "ultimately [...] neural, and [...] therefore governed by the same *physico-chemical* laws that govern perception" (Kuhn 1969, p. 195). It is a matter of seeing or learning to see and not of interpreting: interpretation and perception are two related but different processes and what perception leaves to interpretation because it completes it, depends both on nature and on acquired experience and education (cf. Kuhn 1969, p. 198).

What role then do education and training play in this automatic and involuntary perceptual mechanism that allows us to see something as similar to something else?

Kuhn speaks of a "mental or visual set acquired" (1977, p. 208), through which we can see two problems as similar. The path from stimulus to sensation is partly conditioned by education, but let us see how. Whenever we deal with "data", we manipulate sensations, which are always responses to certain stimuli. It is not the sensations, but the stimuli that interact with us, with our organism: a large number of neural processes then take place between the reception of a stimulus and the sensory response (cf. Kuhn, 1977, pp. 308-309). This is why, on the one hand, the same stimulus can elicit different sensations: just think of the famous images from Gestalt psychology where, for example, the same marks on a sheet of paper can sometimes make one perceive the figure of a duck, sometimes that of a rabbit; on the other hand, however, the same sensation, such as that of a color or sound, can be evoked by different stimuli. There is no two-way correspondence between stimuli and sensations because "they need to be shared responses [...] within the membership of a relativity homogenous community, educational, scientific, or linguistic" (Kuhn 1977, p. 309).

To exemplify this point, Kuhn describes a particular scenario (cf. Kuhn 1977, pp. 309-318) in which a young child walks with his father through a zoo, learning to distinguish swans, geese, and ducks. The main pedagogical method is ostension: the adult shows his son a swan. Immediately the child is led to extend the learned term to the other types of birds, but the father, through correction and reinforcement, induces him to make the right distinctions. Thus, the learning process took place. But how can we explain what happened on the level of neural processes, on the level of the psychophysical laws that govern perception? Kuhn, referring to the child, answers this question in these terms: "During the afternoon, part of the neural mechanism by which he processes visual stimuli has been reprogrammed, and the data he receives from stimuli which would all earlier have evoked 'bird' have changed. Birds that had previously all looked alike […] are now grouped in discrete clusters in perceptual space" (Kuhn 1977, pp. 309-310).

The ability to distinguish swans, geese, and ducks depends on the child, like his father, being part of a community: the learning process causes the child to be "programmed" to recognize what his community of apparatenance presumably already knows (cf. Kuhn 1977, p. 312). This process of "programming" takes on the character of knowledge since our little protagonist, after spending the afternoon with his father at the zoo, knows what the terms "goose", "swan", and "duck" mean, not, probably, in the sense of being able to give exact definitions of each bird, but in the sense of being able to apply these terms immediately, without any effort. Again, referring to the child in question, Kuhn then writes:

> Johnny has learned to apply symbolic labels to nature without anything like definitions or correspondence rules. In their absence he employs a *learned* but nonetheless *primitive* perception of similarity and difference. While acquiring the perception, he has learned something about nature. This knowledge can thereafter be embedded, not in generalizations or rules, but in the similarity relationship itself (Kuhn 1977, p. 312, my italics).

The ability to see commonalities between different problems is thus defined, on the one hand, as something innate, primitive and, on the other, as always subject to education. It is evident how it is a learned ability, in relation to the role Kuhn attributes to the community and the socio-cultural context in which each word or term can take on a certain meaning. But perhaps less obvious is the sense in which the author defines the perception of similarity as primitive. This adjective is probably explained in relation to the value of observation, the use of which is widespread, both in the process of learning a language and in scientific practice (cf. Kuhn 1977, p. 318). The neural processes underlying perception determine, in our organism, that automatic, involuntary process through which we see familiarities, before applying any rules. This automatism, however, can only be explained within a community context. Our observation, and therefore our nervous system, is "programmed" in the interpersonal relationship with reference figures, masters who guide us in the learning of exemplars, which slowly become part of us, and are assimilated by our organism.

The reprogramming process of the neurocerebral mechanisms coincides with the “conversion”, the term by which Kuhn defines the shift from one paradigm to another in *The Structure*. Conversion, understood as a gestalt turn or reorientation, remains at the heart of the revolutionary process. Scientists certainly may resort to translation techniques to persuade other members of the community to make the “leap” to the new system of values, techniques, and scientific instruments; but in fact, the transition eludes any logical reconstruction. The term conversion speaks to us of an explanatory vacuum that runs through the scientific process, a residue of the unspoken which, however, following Kuhn’s *Postscript-1969* and *The Essential Tension*, would largely depend on the physics and physiology of the sense organs, conditions that seem to pre-exist any choice (cf. Casamonti 1999).

2. Exemplars As “Embodied” Examples

The analysis of the Kuhnian concept of the “exemplar”, through reference to the *Poscript-1969* and *The Essential Tension*, has highlighted an important critical aspect that concerns the elaboration of similarity judgments, through a perceptive capacity that is both learned and primitive. Learned, as has already been pointed out, because it is always “educated” within a community context, without which there would be no science, and primitive because it precedes the elaboration of laws or explicit terms, thanks to which it is still possible to justify similarity judgments, but only later, after the initial, automatic or involuntary observation or perception of certain similarities.

Exemplars are constructed based on neurocerebral mechanisms which underly the perceptive ability. These mechanisms determine the similarity judgments and, thus, the activity of “normal science”. The reference Kuhn (1969) makes to these neurocerebral mechanisms leads him to question that field of study from the 1970s onwards, following philosophers such as e.g. M. Ponty and J. Dewey, and initiating a revolution in the way the human mind is conceived. At the center of this revolution is the idea that our minds are not abstract entities in themselves, but have to do with our bodies, in particular the neural structures involved in vision, action, and emotion. The theories of perception, which underpin Embodied Cognition and, in particular, Embodied Simulation Theory (cf. especially Gallese 2009; 2011a, b; 2018a, b; 2019; Gallese and Sinigaglia 2011a, b; Wojciehowski and Gallese 2011; Bergen 2012; Zwaan and Taylor 2006; Raposo et al. 2009) can make an important contribution to Kuhnian exemplar theory by showing how the perceptual mechanism, which determines similarity judgments, can be something primitive but at the same time learned, through simulative mechanisms involving the activity of an always-embodied mind.

The idea behind the embodied revolution, according to which the construction of meanings depends on the experiences of the body (cf. Bergen 2012), allows us to re-read the Kuhnian concept of the exemplar from an embodied perspective, developing the image of science that is never abstract but always connected to its cultural, social, and linguistic dimensions.

The 1980s and 1990s were marked by important results in support of Embodied Cognition, results that ranged from linguistics, with particular reference to the work of Lakoff and Johnson (1980, 1999), to cognitive psychology, with the notion of "grounded cognition" developed by Barsalou (1999) and the theory of mirror neurons, elaborated by a group of neuroscientists in Parma (cf. Rizzolati et al. 1996; Gallese et al. 1996). This second part of the article will refer specifically to the Embodied Simulation Theory, which was particularly influenced by the mirror neuron theory (cf. Gallese 2009; 2011a, b; 2018a, b): the observation of an action implies its simulation at the level of motor-type brain structures through an automatic process that allows the observer to understand the action of others without the need to implement propositional attitudes or elaborate theories on the observed behavior.

The embodied simulation hypothesis, in the construction of meanings, is based on a fundamental assumption: "We understand language by simulating in our mind what it would be like to experience the things that the language describes" (Bergen 2012, p. 13). Simulation concerns the reproduction of sensory and perceptual experiences, in the absence of their external manifestations, on the basis of personal experience. Through simulation, a series of familiar experiences are recreated in the mind and, as we shall see, important experimental results today allow us to consider the reuse of certain brain systems for other and different cognitive functions, as an operational principle of the mind, in its conscious and nonconscious activities. People simulate all the time, not only when they perceive objects or people in motion but also when they hear or read sentences, and try to remember or imagine certain actions or sounds. In his *Louder Than Words*, Bergen (2012) collects numerous experimental results in support of this thesis, showing how visualization, understood as the reuse and activation of parts of the brain that actually control imagined actions, is a pervasive property of the mind, through which we simulate different situations (cf. ch. 2). Studies in the field of sports psychology (cf. Driskell, Copper and Moran 1994; Weinberg 2008), for example, show that imagining the use of one's body then makes the athlete's own performance easier. Another example, cited by Bergen, is that of the well-known Perky Effect, to which I will briefly refer in order to clarify the connection between embodied simulation theory and perceptual activity.

As early as 1910, C.W. Perky conducted an interesting experiment to explore what was going on in people's minds during mental imagery. She asked participants to imagine an object, such as a banana or a leaf, by turning their gaze towards a white wall (cf. Perky 1910). Meanwhile, through gradual focusing and lighting, images of the imagined objects themselves were projected onto the wall. The participants, even when the projected object was sharply focused and illuminated, could not recognize that this was a real image projected on the wall and continued to believe they were simply imagining the objects in question. As Bergen (2012) points out, the so-called Perky Effect can also be experienced in everyday life, during daydreams, or when we imagine doing or seeing something: if you think and imagine your old telephone, for example, you will find it difficult to find the new model you have lost at home (cf. Bergen 2012, p. 28). This simple empirical evidence shows that imaginative activity interferes with vision and that, when we imagine, we enact a series of simulations involving the body, in particular, both the perceptual and the motor systems. Several studies have also shown that there is an overlap, at the level of brain structures, between what we imagine and what we see, an overlap that concerns, in particular, the perception of moving objects[4].

As we have already pointed out, the study of the perception of actions and movements led, in the 1990s, to the development of the so-called mirror neurons theory, thanks to which it was possible to identify a mirror system, first in the brains of macaques, then in those of humans. Through brain imagining, an overlap in brain activations was revealed when people perform and perceive certain actions (cf. Stanfield and Zwaan 2001). Today, there are several areas in which mirror neuron theory is being explored; these include research on the relationship between mirror neurons and aesthetic experience (cf. Gallese 2019), or those on the relationship between mirror neurons and narrative fiction (Wojciehowski and Gallese 2011; Gallese and

[4] Cf. on this point the interesting experiments of Cooper and Shepard (1973) and Cooper (1975), analyzed by Bergen in his text (2012).

Lakoff 2005), and finally, those concerning the relationship between our mirror system and language understanding (Zwaan and Taylor 2006; Raposo et al. 2009; Iacoboni 2008). A major challenge for mirror neuron theory is precisely whether our mirror system is active not only in perception but also in language understanding about actions or movements. In the last twenty years, in particular, there have been numerous studies around the so-called action-sentence compatibility effect (cf. Bergen 2012; Kaschak and Borregine 2008; Glenberg et al. 2008; Tseng and Bergen 2005; Bergen and Wheeler 2005). The result of these experiments was the following: “When you read nouns, even merely to decide whether they’re words or not, you evoke knowledge about how you physically interact with the things that the nouns denote” (Bergen 2012, p. 85). For example, the role of affordances – understood not so much as physical properties of an object, but as practical opportunities that the environment offers to any organism capable of using them (Gibson 1979; Turvey et al. 1981; Turvey 1992) – has also proved central in the comprehension of sentences that refer to actions or objects that can be manipulated: here too, the motor system corresponding to the actual action is activated, in an almost automatic manner (Martin 2007; Raposo et al. 2009). The notion of embodied simulation is also connected to the notion of “motor resonance” (Zwaan and Taylor 2006) that concerns the response, from a neural point of view, of a subject in reading or listening to a narrative: “When we read a novel, our mirror neurons simulate the actions described in the novel, as if we were doing those actions ourselves” (Iacoboni 2008, p. 94). Reading or listening to sentences that reproduce actions, associated with the movement of specific parts of the body, activates the corresponding areas of the brain as if that action or movement were actually being performed (cf. Caracciolo and Kukkonen 2021).

Embodied simulation thus seems to assume a central role in many functions related to the understanding of meaning (cf. Damasio et al. 1996; 2001; Glenberg et al. 2008; Meteyard et al. 2008). In particular, in the representation of meaning, “embodied simulations do the work of representing - they’re internal reflections of purported external scenes” (Bergen 2012, p. 244). More importantly, representation occurs through the subjective experience of learning:

> We’re not mere mechanical thinking machines. We also have subjective experiences […]. The basic idea is that we have subjective experiences when we’re actually perceiving or actually moving our bodies. Reusing our brain systems

> for perception and motor control during language understanding may perhaps provide us with similar subjective experiences. (Bergen 2012, p. 244)

The process of embodied simulation performs its function, with respect to cognition, always in relation to the experience of the individual, an experience that is constructed in interpersonal relationships, in a community context. In order to understand how Embodied Simulation Theory can shed light on a type of learning by exemplars, it is necessary to dwell on the role of experience in the simulation and mental imagery process. This issue is very broad and complex and would require further in-depth analysis; therefore, on the one hand, I will restrict my attention to some experimental studies aimed at showing how the individual's experience affects simulation, and on the other hand, I will make a brief reference to the Walton Theory of Fiction, in order to reflect on the social dimension of our embodied imagery.

The first aspect to be emphasized is that different people "do not all simulate the same things or simulate them in the same way" (Bergen 2012, p. 151). Simulations vary according to the experiences and cognitive abilities of individuals. In support of this thesis, Bergen (2012, ch. 7) presents studies that show that people who are experts in a profession or sport understand the language related to their field of experience differently than non-experts (cf. Beilock et al. 2008); consequently, their embodied simulations will also be somewhat different. For example, more experienced people, such as hockey players, construct more visual details based on their previous training when understanding sentences relating to their activity compared to novices. At the level of brain structures involved in motor simulation, it has been shown that an expert activates brain areas responsible for controlling well-learned action more, whereas non-experts tend to activate primary sensory and motor areas more (cf. Bergen 2012, pp.156-157). In this sense, the comprehension of language, together with the degree of accuracy in embodied simulations can vary from person to person, as well as from group to group, and this can cause communication problems, also in relation to the use of the body, in different cultures. If we take the sentence "*All afternoon, I was waiting for my brother on the corner*" as an example (Bergen 2012, p. 177), the same words can activate different embodied simulations, depending on the culture they belong to: "For instance, in China, when people don't want to stand, they often squat. They squat on the ground, they squat on the sidewalk, and they sometimes even squat on benches, rather than sitting on them" (Bergen 2012, p. 177-178). Such a way of using the body may seem quite unusual or unheard of in Western culture, and if different peoples use their bodies differently, their understanding of the sentence just mentioned will change, or rather will change the embodied simulation that accompanies and makes such an understanding possible. The embodiment and the very way we conceive of the body while waiting on a street corner, in Chinese culture, will be profoundly different than in another culture, such as American or Italian culture: "The embodied simulations we construct do not follow a universal template; they are deeply permeated by not only our individual experiences but the ones we gain as a result of being members of a particular culture" (Bergen 2012, p. 181).

The impact of the cultural, social, and linguistic context on our embodied simulations leads us to attribute an essential role to the social dimension of our imagery. The work of mental imagery cannot be separated from the concrete and tangible relationship with the people around us, guiding us in the different learning processes. Kendall Walton's theory of fiction, and in particular his conception of games of make-believe (Walton 1990), develop the idea that imaginative activity is a social practice, a "game" we play together with others and through which we encounter others (cf. Huemer 2021). From Walton's perspective, representationality is based on make-believe games, which do not only concern works of art in their various forms; the activity of imagining make-believe scenarios is defined as an aspect that pervades all of human existence (cf. Walton 1990, p. 23). The make-believe game, which emerges from childhood, also persists into adulthood in increasingly complex forms, becoming evident, especially in the attempt to understand works of art, from paintings to films to plays, etc. Fictional games take on an important cognitive value, responding to the human being's deep need to understand the environment in which he or she lives. The fact that engagement in fiction tends to be contagious, as is the case for example in children's games (cf. Walton 2015), allows us to consider fictional works not simply as tools for looking inside ourselves but also as a means of encountering concrete people (cf. Heumer 2021). Imagination becomes a social practice in which individuals, through their contributions, shape the cultural space in which the practice itself takes place, through a series of not entirely explicit rules that allow different members of the community to reflect on themselves and express who they are or who they would like to be. In this sense, imagination has a considerable impact on the formation of one's identity. The fact, however, that the rules underlying this collaborative game are not explicit points to the idea that they are rooted in our biological constitution: in this sense, they become the conditions of possibility for comparison with others on a social level (with regard to these considerations, see especially Huemer 2021).

Returning to the Kuhnian concept of the exemplar, I believe that the studies presented in the Embodied Simulation Theory can partly clarify how the perception of similarity, on which the work of the "normal" scientist is based, may on the one hand be primitive and precede the application of any explicit rules, but on the other hand, must be acquired and educated. As has been pointed out, from an embodied point of view, the acquisition of meanings occurs thanks to simulative mechanisms that involve the body, through the activation of the perceptual and motor systems: the understanding and use of a term implies the involvement of our body, understood, however, not only in a biological sense, as an organism, but also as a body in action, within a certain living space and in relation to other bodies. Such a vision of embodied cognition, based on simulative mechanisms, implies the idea of knowledge always intertwined with the planes of action and practice. And this is especially true in a field such as science, where, at the technical-operational level, the activity of the mind is never purely abstract (cf. especially Buzzoni 2008). Science is a practice that we share with others, always in a certain community context, through which the scientist is realized in the interpersonal relationship. Science cannot be a private affair but develops in a public dimension that gives it value and meaning. Learning by exemplars or concrete examples is possible through this ineliminable relationship.

Kuhn, as has been pointed out, referring to the concept of the paradigm as an exemplar, speaks of a perceptual system, based on certain neurological mechanisms, that can be "reprogrammed", depending on the educational community context in which the scientist is formed. Through such a system, the scientist can see similarities between different problems and realize his or her vocation as a "normal scientist". The presence of neurological mechanisms, based on physical laws, allows Kuhn to define the perception of similarity as something primitive, preceding any application of explicit rules. Recent studies on Embodied Simulation Theory can tell us more about such neurological mechanisms, showing the link between perception and action, on the basis of a cognitive activity that is always embodied. The capacity to perceive similarities can be considered as something primitive and innate because it is connected to a series of almost automatic simulation mechanisms that involve our entire organism and precede any propositional attitude. This, however, is not enough. Just as Kuhn, on the one hand, recognizes that this skill must, at the same time, be learned through the safe guidance of experts, so have the studies on Embodied Simulation shown that not everyone simulates the same things in the same way, but the educational experience assumes a central role in the process of embodied simulation. Thus, even the Kuhnian idea that similarity perception must be learned can be exemplified through reference to Embodied Cognition, and, in particular, the aforementioned theory of mirror neurons. The overlap in brain activations, when people perform, imagine, understand, and perceive certain actions, is based, as is well known, on the activation of a mirror system through which awareness of my body passes through the relationship with the body of the other. Each meaning is "constructed" in the interweaving of one's individual experience and the community context that gives each person a role. Therefore, in line with what Kuhn himself states, the ability to see similarities can be learned and educated through the guidance of experienced teachers, thanks to whom science students will be introduced to the community, making scientific language and practice their own.

The ineluctable relationship between perception and action, between mind and body, highlighted by the results of Embodied Cognition, can exemplify the apparent Kuhnian contradiction between an innate and at the same time learned, perceptive ability. Knowing by exemplars or concrete examples becomes, from an embodied perspective, the only authentic way of learning: the human organism's own primitive ability to perceive similarities is based, like any perception, on the automatic and equally primitive link with the motor system and thus with action. In turn, the link with the plane of action implies the relationship with the context in which my body moves and through which the construction and sharing of meanings can take place. Science, like any other human attempt to understand reality, takes on the character of a human practice, in which my every choice or decision affects the work of all the others, in a collaborative relationship, nourished yes by the education and training acquired, but also, and this we cannot forget, by the cognitive vocation of every human being.

Conclusion

The analysis of the Kuhnian argumentation around the concept of exemplar has revealed certain ambiguities concerning a type of learning based on concrete examples. In the *Postscript-1969* and in *The Essential Tension*, there is, in fact, talk of knowledge that is logically and psychologically prior to the application of explicit laws or rules. In the phase of "normal science", the work of the scientist cannot take place except by reference to paradigms, understood first and foremost as solutions to concrete problems. Without reference to such solutions, there can be no science, because the scientists, like the science students, would have no reference points on which to set and build their work. Tools, techniques, and values acquire meaning only in reference to shared practical applications. Underlying learning by examples is a perception of similarity, which Kuhn defines as primitive – because it precedes all rules and depends on a series of neurocerebral processes – but also as learned because it is made possible by experience and education received within a community context.

In the second part of this paper, this dual and rather problematic aspect of the perceptual ability described by Kuhn was taken up, but from the perspective of some recent theories on Embodied Cognition. In particular, reference was made to the Embodied Simulation Theory, in the construction of meanings. The Kuhnian idea of "normal science" as the solution of puzzles, thanks to similarity judgments, can be clarified by thinking about the simulative mechanisms that our embodied mind enacts, not only in the perception of actions or moving objects but also in the comprehension of words and sentences. From an embodied perspective, perception, like language comprehension, involves processes of visualization or mental imagery through which a series of simulations involving our whole body are enacted. Perception, cognition, and action are interconnected. This is why cognitive work cannot be separated from the dimension of the body – understood as an organism – but also as a body acting in a certain space, recognizing itself through interpersonal relationships. Such a vision of cognition is fully aligned with the image of science, in which the work of each is coordinated and constructed in recognition of the work of all others. But above all, the reference to simulative mechanisms through which we learn reality, allows us to return to the perception of similarity, at the basis of learning by exemplars, showing how all perception is primitive because it is connected to certain neurocerebral mechanisms, underlying the activity of an ever-embodied mind, which can, however, exercise its cognitive powers, always and only through the experience acquired in exchanges and interpersonal relationships, within a certain culture.

References

- Barsalou, L.W. (1999). 'Perceptual symbol system', *Behavioral and Brain Sciences*, 22, pp. 577-609.
- Beilock, S.L., Lyons, I.M., mattarella-Micke, A., Nusbaum, H.C. and Small, S.L. (2008). 'Sport experience changes the neural processing of action language', *Processing of the National Academy of Science (USA),* 105, pp. 13269-13273.
- Bergen, B.K. (2012). *Louder Than Words. The New Science of How the Mind Makes Meaning*. New York: Basic Books.
- Bergen, B.K. and Wheeler, K. (2010). 'Grammatical aspect and mental simulation', *Brain and Language*, 112(3), pp. 150-158.
- Buzzoni, M. (1986). *Semantica, ontologia ed ermeneutica della conoscenza scientifica. Saggio su T. S. Kuhn*. Milano: Franco Angeli.
- Buzzoni, M. (2005). 'Relativismo epistemologico e persona uman', *Studium,* 487-502.
- Buzzoni, M. (2008). *Thought Experiment in the Natural Sciences. An Operational and Reflective-Transcendental Conception*, Würzburg: Königshausen+Neumann.
- Buzzoni, M. (2010). 'Paradigmi e giochi linguistici: l'a priori fra Kuhn e Wittgenstein', *Giornale di Metafisica*, 32, pp. 371-388.
- Caracciolo. M. and Kukkonen, K. (2021). *With Bodies: Narrative Theory and Embodied Cognition,* The Ohio State University Press.
- Casamonti, M. (1999). 'Kuhn, Polanyi e Wittgeinstein sul significato: esemplari, conoscenza tacita e giochi linguistici, *Rivista di Storia della Filosofia,* 54 (2), pp. 283-308.
- Cooper, L.A. (1975). 'Mental rotation of random two-dimensional shapes', *Cognitive Psychology*, 7, pp. 20-43.
- Cooper, L.A. and Shepard, R.N. (1973). 'Chronometric studies of the rotation of mental images' in W.G. Ghase (Ed.) *Visual information processing*. New York: Academic Press, pp. 72-121.
- Damasio, H. Grabowski, T.J., Tranel, D., Hichawa, R.D. and Damasio, A.R. (1996). 'A neural basis for lexical retrieval', *Nature*, 380(6574), pp. 499-505.

- Damasio, H. Grabowski, T.J., Tranel, D., Ponto, L.L.B., Hichawa, R.D. and Damasio, A.R. (2001). 'Neural correlates of naming actions and of naming spatial relations', *NeuroImage*, 13, pp. 1053-1064.
- Driskell, J., Copper, C., and Moran, A. (1994). 'Does mental practice enhance performance?', *Journal of Applied Psychology*, 79, pp. 481-492.
- Gibson, J.J. (1979). *The Ecological Approach to Visual Perception*. Boston MA: Houghton Mifflin.
- Gallese, V. (2009). 'Mirror neurons, embodied simulation and the neural basis of social identification', *Psychoanalytic Dialogues*, 19 (5), pp. 519–536
- Gallese, V. (2011a). 'Embodied simulation theory: Imagination and memory', *Neuropsychoanalysis*, *13*(2), pp. 196-200.
- Gallese, V. (2011b). 'Neuroscience and phenomenology', *Phenomenology & Mind*; 1, pp. 33–48.
- Gallese, V. (2018a). 'Embodied simulation and its role in cognition', *Reti, saperi, linguaggi*, *Italian Journal of Cognitive Sciences*, pp. 31-46. Available at: doi: 10.12832/90969.
- Gallese, V. (2018b). 'The power of images: A view from the brain-body', *Phenomenology and Mind*, 14, pp. 70–79.
- Gallese, V. (2019). 'Embodied Simulation. Its Bearing on Aesthetic Experience and the Dialogue Between Neuroscience and the Humanities', *GESTALT THEORY,* 41 (2), pp. 113–128. Available at: doi 10.2478/gth-2019-0013.
- Gallese, V. Fadiga, L., Fogassi, L. and Rizzolati, G. (1996). 'Action recognition in the premotor cortex', *Brain*, 119 (2), pp. 593-609.
- Gallese, V. and Lakoff, G. (2005). 'The Brain's Concepts: The Role of the Sensory-Motor System in Conceptual Knowledge', *Cognitive Neuropsychology* 22(3), pp. 455-79.
- Gallese V., and Sinigaglia C. (2011a). 'What is so special with embodied simulation', *Trends in Cognitive Sciences*, 15 (11), pp. 512–519.
- Gallese V., Sinigaglia C. (2011b*).* 'How the body in action shapes the self', *Journal of Consciousness Studies* 18(7-8), pp. 117-143.

- Glenberg, A.M., Sato, M. and Cattaneo, L. (2008). 'Use-induced motor plasticity affects the processing of abstract and concrete language', *Current Biology*, 19, pp. R290-R291.
- Huemer, W. (2021). 'Reading with other' in S. Sedivy (ed.) *Art, Representation, and Make-Believe: Essays on the Philosophy of Kendall L. Walton*, New York: Routledge, pp. 112–126. Available at: doi 10.4324/9780367808662-8.
- Iacoboni, M. (2008). *Mirroring people: The new science of how we connect with others*. New York: Farrar, Straus and Giroux.
- Kaschak, M.P. and Borregine, K.L. (2008). 'Is long-term structural priming affected by patterns of experience with individual verbs?, *Journal of Memory and Language*, 58, pp. 862-878.
- Kuhn, Th. S. (1962): *The structure of scientific revolutions*, Chicago: University of Chicago Press; cit. from 2nd edn 1970, Chicago and London: University of Chicago Press.
- Kuhn, Th. S. (1969). 'Postscript-1969' in *The structure of scientific revolutions*, 2nd edn 1970, Chicago and London: University of Chicago Press, pp. 174-210
- Kuhn, Th. S. (1977). *The Essential Tention: Selected Studies in Scientific Tradition and Change*, Chicago and London: University of Chicago Press.
- Lakoff G. and Johnson M. (1980). *Metaphors We Live By*. Chicago: University of Chicago Press.
- Lakoff G. and Johnson M. (1999). *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought.* New York: Basic Books.
- Martin, A. (2007). 'The representation of object concepts in the brain', *Annual Review of Psychology*, 58, pp. 25-45.
- Masterman, M. (1970). 'The Nature of a Paradigm', in I. Lakatos and A. Musgrave (Eds.) *Criticism and the Growth of Knowledge.* London: Cambridge University Press, pp. 59-89.
- Meteyard, L., Zokaei, N., Bahrami, B. and Vigliocco, G. (2008). 'Visual motion interferes with lexical decision on motion words', *Current Biology*, 18, pp. R732-R737.
- Perky, C.W. (1910). 'An experimental study of imagination', *American Journal of Psychology*, 21, pp. 422-452.

- Raposo, A., Mossa, H.E., Stamatakisa, E.A. and Tylera, L.K. (2009). ‘Modulation of motor and premotor cortices by actions, action words and action sentences’, *Neuropsychologia,* 47, pp. 388-396.
- Rizzolatti, G., Fadiga, L., Gallese, V. and Fogassi, L. (1996). ‘Premotor cortex and the recognition of motor actions’, *Cognitive Brain Research*, *3, pp.* 131–41.
- Savojardo, V. (2013). *Scienza, fede e verità personale in Michael Polanyi*, Roma: Aracne.
- Stanfield, R.A. and Zwaan, R.A. (2001). ‘The effect of implied orientation derived from verbal context on picture recognition’, *Psychological Science*, 12, pp. 153-156.
- Tseng, M. and Bergen, B.K.. (2005). ‘Lexical processing drives motor simulation’. *Proceedings of the Twenty-Seventh Annual Conference of the Cognitive Science Society*, [online]. Available at: https://escholarship.org/uc/item/28t0v2fc (Accessed 25 March 2023).
- Turvey, M.T., Shaw, R.E., Reed, E.S. and Mace, W.M. (1981). ‘Ecological laws of perceiving and acting: In reply to Fodor and Pylyshyn’, *Cognition,* 9, pp. 237–304.
- Turvey, M.T. (1992). ‘Affordances and prospective control: An outline of the ontology’, *Ecological Psychology,* 4, pp.173–187.
- Walton, K. L. (1990). *Mimesis as Make-Believe*, Harvard University Press.
- Walton, K. L. (2015). ‘Existence as Metaphor?’ in *Other Shoes: Music, Metaphor, Empathy, Existence,* New York: Oxford University Press, pp. 89-117.
- Weinberg, R. (2008). ‘Does imagery work? Effects on performance and mental skills’, *Journal of Imagery Research in Sport and Physical Activity*, 3(1), pp. 1-21.
- Wojciehowski, H.C. and Gallese, V. (2011). ‘How stories make us feel. Toward an embodied narratology’, *California Italian Studies* 2 (1) [online]. Available at: doi 10.5070/C321008974.
- Zwaan R.A. and Taylor L.J. (2006). ‘Seeing, acting, understanding: motor resonance in language comprehension’, *Journal of Experimental Psychology,* 135(1), pp. 1-11. Available at: doi: 10.1037/0096-3445.135.1.1.