Signo
Http://online.unisc.br/seer/index.php/signo
ISSN on-line: 1982-2014
Doi: 10.17058/signo.v48i91.17950

UNISC
UNIVERSIDADE DE SANTA CRUZ DO SUL

Recebido em 19 de Outubro de 2022 Aceito em 31 de Janeiro de 2023 Autor para contato: micaela.rossi@unige.it

Metaphors in scientific discourse: some observations on a Nobel lectures corpus

Metáforas no discurso científico: algumas observações em um corpus de palestras do Prêmio Nobel

Micaela Rossi

Universidade de Gênova – UniGe – Gênova – Itália

Abstract: This paper aims at describing the role and the different manifestations of metaphor in scientific discourse, drawing a distinction between creative and conventional metaphors. To this end, a corpus composed of nineteen Nobel lectures, delivered by nineteen women, will be analysed by means of the critical discourse analysis theoretical and methodological tool, with particular attention to the framing that metaphor produced in scientific discourse. Our analysis shows that scientific discourse tends to privilege conventional metaphors, rather than creative ones, above all as far as the main shared domain concepts are concerned.

Keywords: metaphor, scientific discourse, framing.

Resumo: Este artigo visa descrever o papel e as diferentes manifestações da metáfora no discurso científico, fazendo a diferença entre as metáforas criativas e as convencionais. Um corpus composto por dezanove Palestras Nobel, pronunciadas por dezanove mulheres, será analisado para este efeito, através da ferramenta de análise crítica do discurso, com particular atenção para o enquadramento que a metáfora pode produzir no discurso científico. A nossa análise mostra que o discurso científico tende a privilegiar as metáforas convencionais, em vez das criativas, sobretudo no que diz respeito aos principais conceitos de domínio partilhado.

Palavras-chave: metáfora, discurso científico, enquadramento.

1 Introduction - The role of Metaphor in Science: creativity and convention

The role of metaphor in scientific discourse has always fascinated scholars and specialists from a variety of disciplines and perspectives, some of them far apart (among others, see Brown, 2003, for an exhaustive overview of this issue). The studies within the sociology of science highlight the modelling power of metaphor in the creation of new scientific theories, and the impact at the level of *framing* (Fairclough and Wodak, 2007) that metaphorical expression can produce in the figuration of scientific theories and concepts.

However, the richness and complexity of metaphorical expressions in scientific languages are often at risk of being underestimated and described in a limited way. This phenomenon is due to several factors, among which the “cognitive turn” of cognitive linguistics is not the least important. The cognitivist approach to metaphors in fact privileges above all conventional linguistic expressions that derive from shared conceptual metaphors, relegating creative, isolated metaphors that do not correspond to coherence criteria resulting from consensus of the majority of the speech community to a secondary role. This creates a discrepancy between the metaphors that are analysed, studied and favoured by the cognitivist approach (the “metaphors we live by”, to borrow the title of George Lakoff and Mark Johnson's founding and celebrated work, published in 1980), and the creative, conflicting metaphors, which nonetheless exist not only in literary discourse, but also (alive and kicking…) in scientific discourse.

In fact, metaphor takes on a great variety of forms and manifestations in scientific language, ranging from the simple denominative catachresis to the most imaginative personal creations (Rossi, 2022); metaphors find a wide palette of realisations in the sciences, all of which share a set of common criteria, but are differentiated on the basis of social, semiotic and cultural factors:

Table 1: Adapted from Rossi (2022)

	Isolated image metaphors	**Consistent creative metaphors**	**Conflictual creative metaphors**
Example	*hairpin loop*	*housekeeping gene, host cell, cell colony*	*a boojum*[1]
Function	denominative	denominative (concept) – structural (domain)	constitutive (concept) - heuristic
Analogy between source and target domains	evident	validated inside specialist community	0 (max. distance)
Creativity level	zero	weak-medium	high
Creation path	collective (anonymous or official)	collective (+/- anonymous)	individual, known
Term dating	undefined	not always defined	defined and documented
Users	technicians and specialists	*amateurs* and specialists	specialists and scientists
Cultural-bound	weak or zero (depending on lexical availability)	high	author-bound

[1] For the history of this term: https://physicstoday.scitation.org/doi/10.1063/1.2914510

As in Table 1, in scientific discourse we can find conventional metaphors, such as *hairpin loop*, to designate the hairpin-like DNA fragment, or such as *housekeeping gene*, which refers to the shared conceptual metaphor the cell is a person (a metaphor that is present in many terms in genetics, see Rossi, 2017). Nevertheless, we can also find very creative metaphors, the result of the imagination of individual researchers (*boojum* is a perfect example, but so are Gell-Mann's *quarks*).

The scientific metaphor thus appears as a phenomenon of conceptualisation in constant tension between the pole of convention, necessary to make the concept acceptable and valid in the scientific community, and that of creativity, essential to make real the ideational phase that always accompanies scientific discoveries.

We cannot forget, finally, that through the choice of one metaphor or another, scientific discourse fulfils both the function of *legitimising* the researchers, creators of the expression and consequently custodians of the concept, and that of *orientation*, of *framing* of the concept and of the field of study itself. It is no coincidence that scientific metaphors are the subject of lively debates much more than poetic metaphors, and that scientific controversy often dwells precisely on the metaphors used (one example above all: the controversy on the metaphor of natural selection in Darwin's theory).

An accurate study cannot do without taking into account this variety, this diversity, which constitutes the richness of metaphor in scientific discourse. It is therefore in keeping with the constant pendulum swing between the two poles of creativity and convention that we have decided to conduct an initial exploratory study of the metaphors present in the speeches made at the awarding of the Nobel Prizes.

2 A Corpus Analysis of Nobel Lectures

The textual typology of the Nobel lecture is particularly interesting for accounting for the richness of metaphorical typology. It is in fact a scientific discourse in its own right, which nevertheless has an evident rhetorical intent, and as such is often open to digressions and *figures de style* not normally common in scientific articles.

Although they share some common traits (see Brancaccio and Bracci, 2019), the different disciplines have different styles, which is why we decided in this first exploratory study to privilege speeches delivered in the disciplines of chemistry, physics and physiology and medicine. These are in fact "hard" sciences par excellence, in which the rhetorical impact of ornamental metaphor is less evident than in other types of discourses such as the Nobel Prize lectures for literature or peace.

Furthermore, in order to be able to produce a limited corpus, we sought a subgroup of winners that was easily detectable. In this sense, the official Nobel Prize website came to our aid, as it dedicates a section to nineteen women, Nobel Prize winners in the hard sciences, from 1903 to 2018 (figure 1). We therefore decided to select and analyse this first group of speeches:

Figure 1: https://www.nobelprize.org/

As in Table2, this subgroup covers the whole of the XXth century and the beginning of the XXIth, and it is quite equilibrated as far as disciplines are concerned (even if physiology and medicine are dominant from a quantitative point of view):

Table 2: Nobel Prizes analysed

Marie Curie	1903-1911	Physics-Chemistry
Irène Joliot Curie	1935	Chemistry
Gerty T. Cori	1947	Physiology or

		medicine
Maria Goeppert Mayer	1963	Physics
Dorothy Crowfoot Hodgkin	1964	Chemistry
Rosalyn S. Yalow	1977	Physiology or medicine
Barbara Mc Clintock	1983	Physiology or medicine
Rita Levi Montalcini	1986	Physiology or medicine
Gertude B. Elion	1988	Physiology or medicine
Christiane Nüsslein-Vohlard	1995	Physiology or medicine
Linda B. Buck	2004	Physiology or medicine
Françoise Barré Sinoussi	2008	Physiology or medicine
Elizabeth H. Blackburn	2009	Physiology or medicine
Carol W. Greider	2009	Physiology or medicine
Ada E. Yonath	2009	Chemistry
May-Britt Moser	2014	Physiology or medicine
Tu Youyou	2015	Physiology or medicine
Frances H. Arnold	2018	Chemistry
Donna Strickland	2018	Physics

The nineteen speeches (for Marie Curie, only the 1911 speech was present) were collected to form a corpus consisting of 281,076 words. We first submitted our corpus to a quantitative analysis thanks to the *Sketch Engine* platform, extracting the terminology by the *Keyword* function:

Despite these results, the automatic detection of terms proved to be insufficient to isolate the metaphors present in the lectures; for this reason, a manual analysis has been conducted, to identify in each speech:

1. The conceptual metaphors present in the text (CM);

2. The creative linguistic metaphors (LM) expressed on the basis of the CM identified in step 1;

3. The conventional specialised linguistic metaphors (SM) expressed on the basis of the CM identified in step 1.

As in the following pages, the same conceptual interaction can give rise to different linguistic metaphorical expressions, partly creative, partly conventional. Two main metaphorical veins can be identified: the first, related to the representation of research, the second, more strictly related to disciplinary achievements.

We will now analyse each lecture in this perspective:

2.1. Frances H. Arnold, "Innovation by Evolution: Bringing New Chemistry to Life" (2018)

Particularly creative, Arnold uses conceptual metaphors deeply rooted into scientific discourse (genetic material is a code, the cell is a person, the human body is a machine) to produce novel, creative metaphors that share their place with conventional ones:

CM	LM	SM
RESEARCH IS A QUEST	Early protein engineers *struggled mightily* with this *goal* The challenge therefore is to *discover* protein sequences that provide new benefits and deliver novel improvements on a thrifty scale of weeks, rather than millennia or eons, and with the help of one graduate student rather than that of an army. To outperform Nature, I needed a *strategy* that sidesteps the despair of the Babel librarians. Beneficial mutations found by directed evolution are often far from the site of catalysis. Even today we *struggle* to explain their effects, and are unable to predict them reliably or easily	
NATURE IS AN ENGINEER	Nature, herself a *brilliant chemist and by far the best engineer* of all time, invented life that has flourished for billions of years under an astonishing range of conditions. I am in awe of the exquisite specificity and efficiency with which Nature *assembles* these products from simple, abundant, and renewable starting materials. Equally awe-inspiring is the process by which Nature created these enzyme catalysts and in fact everything else in the biological world. The process is evolution, the grand *diversity-generating machine* that created all life on earth, starting more than three billion years ago	
NATURE IS A FARMER	*Natural selection picks the wheat from the chaff* and *guides* mutating proteins along continuously functional paths through the vast space of sequences mostly devoid of function.	
GENETIC MATERIAL IS A CODE	I dream of the day that much of our chemistry becomes genetically *encodable*, and microorganisms and plants are our *programmable factories*[1]	Unfortunately, this is still true: today we can for all practical purposes *read, write, and edit any sequence* of DNA, but we cannot compose it. We used common microbes like Escherichia coli or yeast to produce *'libraries'* of mutant enzymes to test for desired functions

[1] This example is particularly interesting: starting from a conventional metaphor, Arnold produces a creative linguistic metaphorical expression: *programmable factories*.

		In its original and in many modified forms, directed evolution produces new gene *editing tools*, therapeutic enzymes…
GENETIC MATERIAL IS A SYMPHONY	The code of life *is a symphony*, guiding intricate and beautiful parts performed by an untold number of *players and instruments*. Maybe we can cut and paste pieces from nature's *compositions*, but we do not know how to *write the bars* for a single enzymic passage.	
CELL IS A PERSON	While a natural enzyme generally *performs* well in its biological job, it is often less *enthusiastic* about doing a new job and initially *works poorly*	
EVOLUTION IS A DIFFICULT VOYAGE	New demands change the fitness landscape, often knocking a protein down from a position that *was painstakingly acquired* through the work of natural evolution. Sequential rounds of random mutation and screening for improved performance, however, can accumulate the beneficial mutations needed to *climb to a new peak*. Evolution on a *rugged landscape* is difficult, as mutation propels sequences into crevasses of non-function. However, latching onto Maynard Smith's argument that proteins evolve on a *landscape smooth* in at least some of its many dimensions, I reasoned that directed evolution could find and *follow continuous paths* leading to higher fitness	
HUMAN BODY IS A MACHINE		Rather, to support the fight for survival or to move into a new niche, emerging enzymes exploit existing catalytic *mechanisms and machineries* I will describe how we can now create biocatalytic *machinery* to make bonds unknown in biology

2.2. Françoise Barré Sinoussi, "HIV: A Discovery Opening the Road to Novel Scientific Knowledge and Global Health Improvement" (2008)

In this lecture, we can find the same conventional/creative metaphorical dynamics: see for example the *interplay* and the *cross-talk* between DC, NK and T-cells in HIV infection. We can also remark the presence of a conventional well-known conceptual metaphor in medicine, illness is war (Sontag, 1978):

CM	LM	SM
RESEARCH IS A QUEST	Future *directions* for new intervention *strategies* which should be investigated in further detail include, for example, the identification of new *targets* and the use of siRNA to restrict HIV infection HIV, however, exhibits several scientific *challenges* the development of an effective HIV vaccine requires innovative and creative *strategies* HIV can be a powerful tool for *unravelling* future scientific knowledge Although the *road ahead* is still long, we are on the *right path* to achieve a world without AIDS	
CELL IS A PERSON	the specific evolution of the disease caused by HIV is the result of an intricate *interplay* between the virus and the host Future research will need to focus on understanding in greater detail the complex *cross-talk* between DC, NK and T cells during HIV infection Future research on understanding the immune responses induced by HIV will provide more information on the complex *cross-talk* between innate and adaptive immunity	The evolution and progression of the disease caused by HIV is closely linked to a number of determinants of both the virus itself and the *host*.
HUMAN BODY IS A MACHINE		To address the *mechanisms* involved in this natural protection against infection by HIV, the innate immune responses of the two groups were compared This observation indicates that there is likely more than one immune *mechanism* contributing to the tight control of HIV replication in these lucky few individuals Most naturally infected African primates, like the African Green Monkey (AGM) do not develop AIDS, in contrary to the Asian Rhesus Macaque; they therefore provide a unique model to investigate protective *mechanisms* against AIDS To add to the complexity, HIV is transmitted not only by cell-free virus, but also by cell-to-cell contact, and it is still unclear what

		mechanisms are necessary to impede cell-to-cell transmission A key step in the development of an effective vaccine will be the identification and definition of the viral determinants responsible for early pathogenic signals and *mechanisms* to prevent such harmful pathogenic pathways
ILLNESS IS WAR	Given the importance of this very early phase following infection, the role of the innate immune system, our body's *first line of defence* against infections, should strongly be considered Importantly, the *fight* against HIV is also a key element in the improvement of global health	More detailed insight into the role of the innate immune system in HIV has been *gained* by an in vitro model of a co-culture of natural killer (NK) cells and dendritic cells

2.3 Elizabeth H. Blackburn, "Telomeres and Telomerase: The Means to the End" (2009)

We can find in this lecture the main conventional scientific metaphors (genetic material is a film, genetic material is a hereditary code – see Temmerman, 2007), but also a very personal and creative linguistic metaphor (telomere is a bee swarm):

CM	**LM**	**SM**
RESEARCH IS A HUNT	Four main lines of such molecular evidence were instrumental in spurring me to *hunt* for a new type of enzymatic activity Tetrahymena cells provided an attractive system to use to *hunt* for this putative telomeric DNA-adding enzymatic activity In early 1984 I was able to see increasing amounts of telomeric GGGGTT-hybridizing repeat sequences were somehow generated during the course of the reactions. *The hunt was on*!	
RESEARCH IS DIVING INTO WATER	Answering the question of the molecular nature of telomeres meant *going into pond water*	
CELL IS A PERSON	Thus the telomere itself was a like *a gatekeeper*, regulating access of telomerase onto the telomere, even in the presence of excess telomerase in the cells	As described above, abrogating telomerase in otherwise effectively "immortal" single-celled species causes progressive telomere shortening over several cell generations followed by cessation of cell division ("*senescence*").
TELOMERE IS A BEE SWARM	Rather than being a rock-stable complex, it is perhaps reminiscent of a *swarm of bees*: the size and shape of the *swarm* overall appears the same, but in reality its composition is constantly changing as the bees (the telomeric proteins) of the *swarm* constantly come off it and are replaced by other bees.	

GENETIC MATERIAL IS A HEREDITARY CODE		DNA carries *coding* and *noncoding* sequences. Noncoding DNA both regulates and ensures the continued *inheritance* of DNA's *coding information*. By the end of the 1920s it was understood that the *hereditary material* was in chromosomes They were monitoring the *inheritance* of a gene of trypanosomes (which cause sleeping-sickness)
GENETIC MATERIAL IS A BUILDING		What DNA would be best to use to prime any telomeric DNAaddition, and what nucleotide *building-block* precursors would be required?
GENETIC MATERIAL IS A FILM		Peter Challoner had in turn adapted from one used by Tom Cech and collaborators to examine rDNA gene expression (which led Tom Cech to the discovery of *self-splicing* RNA).
HUMAN BODY IS A MACHINE		The molecular *mechanisms* underlying the telomeric properties were completely unknown when, in the mid-1970s, I first began research using DNA purified from the ciliated protozoan Tetrahymena Similar Molecular *Machineries*: Different Life Histories

2.4. Linda B. Buck, "Unraveling the Sense of Smell", 2004

This lecture is a good example of the fact that most of metaphorical expressions we found in our corpus are conventional scientific ones. Except for the description of what research is, all the linguistic metaphors present in the text are specialised terms:

CM	LM	SM
RESEARCH IS A QUEST	In 1988, Richard Axel and I *embarked* on a *search* for odorant receptors. The strategy we devised was based on three assumptions.	
GENETIC MATERIAL IS A FILM		To do this we *cut* the DNA in each PCR product with a restriction enzyme.
GENETIC MATERIAL IS A PERSON		However, one band, #13, was cut into a large number of fragments, suggesting that it might contain multiple members of a multigene *family*. Genomic library screens indicated that the multigene *family* contained in excess of 100 members The V1R *family* was identified in 1995 by Dulac and Axel (Dulac and Axel, 1995), and the V2R family was identified in 1997 by Hiroaki Matsunami in my lab
GENETIC MATERIAL IS A CODE		Genomic *library* screens indicated that the multigene family contained in excess of 100 members These results indicated that ORs are used combinatorially to encode odor identities (Malnic et al., 1999). Different odorants are detected and thereby *encoded* by different combinations of ORs. However, each OR serves as one component of the *codes* for many odorants. Different odorants have different "*receptor codes*". Given the number of possible combinations of 1000 different ORs, this combinatorial *coding* scheme could allow for the discrimination of an almost unlimited number of odorants This divergence of OR inputs may allow a parallel *processing* of OR *signals* in which *signals* from the same ORs are combined or modulated in different ways prior to transmission to other brain regions that have different functions.

2.5. Gerty T. Cori (with Carl Cori), "Polysaccharide phosphorylase", 1947

No significant metaphors for the present analysis were detected in this lecture.

2.6. Marie Curie, "Radium and the New Concepts in Chemistry", 1911

Very brief and technical, Curie's lecture contains one interesting metaphor as far as research concept is concerned (see the final paragraph of this paper for a synthesis on this point):

CM	LM	SM
RESEARCH IS A BUILDING	Viewing the subject from this angle, it can be said that the task of isolating radium is the *corner-stone* of the *edifice* of the science of radioactivity	

2.7. Gertude B. Elion, "The Purine Path to Chemotherapy", 1988

In this case, too, the only significant metaphor for our analysis concerns the concept of *research*:

CM	LM	SM
RESEARCH IS A QUEST	Although we felt we were on the *right track* in 1952, there were still many unanswered questions In 1958, *a new horizon* appeared In 1968, we decided to return to *a path* which had intrigued us as early as 1948 I have successfully conveyed our philosophy that chemotherapeutic agents are not only ends in themselves but also serve as tools for *unlocking doors* and probing Nature's mysteries	

2.8. Maria Goeppert Mayer, "The Shell Model", 1963

Quite poor as far as metaphorical language is concerned, this lecture is nevertheless a good example of scientific creativity. The *shell* is the metaphor that expresses a new model for atomic analysis:

CM	LM	SM
RESEARCH IS A DETECTIVE STORY	One hopes in this way to *find* regularities and correlations which *give a clue* to the structure of the nucleus	
NUCLEI MODELS ARE SHELLS		The *shell* model
CELLS ARE TERRITORIES		The three *regions* of isomerism are now called *islands* of isomerism

2.9. Carol W. Greider, "Telomerase discovery: the excitement of putting together pieces of the puzzle", 2009

As in other lectures of our corpus, here the pole of creativity is concentrated on the *research* concept, whereas scientific precise concepts are referred to by conventional metaphorical terms:

CM	LM	SM
RESEARCH IS A DETECTIVE STORY	The *story* of telomerase discovery is a *story of the thrill of putting pieces of a puzzle together to find something new* Telomeres posed a *puzzle* for biologists for a many years Looking for telomere elongation: defining the *edges of the puzzle* The most productive way to *solve a puzzle* is to *attack* it with the right *strategy* Establishing that RNA was needed for elongation was	

	a *key clue* All of the accumulated evidence indicated there must be a template in telomerase, but we did not have the *final key piece of the puzzle* As is often the case in science, unexpected results provided the most important *puzzle pieces* *Putting together puzzle pieces* is challenging, fun, and extremely gratifying, especially when they lead to new understanding in biology The pleasure of *figuring out the puzzle* and finding out things not known before is a great reward I would like to thank all of the talented scientists who have worked with me over the years for their energy and ideas that have made *solving the puzzles fun, and opened up new puzzles*	
RESEARCH IS DIVING INTO WATER	The willingness to keep an open mind, to *enter uncharted waters* and try something new	
GENETIC MATERIAL IS A PERSON		The variable-length telomeres had *generated* heterogeneous fragment lengths, which all *migrated* to slightly different positions on the agarose gel
GENETIC MATERIAL IS A CODE		The fact that the CCCCAA primer was not elongated ruled out the trivial explanation that the repeating pattern was coming from the *copying* of endogenous DNA The next big question was where the *information* for the addition of TTGGGG repeats was coming from

2.10. Dorothy Crowfoot Hodgkin, "The X-ray analysis of complicated molecules", 1964

Just a few examples can be found in this lecture; particularly interesting is the conceptual metaphor MOLECULE IS A TOWN, the metaphor centre-periphery being exploited in chemistry, in physics and in physiology:

CM	LM	SM
RESEARCH IS A BUILDING	I became captivated by the *edifices* chemists had *raised* through experiment and imagination	
MOLECULE IS A TOWN		Thus theamide groups on the *periphery* of the molecule are all hydrogen-bonded to those of *neighbouring* molecules
ELEMENTS ARE PERSONS		How so complex a system can effect the simple and fundamental *migration* process that changes methyhnalonate to succinate

2.11. Irène Joliot Curie, "Artificial Production of Radioactive Elements", 1935.

No significant metaphors for the present analysis were detected in this lecture.

2.12. Rita Levi Montalcini, "The Nerve Growth Factor: Thirty-Five Years Later", 1986

As in other lectures of our corpus, the creative pole is devoted to the *research* concept, whereas conventional metaphors appear for scientific terminology:

CM	LM	SM
RESEARCH IS A TREE	The side *branch* of experimental neuroembryology, which had *stemmed out* from the *common tree* and was entirely devoted to the study of the trophic interrelations between neuronal cell populations and between these and the innervated organs and tissues, was then in its *initial vigorous growth phase*	
RESEARCH IS A QUEST	It in turn suffered from a sharp decrease in the enthusiasm that had inflamed the *pioneers* in this field…	
CELL IS A PERSON	The unexpected break: a *gift* from malignant tissues	
NEURAL SYSTEM IS A TOWN	Predictions of the unpredictable are encouraged by the same history of NGF which may be defined as a long sequence of unanticipated events which each time resulted in a new turn in the NGF *unchartered route*, and opened new vistas on an ever-changing *panorama*	[…] lent strong support to the concept of NGF as a strophic messenger, conveyed through nerve fibers from *peripheral* cells to the innervating neurons Within this category of studies on NGF and its coding gene, one can conceive a strategy aimed at exploiting the property of non-neuronal cells in *peripheral* tissues and of neurons and *satellites* in the CNS
NEURONS ARE PEOPLE		Small and large neuronal *populations* located in different brain areas have been shown to exhibit all properties and responses typical of sensory and *sympathetic* cells
BIOLOGICAL MATERIAL IS A CODE		Since the same peptides may undergo *post-transcriptional* or *posttranslational* modification, the submerged areas of the NGF iceberg loom very large

2.13. Barbara Mc Clintock, “The Significance of Responses of the Genome to Challenge”, 1983

One of the rare lectures where no metaphor for *research* is formulated; Mc Clintock uses mainly conventional specialised metaphors:

CM	LM	SM
BIOLOGICAL MATERIAL IS A PERSON		Our present knowledge would suggest that these reorganizations originated from some “shock” that forced the genome to restructure itself in order to overcome a threat to its *survival* cells are able to *sense* the presence in their nuclei of ruptured ends of chromosomes, and then to activate a mechanism that will bring together and then unite these ends, one with another […] the *sensitivity* of cells to all that is going on within them. They make wise decisions and act upon them Proof that entrance of a newly ruptured end of a chromosome into a telophase nucleus can initiate activations of previously *silent* genomic elements These deviations are *sensed* in each *daughter* cell It was this event that, basically, was responsible for activations of potentially transposable elements that are carried in a *silent* state in the maize genome
DNA IS A PEARL NECKLACE		Genes were “*beads*” arranged in linear order on the chromosome “*string*.”

2.14. May-Britt Moser, “Grid Cells, Place Cells and Memory”, 2014

The usual scheme appears in this lecture. We find more creative metaphors to define the *research* concept, and conventional metaphorical terminology for specialised concepts:

CM	LM	SM
RESEARCH IS A HUNT	In this lecture, I will show how the discovery of place cells and grid cells has opened our eyes to some of the secrets of the brain, and how work on these cells *has put us on the track* of the neural computations responsible for perception of space as well as cognitive brain functions in general	
RESEARCH IS WANDERING	It is inspired by our search for knowledge—a search that sometimes feels like *wandering in a fog landscape* where we see things close to us but fail to obtain a global view	
BIOLOGICAL MATERIAL IS A CODE		The information *encoded* by these speed cells provides exactly what grid cells need for position to be updated dynamically during movement. We do not know yet how the speed signal is generated
MEMORY IS A MATERIAL		Presumably, each memory *stored* in the hippocampus contains information about place, expressed in firing locations of place cells, as well as the events that take place in each of those places, expressed in the form of rate variations

2.15. Christiane Nüsslein-Vohlard, “The Identification of Genes Controlling Development in Flies and Fishes”, 1995

We can only find a few examples of metaphorical expressions in this lecture, linked to the conventional metaphor of the genetic *code*:

CM	LM	SM
GENETIC MATERIAL IS A CODE		During early embryogenesis, a series of such molecular prepatterns, composed of the expression domains of *transcription* factors, which are the products of the segmentation genes, is formed. The gap genes are expressed in large unique regions early in embryogenesis, their expression patterns being controlled by maternally provided *transcription* factors The refinement of the dorsoventral pattern on the dorsal side involves a long range *signalling* process

2.16. Donna Strickland, "Generating High-Intensity Ultrashort Optical Pulses", 2018

In this case, we can find a very conventional metaphor for light as a liquid wave (accepted after the advent of Maxwell's theory), but also a more creative metaphorical expression for Strickland's discovery: a *laser hammer*:

2.17. Rosalyn S. Yalow, "Radioimmunoassay", 1977

We cite some few examples from this lecture, highly technical, where metaphorical expressions are conventional terms:

CM	LM	SM
CELL IS A PERSON		Shown in Fig. 2 are the electrophoresis patterns of labeled insulin in the plasma of controls and insulintreated subjects. In the insulin-treated patients the labeled insulin is bound to and *migrates* with an inter beta-gamma globulin
BIOLOGICAL MATERIAL IS A LIQUID		At the present state of our knowledge, we consider it most likely that hormones known to be synthesized in the pituitary are synthesized only there and are transported to the brain by one or more mechanisms; perhaps by retrograde *flow* along the portal *vessels* or by *leakage* into the basal *cistern*

2.18. Ada E. Yonath, "Hibernating Bears, Antibiotics and the Evolving Ribosome", 2009

As for the previous lecture, the main metaphors in the text are linked to conventional expressions and conceptual interactions, well-known in hard sciences:

CM	LM	SM
GENETIC MATERIAL IS A CODE		High resolution structures of ribosomes, the cellular machines that *translate* the genetic code into proteins, revealed the *decoding* mechanism The *translation* of the genetic code into proteins is performed by a complex apparatus typical mammalian cells can contain over a million ribosomes (the 'factories' that *translate* the genetic *code* into proteins) Other players in the process are messenger RNA (mRNA), which carries the genetic *code* and *transfer* RNA molecules
HUMAN BODY IS A MACHINE		High resolution structures of ribosomes, the cellular *machines* that translate the genetic code into proteins, revealed the decoding mechanism As this symmetrical region is highly conserved and provides the *machinery* required for peptide bond formation typical mammalian cells can contain over a million ribosomes (the '*factories'* that translate the genetic code into proteins) The recent availability of crystal structures of bacterial ribosome and their complexes, all obtained by advanced synchrotron radiation, enabled a quantum jump in the understanding of the *machinery* of protein biosynthesis High resolution structures have shed light on many of the functional properties on the translation *machinery*
CELL IS A PERSON		Structures of complexes of ribosomes with antibiotics targeting them, revealed the principles allowing for the clinical use of antibiotics, identified resistance mechanisms and showed the structural bases for discriminating pathogenic bacteria

		from *hosts*

2.19. Tu Youyou, "Artemisinin - A Gift from Traditional Chinese Medicine to the World", 2015

A final example of creativity, linked to the author's Chinese origins, is the following:

CM	LM	SM
CHINESE MEDICINE IS A TREASURE HOUSE	Before concluding, I would like to briefly discuss Chinese medicine. "Chinese medicine and pharmacology are a *great treasure-house*	

3. Conclusions - Visions of Science and Research

Some conclusions, albeit partial, to conclude this first exploratory study can be formulated as follows:

1. it is noticeable that conventional metaphors in the analysed scientific fields are widely shared, and point to fundamental concepts in the history of physics, chemistry, physiology: metaphors such as cells are people, genetic material is a code, the human body is a machine, are now deeply embedded in conceptualisations and terminologies. It is therefore evident that they are widely shared in the lectures analysed;

2. it appears rare that the authors go so far as to create new metaphors from these conceptualisations. This happens in a few cases, but it can be assumed that the manipulation of concepts that form the backbone of the specialist domain is a risky operation for the legitimacy of the researcher, and therefore very sporadic;

3. aspects of (limited) creativity seem to be confined to concepts outside the specific scientific domain; in particular, more creativity is noted around the concept of *research* (see in this regard Bucchi *et al.*, 2019), defined with metaphors related to the enigma, the perilous journey, the quest, or even wandering in the fog. Such creativity never or hardly ever exceeds, however, the frame of the event. The rare cases of novel metaphor for a scientific concept are those related to the naming or description of the new theory presented in the lecture (*shell model*, *laser hammer*)

Some aspects worthy of investigation remain to verify; among others: the diachronic evolution of metaphors in a specific domain; the gender variation, if any, in lectures and, last but not least, the linguistic factor. The lectures that are presented on the Nobel Prize's official website are in fact almost all in English, the *lingua franca* of scientific communication. However, this linguistic standardisation also represents a sort of bias in the analysis of the metaphors, conceptual interactions which are profoundly linked to the scientific imaginary of the culture to which they belong (Bordet, 2016, for an interesting in-depth study on this crucial point).

References

BERTHOUD, Anne-Claude. Les enjeux du plurilinguisme pour le discours scientifique. *Diversité et Identité Culturelle en Europe,* 13.1, 2016,13-22.

BORDET, Geneviève. Counteracting Domain Loss and Epistemicide in Specialized Discourse: A Case Study on the Translation of Anglophone Metaphors to French. *Publications*, 2016, 4-18.

BRANCACCIO Emilio, BRACCI Giacomo. Il discorso del potere. Il premio Nobel per l'Economia tra scienza, ideologia e politica. Milano: il Saggiatore, 2019.

BRANCH, T. Y., ORIGGI, Gloria. Social Indicators of Trust in the Age of Informational Chaos. *Social Epistemology*, 36:5, 533-540, 2022.

BROWN, Theodore L. Making Truth : Metaphor in Science. Chicago: University of Illinois Press, 2003.

BUCCHI, Massimiano. Come vincere un Nobel: il premio più famoso della scienza. Torino: Einaudi, 2017.

BUCCHI, Massimiano, LONER, Enzo, FATTORINI, Eliana. Give science and peace a chance: Speeches by Nobel laureates in the sciences, 1901-2018. *Plos One*, 14(10) [online], 2019, https://doi.org/10.1371/journal.pone.0223505

CHIAVETTA, Eleonora, SCIARRINO, Silvana (Org.). Perspectives on the Popularisation of Natural Sciences in a Diachronic Overview. Cambridge: Cambridge Scholars, 2014.

FAIRCLOUGH, Norman, WODAK, Ruth. Critical discourse analysis. In: Van Dijk T. (Org.). Discourse as Social Interaction. London: Sage, 1997.

FOX-KELLER, Evelyn. *Refiguring Life: Metaphors of Twentieth-century Biology*. Irvine: Columbia University Press, 1995.

GAGLIASSO, Elena, FREZZA, Giulia. Fare metafore e fare scienza. *Aisthesis. Pratiche, linguaggi e saperi dell'estetico*, v. 7, n. 2, 25-42, 2014.

GAUDIN, François. Socioterminologie, une approche sociolinguistique de la terminologie. Bruxelles: Duculot De Boeck, 2002.

GOATLY, Andrew. Washing the brain. Metaphor and hidden ideology. New York/Philadelphia: John Benjamins, 2007.

JAMET Denis, TERRY, Adeline. Principes et fonctions de la métaphore en langue de spécialité dans un cadre cognitiviste. *ELAD-SILDA 2*. https://publications-prairial.fr/elad-silda/index.php?id=412, 2019.

LÉVY-LEBLOND, Jean-Marc. La science au défi de la langue. *Synergies Europe*, n.8, 19-28, 2013.

ORIGGI, Gloria. Qu'est-ce que la confiance ? Paris : Vrin, 2008.

PRANDI, Michele. Conceptual Conflicts in Metaphors and Figurative Language. New York – London: Routledge, 2017.

ROSSI, Micaela. La francisation dans le Vocabulaire de la biologie (2017) : métaphores, termes et idéologies scientifiques. In: G. Tallarico et al. (Org.) Nouveaux horizons pour la néologie en français. Hommage à Jean-François Sablayrolles. Limoges: Lambert-Lucas, 87-101, 2020.

ROSSI, Micaela. Creating metaphors in specialised languages: choice criteria for the success of metaphorical terms. In M. Prandi, M. Rossi (Org) Researching Metaphors: Towards a Comprehensive Approach. London: Routledge, 132-147, 2022.

SONTAG, Susan. 1978. Illness as Metaphor. New York: Farrar, Straus & Giroux.

TEMMERMAN, Rita. Les métaphores dans les sciences de la vie et le situé socioculturel. *Cahiers du RIFAL*, n.26, 72–83, 2007.

VICARI, Stefano (Org.). Introduction : Autorité et Web 2.0. *Argumentation et Analyse du Discours* [En ligne], 26, 2021.

VIOLA, Marco. La scienza dei premi Nobel per le scienze. *Quaderni di Sociologia*, 82- LXIV, 2020, 83-93.