УДК 811.111: 81`42

N. A. Kramar,
orcid.org/0000-0001-5767-9200

CONCEPTUAL METAPHORS UNDERLYING SCIENTIFIC RESEARCH REPRESENTATION: THE CASE OF R. P. FEYNMAN

The paper addresses conceptual metaphors related to the representation of scientific work and education based on the memoirs by a famous American physicist, Richard P. Feynman. Both conventional and author-specific novel metaphorical models are identified and discussed with regard to the scientist's personality and knowledge-making beliefs. It is argued that frequently-used metaphorical models can serve as a valid indicator of a researcher's system of values and views on science.

***Key words**:* conceptual metaphor, science, metaphorical mapping, R. Feynman, memoirs.

У статті розглянуто концептуальні метафори, пов'язані з репрезентацією наукової роботи та навчання на матеріалі мемуарів відомого американського фізика Річарда Файнмана. Виокремлено як конвенційні, так і специфічні для автора, нові метафоричні моделі, які аналізуються у їх зв'язку із характером науковця та його поглядами на продукування знання. Висловлюється думка про те, що частотні метафоричні моделі можуть слугувати вірогідним індикатором авторської системи цінностей та поглядів на науку.

***Ключові слова**:* концептуальна метафора, наука, метафоричне мапування, Р. Файнман, мемуари.

В статье рассмотрены концептуальные метафоры, связанные с репрезентацией научной работы и образования на материале мемуаров известного американского физика Ричарда Файнмана. Определены как конвенционные, так и специфические для автора, новые метафорические модели, которые анализируются в их связи с характером ученого и его взглядами на продуцирование знания. Высказывается мнение о том, что частотные метафорические модели могут служить вероятным индикатором авторской системы ценностей и взглядов на науку.

***Ключевые слова**:* концептуальная метафора, наука, метафорическое картирование, Р. Файнман, мемуары.

Since the publication of the seminal work «Metaphors We Live By» by G. Lakoff and M. Johnson in 1980, metaphor has been in the limelight of cognitive linguistics and discourse studies as a tool that is central to our cognitive process and categorization of the world. In the most general way, metaphor can be defined as «understanding and experiencing one kind of thing in terms of another» (Lakoff & Johnson, 1980, 5). It can also be described as a structured mapping from a source domain to a target domain. Far from being merely a rhetorical device, metaphor is an underlying mechanism that enables abstract reasoning and comprehension of complex ideas, some of which we would never be able to grasp otherwise (Lakoff, 1993, 40–41). Despite the fact that conceptual metaphors play such a large part in our cognition, we are rarely aware of their pervasive presence in our everyday communication. According to G. Lakoff and M. Turner, «basic **conceptual metaphors** are part of the common conceptual apparatus shared by members of a culture […] They are largely unconscious, though attention may be drawn to them. Their operation in cognition is almost automatic.» (Lakoff & Turner, 2009, 51). On

the other hand, conventional metaphors provide a foundation for the formation and interpretation of novel metaphorical language that is specific to a speaker.

The last decade has seen a great number of studies focused on the importance and the particular functions of metaphors in academic discourse. Based on thorough corpus-based analysis, J. B. Hermann (2010) has showed that, contrary to commonly held beliefs, metaphors are more frequent in academic discourse than in conversation, news and fiction (p. 308). Recently, metaphors in scientific texts have been approached from various theoretical perspectives by Kudriavtseva (Кудрявцева, 2015), Losyeva (Лосева, 2015), Permyakova & Utkina (2016), Shalya (Шаля, 2008), to name a few. However, little attention has been paid to conceptual metaphors that lie at the basis of scientific work and shape researchers' assumptions, or knowledge-making beliefs (to use the term of Ivanič & Camps, 2001) in general. Most extensively this issue has been addressed in the study by Sherwood (2005), which used conceptual metaphors as a starting point to analyze the long-standing conflict between practitioners' and academic discourse of technical communication. The topicality of our research is therefore grounded in the obvious lack of studies on the role of metaphor in the shaping of scientific thinking, against the background of the unabated interest to the mechanisms of metaphorical mapping as such.

The aim of the present paper is to identify the most fundamental metaphorical models that guided the research process of Richard Feynman (1918–1988), an outstanding physicist and Nobel laureate. Among his other merits, R. P. Feynman was well known for his linguocreativity and imaginative use of language. In his commencement speech at Caltech (1974) he coined the metaphoric term «Cargo Cult Science» to denote pseudoscientific practices which lack integrity and do not rely on the scientific method. Herein he referred to the religious rite of certain tribes with the purpose of obtaining the material goods of advanced societies by furnishing all the conditions for their airplanes to land. Therefore, the practices of Cargo Cult Science «follow all the apparent precepts and forms of scientific investigation, but they're missing something essential, because the planes don't land» (1974).

For the purposes of our research, we chose to particularly focus on Feynman's memoirs (*Surely You're Joking, Mr. Feynman* and *What Do You Care What Other People Think?*), which, apart from being quite an engaging read, also reveal much valuable information about his attitude to science and the key milestones of his growth as a scientist. As noted by Rosen, «since much of the work of scientists is esoteric, inscrutable to all but the technically trained, memoirs can make science approachable, giving us autobiographical narratives that can help the rest of us grasp what modern science really is» (Rosen, 2006, 37-38). All the examples cited in the paper are taken from *Surely You're Joking, Mr. Feynman*, unless specifically indicated as taken from *What Do You Care What Other People Think?* (abbreviated as WDYC).

Based on our analysis, the prevalent science-related metaphor that runs all through the memoirs is RESEARCH IS JOURNEY by analogy with LIFE IS JOURNEY and other models that inherit its experiential basis, namely CAREER IS JOURNEY and LOVE IS JOURNEY (Lakoff, 1993). Just like LIFE IS JOURNEY

and CAREER IS JOURNEY models, RESEARCH IS JOURNEY inherits the Event Structure Metaphor, with events mapping significant life events and purposes mapping life goals (or research goals, in this case). One of the basic entailments of the Event Structure metaphor is Purposeful Action is Self-propelled Motion To a Destination. This has a number of special cases that are each exemplified in Feynman's memoirs:

Starting an Action is Starting out on a Path:

Altogether, it's a lot of fun to try to decipher something like that, because when you start out you don't know anything – you have no clue to go by.

Making Progress Is Forward Movement:

[…] and the next year, when I took the course, I advanced rapidly.

Amount of Progress is Distance Moved:

I'd have blown my top, because I want to beat this damn thing, as long as I've gone this far.

Lack of Progress is Lack of Movement:

All science stopped during the war except the little bit that was done at Los Alamos.

Undoing Progress is Backward Movement:

If they were sliding behind, the guys who studied all the time would teach them and help them do their work.

Expected Progress is a Travel Schedule:

At that particular time I was not really quite up to things: I was always a little behind. Everybody seemed to be smart, and I didn't feel I was keeping up.

Sometimes, however, it's not the author but the destinations on this path that are represented as movable, e. g. *But my real accomplishment came later.* This is an example of one more typical entailment of the Event Structure Metaphor – External Events Are Large, Moving Objects. In accordance with the RESEARCH IS JOURNEY mapping, it is typical to Feynman to conceptualize science in terms of space, where one can travel not only inwards, e. g.:

In physics you had to go a little deeper before you could find an interesting question that people didn't know.

They explained how far they had gotten in figuring out the problem (WDYC, 137), but also between the fields, e. g.

This summer, instead of going to a different place, I'll go to a different field (said in the context of his working in a biology lab for a summer).

Interestingly, the process of thinking seems to be physically connected with movement in Feynman's case, as he had the habit of walking back and forth while concentrating on something:

I start walking back and forth, thinking, and I realize that one way it can happen is that the tubes are heating up in the wrong order […]

Then I began to pace the floor and think about this thing.

These examples only serve to confirm the experiential basis of the RESEARCH IS JOURNEY metaphor model and its numerous counterparts within the Event Structure Metaphor.

One more conceptual metaphor that seems all too common to the Western culture but is rarely construed in terms of scientific research is TIME IS MONEY. When talking about education and science, R. Feynman is always concerned with how much time is takes, obviously viewing it as a precious resource:

I spent a lot of time explaining things that all the biologists knew.

So while all the biology guys were trying to understand these "new" things, I could spend my time learning the biology part.

They had wasted all their time memorizing stuff like that, when it could be looked up in fifteen minutes.

In a less conventional manner, the metaphor TIME IS MONEY is presented in the following case, where time is juxtaposed with effort and modified with the verb «contribute»:

If you're asked to contribute months of time and effort to the government (and you lose money you would have made consulting for a company), the government ought to appreciate it a little more than to be cheap about paying you back (WDYC, 131).

The memoirs reveal that since his early years Feynman was preoccupied with optimization of various technical processes, whether it be chopping potatoes in a restaurant kitchen or managing telephone switchboard, which was set up in a way that «took extra time», in his view (WDYC, 28). When assigned to work on the Challenger disaster investigation board, R. P. Feynman was mostly disappointed with large amount of idle time in his schedule and having nothing to work on, while this did not bother the other Commission members at all. Curiously, *time* is the most frequent noun in Feynman's memoirs (used 626 times in total), which serves to emphasize his preoccupation with this concept even more. An interesting question that warrants further research is whether prominent scientists share such a strong appreciation of time (literally, every second of it) that makes them so productive and successful, as opposed to equally talented researchers who nonetheless fail to reach success.

Another common conceptual metaphor that has important implications for science and is represented by a broad variety of phrases in Feynman's memoirs is ARGUMENT IS WAR. When relating stories about debates and arguments, he metaphorically uses the verbs «to attack», «to beat», «to compete», «to turn over to one's side», «to counter», not to mention more conventional «to win» and «to lose». Interestingly, the author resorts to verbs with the semantics of war both in the context of significant scientific theories and petty challenges or competitions that he was so passionate about. In many cases the incongruity in the magnitude of the source domain and the target domain serves to create a humorous effect: thus, persuading an organizer in Japan to put him up in a Japanese-style hotel is ironically called «a battle of minds» as his interlocutor turned out to be very obstinate.

One of the most productive source domains for ARGUMENT IS WAR metaphor in Feynman's memoirs is hunting, e. g.

I was hot on the trail of the booster rocket […] (said in the context of the Challenger disaster investigation) (WDYC, 92).

[…] so I decided to trap the students in a logical discussion.

I already smell certain rats that I will not forget, because I just love the smell of rats, for it is the spoor of exciting adventure. (WDYC, 114).

The next day, in class, she lay in wait for her teacher (said about his wife Arlene in the context of her challenging her Philosophy teacher) (WDYC, 17).

On some occasions, arguments are conceptualized not so much as war as a hand-to-hand fight: thus, he supposes that his sister tried to «floor» him by sending him a Chinese dictionary but he would not let her «score one» on him.

We suggest that, in terms of science, the predominance of the conceptual metaphor ARGUMENT IS WAR and particular manner of its use can be a salient indicator of the researcher's competitiveness and motivational attitudes in the overall. In many of his famous tricks and experiments, R. P. Feynman is solely motivated with the desire to «beat» or to «fix» someone, which at a glance seems to be at odds with his pervasive self-presentation as an enthusiastic scientist who is obsessed with solving puzzles and does not even care about himself getting the Nobel Prize. The abundance of ARGUMENT IS WAR patterns as well as Feynman's confessed love for challenging others indicates quite clearly that he enjoyed the sense of intellectual superiority above others, with science being one of the most convenient areas to find it. While agonism in the academia is sometimes viewed as a destructive element (most notably by Tannen, 2002), it nevertheless remains a potent driving force behind the proliferation of new ideas and theories. However much a scientist enjoys his/her work and focuses on the end result, he/she has to be able to defend his/her claims and that's where the inborn competitiveness can come in handy, as it did in Feynman's case.

Typical of R. Feynman is also the CONTAINER metaphor, an ontological metaphor where a concept is represented as bounded on the inside and outside and capable of holding some content (Lakoff & Johnson, 1980, 29–30). Conceptualized as containers in Feynman's memoirs are primarily people, including the author himself («I contained myself», «I was out», «it scared the life out of me», «we were all full of sacrificial feeling», «the guys from this department were particularly inane»), the world («to fit the miracle into the real world»), difficulties («my curiosity for investigation has landed me in a difficulty», «I'm going out to get myself in trouble») and numerous abstract notions like imagination («confined to the limits of our present imagination»), patriotism («but I was caught up in a patriotic fever»), the unknown («If we want to solve a problem that we have never solved before, we must leave the door to the unknown ajar») etc. This type of metaphor also underlies plenty of idioms used by Feynman primarily when talking about himself, e. g. *out of one's depth, beyond one's capacity, through ins and outs, out of control, out of reach, out of hand* and the like. On the other hand, the CONTAINER metaphor is so pervasive and deeply ingrained into human cognition that it would not be worth mentioning were it not for the large effect it seemingly has on Feynman's views on the human brain and, more broadly, mind. Manifold phrases like «to occupy one's mind», «to reserve the possibility in one's mind», «to put smth. in one's mind», «in the back of one's mind» make it clear that the author conceptualizes his mind as a container for thoughts and ideas. Moreover, mind is

often personified (it «talks», «operates» and «wanders»), thus being attributed with much agency as if it acted independently from the rest of the person's body and soul. We also come across a peculiar metaphorical conceptualization of MIND AS AN ENTITY: when providing his (often ironic) explanations to quite different phenomena, the author conjures «departments» of the brain, such as «playing department», «talking department», «interpretation department», «judgment department» and the like. The fact that this metaphor is instantiated on many different occasions and even in different works (both of the memoirs analyzed here) highlights its centrality to Feynman's conceptual system: as compared to it, another possible representation of mind – MIND AS A MACHINE – is encountered far less frequently (on two occasions only). Conceptualized as an entity is also the «content» of the brain/mind – knowledge and ideas: e. g. «their knowledge is so fragile», «new ideas could be developed, tried out, and tossed out if necessary». These are often personified, which is typical of entity metaphor, e. g. «there's no knowledge coming in», «and then there are the longer periods of time when not much is coming to you». Thus, we may suggest that R. P. Feynman viewed mind not as a monolith, but rather a multidimensional object, whose various functions may at times be in discordance with each other as well as with the rest of the human personality. Being able to observe one's cognitive processes impartially, without complete self-identification with one's thoughts and ideas is a great feature for any scientist to cultivate as it facilitates critical and objective approach to one's work.

With regard to knowledge as the most important product of science, it is common to researchers to conceptualize it «as a valuable but elusive object that can be discovered if one perseveres» (Lakoff, 1993, 40). Thus, R. P. Feynman describes how excited he was about his discovery of the new beta decay equation, which accounted for all the phenomena that the previous equation could not explain: «The other things I had done before were to take somebody else's theory and improve the method of calculating, or take an equation, such as the Schrodinger Equation, to explain a phenomenon, such as helium. We know the equation, and we know the phenomenon, but how does it work? […] It's the only time I ever discovered a new law.» Therefore, the scientist was never satisfied with merely complementing what others have discovered or applying it to new contexts: he strived for a fundamental discovery, which eluded him for many years but finally yielded to his perseverance. It's only then that his ambition was fulfilled: the author does not conceal that he «felt pretty good about this discovery». The immense amount of work and the emotional strain invested in fruitful scientific work is emphasized in the CREATION IS PROGENERATION metaphorical model, as it was named by M. Turner (Lakoff, 1993, 29). Thus, in talking about Einstein, Feynman calls the general theory of relativity his «baby»; with regard to the Challenger disaster investigation, Feynman admits that «It was quite a struggle, nursing my report along» (WDYC, 146), thus metaphorically representing himself as a caring «father».

Apart from conventional metaphors, we can identify a curious metaphorical model that is specific to R. Feynman: SCIENCE IS PLAY. When explaining his habitual attitude to science, the author admits: «I used to play with it. I used to do

whatever I felt like doing – it didn't have to do with whether it was important for the development of nuclear physics, but whether it was interesting and amusing for me to play with. When I was in high school, I'd see water running out of a faucet growing narrower, and wonder if I could figure out what determines that curve. I found it was rather easy to do. I didn't have to do it; it wasn't important for the future of science; somebody else had already done it. That didn't make any difference: I'd invent things and play with things for my own entertainment». Feynman attributes his persistence in scientific matters to «a puzzle drive», which also accounted for his «wanting to decipher Mayan hieroglyphics, for trying to open safes».

Besides explicit references to play and games (particularly puzzles), the model SCIENCE IS PLAY is also evident in the abundance of relatively disparaging lexical units such as *to fiddle, to piddle around, to fool around, to kid around, a trick, a ruse* when talking about science and education. Moreover, R. P. Feynman often ties science to fun («just for fun», «get fun out of it», «get a kick out of it»), which seems more fitting for description of games rather than serious scientific endeavors.

Conceptual metaphors, pervasive as they are, are nonetheless tell-tale of a person's outlook and attitudes, provided that they are instantiated at regular patterns. Upon analyzing the memoirs of a prominent scientist, Richard Feynman, we have identified the conventional metaphorical models that were most typical of him and shaped his conceptualization of science making to a great extent, namely ARGUMENT IS WAR, TIME IS MONEY, MIND IS AN ENTITY, as well as two novel author-specific metaphors, SCIENCE IS PLAY and RESEARCH IS JOURNEY, based on the common LIFE IS JOURNEY metaphor. The prevalence of these metaphorical models serves to delineate two major characteristics of his personality: on the one side, enthusiastic love for science up to the total absorption, which he confessed directly; on the other side, less obvious practical and critical mind frame that urged him to compete with others in both scientific and everyday matters. In prospect, researchers could draw more attention to the comparative aspect of conceptual metaphorization, analyzing the works of multiple scientists and relating their most prominent metaphorical models to personal traits and epistemic beliefs.

Література

1. Herrmann, J. B. (2013). *Metaphor in academic discourse. Linguistic forms, conceptual structures, communicative functions and cognitive representations*. LOT International Series 333. Amsterdam: University of Amsterdam.
2. Ivanič, R., & Camps, D. (2001). I am how I sound: Voice as self-representation in L2 writing. *Journal of Second Language Writing,* 10(1–2): 3–33.
3. Lakoff, G. & Johnson, M. (1980). *Metaphors We Live By*. Chicago: University Of Chicago Press.
4. Lakoff, G. (1993). The Contemporary Theory of Metaphor. Andrew Ortony (ed.). *Metaphor and Thought*, 202–251. Cambridge: Cambridge University Press. Retrieved from http://escholarship.org uc/item/54g7j6zh#page-2.
5. Lakoff, G. & Turner, M. (2009). *More than Cool Reason: A Field Guide to Poetic Metaphor*. Chicago: University of Chicago Press.
6. Permyakova, T. & Utkina, T. (2016). The study of conceptual metaphors in ESAP l2 writing: range and variability. *Research in Language,* 14(4), 437–451.
7. Rosen, C. (2006). The Self-Portrait of a Scientist. *The New Atlantis*, 13, 37–46. Retrieved from http://www.thenewatlantis.com/publications/the-self-portrait-of-a-scientist.

8. Sherwood, M. A. (2005). *An analysis of conceptual metaphor in the professional and academic discourse of technical communication*. (Doctoral dissertation). College Station, TX: Texas A&M University. Retrieved from http://hdl.handle.net/1969.1/1483.

9. Tannen, D. (2002). Agonism in Academic Discourse. *Journal of Pragmatics*, 34(10–11), 1651–1669.

10. Кудрявцева, Н. С. (2015). Концептуальна метафора як підгрунтя наукової теорії. *Науковий вісник кафедри ЮНЕСКО Київського національного лінгвістичного університету,* 30, 37–41.

11. Лосева, О. (2015). Метафора в научно-техническом тексте. *Филологические науки. Вопросы теории и практики*, 8(3), 118–121.

12. Шаля, О. (2008). Метафора як когнітивна модель у сучасному англомовному науковому дискурсі. *Лінгвістика XXI століття: нові дослідження і перспективи,* 2, 303–308.

Джерела ілюстративного матеріалу

1. Feynman, R. P. (1974). *Cargo Cult Science. Commencement Address*. The California Institute of Technology. Retrieved from http://calteches.library.caltech.edu/51/2/CargoCult.htm.

2. Feynman, R. P. (1985). *«Surely you're joking, Mr. Feynman!»: Adventures of a Curious Character*. Retrieved from http://www.earth.northwestern.edu/~amir/files/Richard_P_Feynman_Surely_Youre_Joking_Mr_Feynman_v5.pdf.

3. Feynman, R. P. (1989). *What do you care what other people think?* New York: Bantam Books. Retrieved from http://scilib-physics.narod.ru/Feynman/WDYC/en/contents.htm.

References

1. Herrmann, J. B. (2013). *Metaphor in academic discourse. Linguistic forms, conceptual structures, communicative functions and cognitive representations*. LOT International Series 333. Amsterdam: University of Amsterdam.

2. Ivanič, R., & Camps, D. (2001). I am how I sound: Voice as self-representation in L2 writing. *Journal of Second Language Writing,* 10(1–2): 3–33.

3. Lakoff, G. & Johnson, M. (1980). *Metaphors We Live By*. Chicago: University Of Chicago Press.

4. Lakoff, G. (1993). The Contemporary Theory of Metaphor. In Andrew Ortony (ed.). *Metaphor and Thought*, 202–251. Cambridge: Cambridge University Press. Retrieved from http://escholarship.org/uc/item/54g7j6zh#page-2.

5. Lakoff, G. & Turner, M. (2009). *More than Cool Reason: A Field Guide to Poetic Metaphor*. Chicago: University of Chicago Press.

6. Permyakova, T. & Utkina, T. (2016). The study of conceptual metaphors in ESAP l2 writing: range and variability. *Research in Language,* 14(4), 437–451.

7. Rosen, C. (2006). The Self-Portrait of a Scientist. *The New Atlantis*, 13, 37–46. Retrieved from http://www.thenewatlantis.com/publications/the-self-portrait-of-a-scientist.

8. Sherwood, M. A. (2005). *An analysis of conceptual metaphor in the professional and academic discourse of technical communication*. (Doctoral dissertation). College Station, TX: Texas A&M University. Retrieved from http://hdl.handle.net/1969.1/1483.

9. Tannen, D. (2002). Agonism in Academic Discourse. *Journal of Pragmatics*, 34(10–11), 1651–1669.

10. Kudryavtseva, N. S. (2015) Kontseptualna metaphora yak pidgruntya naukovoy teoriy. *Naukovy visnik kafedry UNESCO Kyivskogo natsionalnogo lingvistichnogo universitetu*, 30, 37–41.

11. Loseva, O. (2015). Metaphora v nauchno-tekhnicheskom tekste. *Filologuicheskiye nauki. Voprosy teorii i praktiki*, 8 (3), 118–121.

12. Shalya, O. (2008). Metaphora yak kognitivna model u suchasnomu anglomovnomu naukovomu diskursi. *Lingvistika XXI stolitya: novi doslidzhenya i perspektivi*, 2, 303–308.