ФУНКЦИОНАЛЬНАЯ СПЕЦИАЛИЗАЦИЯ ПОЛУШАРИЙ МОЗГА. ФИЛОСОФСКИЙ АСПЕКТ

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Работы о том, что функции левого и правого полушария асимметричны, появились еще в середине XIX в. Французские ученые Дакс и Брюк отмечали, что нарушение речи наступает только при поражении левого полушария. О специфических функциях правого полушария долго ничего не сообщалось. В 1981 г. была присуждена Нобелевская премия профессору Калифорнийского института США Роджеру Сперри за открытие функциональной специализации полушарий мозга. После этого открытия появилось огромное количество работ и экспериментального, и теоретического характера. Исследуется и ряд новых вопросов, например, о том, что в зачаточном состоянии феномен функциональной специализации полушарий наблюдается у высших обезьян.

В нашем сообщении мы хотим обратить внимание на то обстоятельство, что при изучении указанного феномена обогащаются и наши представления о возможностях методов, используемых в философии. Сравнительно недавно известный философ нашей страны Феликс Трофимович Михайлов показал, что в ряде случаев целесообразно использовать метод, который условно возможно назвать «Метод изучения отсутствующего объекта». В своей книге «Загадка человеческого Я» и других работах Ф.Т.Михайлов пишет о том, что изучение познавательных возможностей людей, лишенных зрения и слуха, может быть использовано как средство для более глубокого понимания функций этих органов у тех людей, которые обладают слухом и зрением.

Оказывается, что этот метод, а именно метод изучения отсутствующего объекта, может быть использован и при дальнейшем изучении феномена функциональной специализации полушарий мозга. Все дело в том, что указанная функция динамична и подвижна. Она наиболее сильно выражена утром и ослабевает к вечеру. Она слабо выражена в онтогенезе, с предельной полнотой проявляется в зрелом возрасте, и в геронтогенезе ослабевает. Кроме того, следует иметь ввиду, что имеются заболевания, при которых функциональная асимметрия почти полностью отсутствует. Именно исследование данного психического заболевания и представляет интерес в плане применения метода «изучения отсутствующего объекта».

Сведения о специфике взаимозависимостей между деятельностью полушарий возможно почерпнуть, если подобрать ситуации, в которых ярко проявляются различия в поведении детей и взрослых. Одной из таких ситуаций является просмотр театральных спектаклей. Напомним, что чувственный образ строится, основываясь на деятельности правого полушария. Что касается гносеологического образа, абстрактного мышления, то за его формирование

ответственно левое полушарие. Дети и взрослые при просмотре спектакля в театре ведут себя по-разному. Здесь особую роль играет символичность театрального действия как произведения культуры. Ребенок способен только на более низких уровнях осмыслить символические формы. Эти вопросы являются предметом рассмотрения в исследованиях по рецептивной эстетике.

Целесообразным, на наш взгляд, является и осмысление самого метода изучения отсутствующего объекта с позиций параметрической общей теории систем, разработанной известным логиком А.И.Уемовым. В этой теории любая вещь рассматривается как система в предельно общем смысле: системы могут быть и с исчезающими элементами, акцентируется внимание на сохранении определенных отношений и функций (Уемов А.И. Основы формального аппарата параметрической общей теории систем // Системные исследования: Ежегод.– М.: Наука, 1984.- С.152-180). Использование параметрической общей теории систем в процессе дальнейшего изучения функциональной специфики полушарий мозга, бесспорно, является перспективным.

100 YEARS OF CHEMISTRY – REFLECTIONS IN THE LIGHT OF NOBEL PRIZES

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Gottfried Wilhelm Leibniz, founder of the Academy of Sciences in what was then the Electorate of Brandenburg, stated in 1680: «It is a real disgrace for the human race to see how small is the number of those really working to make inventions; we owe almost our entire knowledge ... to a handful of people».

In the 20th century the Nobel Prize Winners in the field of physics, chemistry, physiology or medicine are doubtless among the limited number of figures who have recorded outstanding research achievements in our time. As far as chemistry is concerned, in the period from 1901 to 1990 a total of 82 Nobel prizes were awarded to 115 persons. 56 Nobel Prizes in chemistry went to individuals, 19 to two-man teams and 7 to groups of three (Table I).

Although I shall not go into the oft discussed question of the distribution of Nobel prizes by country, the record of Nobel prizes for chemistry as per 1990 is given in Table 2. Scientists today attribute the dominant position of the United States not only to achievements deserving to be honoured with a prize. The Americans are said to work systematically towards Nobel Prizes. Hartmut Michel, one of the Germans who won the Noble Prize for chemistry in 1988), described the situation as follows: «It's a fact of life that even at high school Americans learn to sell themselves better than we Europeans» [1].

Studies by Harriett Zuckerman have shown that a special conveyance mechanism exists between Nobel Prize Winners and their pupils. She put it in a nutshell like this: «Laureates breed laureates».

Table 3 uses abbreviations to show for what research achievements Nobel Prizes were awarded in the field of chemistry. Looking at the prizewinning accomplishments, it can be said that those singled out for the Nobel Prize reflect the history of chemistry over the past 100 years in many of its highlights and major breakthroughs. The period of 100 years is chosen deliberately since the first Nobel prizes for chemistry were awarded for work begun in the 1880s. This applies for instance to the Nobel Prize awarded to Svante Arrhenius for his work on the theory of electrolytic dissociation.

Fruitful sources for those interested in the history of chemistry are to be found both in the specialist publications put out by the laureates and the papers on the history of their field, e.g. which they were prompted to deliver at the award ceremony, frequently occasioned by the award of the prize. The record of prizewinning achievements provides a useful orientation for those interested in the history of science, even though that history is often reflected long in areas. The significance of certain discoveries is often not immediately apparent. This is why it took much longer for certain achievements to be honoured. While Butenandt received a Nobel Prize for his work on sex hormones in a matter of three years and Hahn for the splitting of uranium in seven, it took fully three decades before Staudinger's work on macromolecules was recognized. It would, of course, be too much to expect the list of Nobel Prizes to present a complete picture of the development of chemistry. The limit of three persons per discipline and year is far too small for that. These and other restrictions, e.g. the fact that only living persons are eligible, mean that major achievements like the development of nylon (Carothers) and perlon (Schlack) were passed over by the Nobel Prize Committee. At this point it might be appropriate to recall the words of Bagge: «The award of Nobel Prizes only placed beacons in a few prominent places. These beacons do not always light up at the right time. Sometimes they appear very late in the day and occasionally not at all, and certainly not because the candidate to be honoured has died in the meantime» [2].

If, to gain a better overview and depict connections and development trends, we try to break down the research projects honoured with the Nobel Prize for chemistry by subject areas, we encounter in a number of cases difficulties of classification and, of course, problems with the definition of such subject areas. Some results are on the borderline between one area and another or clearly have a bearing on more than one area, so that multiple classifications would result. Table 4 shows three different versions using eight subject areas. The differentiation could, of course, be taken further. Analytical chemistry, for example, might be determined to include partition chromatography, mass-spectography and polarography. On the

other hand, many prizewinning projects in synthetic chemistry also embody a major analytical element, so that it is difficult to use this as a criterion for classification. Some people might miss the inclusion of «theoretical chemistry» as s subject area if they think of the Nobel Prizes awarded to Mulliken (1966) and to Fukui and Hoffmann (1981), but the theory of chemistry can hardly be reduced to the application of quantum mechanics and molecular physics to the solution of problems in chemistry [3]. All subject areas used for the categorization in Table 4 imply theoretical chemistry.

All three versions in Table 4 only give two Nobel Prize Winners in the field of chemical engineering. The figure refers to Bergius and Bosch who were honoured in 1931 for the development of chemical high-pressure methods. It is typical of Nobel prizes that they are awarded mainly for achievements in basic research and only rarely for technical or technological accomplishments (inventions). This is due to the understanding of science held by the Nobel Prize Committee whose task it is to propose the candidates. It is therefore a lost cause to try and gain an impression of the advances in chemical engineering in the 20th century by looking at the Nobel Prizes awarded in this field. The major subject areas of organic chemistry, physical chemistry and biochemistry are represented almost equally in Version 1 (c.30 Nobel Prize Winners). If we look at the number of Nobel Prize Winners for chemistry as it developed over the years, organic chemistry is represented very evenly throughout. In the case of physical chemistry, a very sharp rise is noticeable beginning in the early sixties. The rapid advances made in biochemistry in the 20th century can be gauged very well from the award of Nobel Prizes for chemistry.

Whether one regards biochemistry as coming under chemistry, biological sciences or as a discipline in its own right, it is indisputable that major accomplishments in the field have been honoured with the Nobel Prize for chemistry. If we take the most favourable version for biochemistry in Table 4, we find 31 Nobel Prize winners in this field. While in the 70 years from 1901 to 1970 we find 15 Nobel Prize winners for chemistry in the field of biochemistry, there were a further 14 in the past 20 years (1970-1990) alone. If we further consider that a number of accomplishments in biochemistry were honoured with the Nobel Prize for physiology or medicine, this quite clearly reflects mounting achievements and a rapid pace of advance in the field in question. It is, of course, particularly attractive for a scientist working in chemistry to trace the success of his discipline in the 20th century in Nobel prizewinning accomplishments. Since I must assume that there are very few chemists in the audience, I shall concentrate in my remarks on biochemistry.

A large proportion of the «biochemical Nobel Prizes» were awarded for work with proteins. The focuses of this work included the structures and reactions of enzymes. No less than Emil Fischer – the first German to win the Nobel Prize for chemistry – had referred in his acceptance speech in 1902 to the importance of enzyme research and expressed his belief that a time would come when artificial enzymes were synthesized. «Ferments, usually called enzymes in more recent times, occupy an outstanding position among the chemical ingredients of the living organism, and it may be claimed that chemical transformations in the living cell are overwhelmingly associated with their action. An examination of artificial glycosides has now shown that the effect of the enzyme depends to a high degree on the configuration of the molecule on which it acts, that the two must fit together like a key in a lock. If this is the case, the organism can use the enzyme to bring about very specific chemical conversions which would never be possible with conventional agents. If we wish to gain access to nature here, we must use the same means, and I therefore foresee the time when not only natural agents will be used on an extensive scale as agents in physiological chemistry but artificial ferments will be produced for their purposes» [4].

The first person to be awarded a Nobel Prize for outstanding work with enzymes was Eduard Buchner in 1907. You will recall that his discovery of unicellular fermentation exploded Pasteur's dogma that fermentation was not possible in the absence of life. Later Nobel Laureates included Harden and Euler-Chelpin (1929) for their investigations on the fermentation of sugars and the enzymes acting in this connection and Sumner, Northrop and Stanley (1946) for their work on the crystallizability and preparation of enzymes and virus proteins in pure form. In the seventies, Anfinsen, Moore and Stein (1972) were honoured for their work on the connection between the spatial structure and biological functioning of enzymes, as was Cornforth (1975) for his investigations into the stereochemistry of enzyme-catalyzed reactions.

The time for Fischer's prediction on the synthesis of enzymes to materialize came in 1969 when Merrifield (Nobel prize winner 1984) succeeded in synthesizing ribonuclease, an enzyme consisting of 124 amino acid building blocks, using the solid-phase peptide synthesis technique he had developed in 1959. Though he has "only" managed to synthesize a naturally occurring protein, the Merrifield technique does provide the basis for the synthesis of artificial enzymes. Other Nobel prizes for work with proteins were awarded to Tiselius (1948) for his use of electrophoresis to separate serum proteins, to Vigneaud (1955) for the structural analysis and first synthesis of a polypeptide hormone, to Pauling (1954) for the study of the nature of the chemical bond - let me just mention the α-helix here, to Sanger (1958) for the determination of the structure of the insulin molecule, and to Kendrew and Perutz (1962) for the determination of the three-dimensional structure of the globular proteins myoglobulin and hemoglobulin.

The other group of substances vital to life, the nucleic acids, played a part in Nobel prizes for chemistry when Todd was honoured (1957) for his work on syntheses of nucleotides (We have classified this as belonging to the subject area of organic chemistry.). The well-known work on structural chemistry *A structure for deoxyribonucleic acid* written by Watson and Crick in 1953 formed the essential

basis for the 1962 Nobel Prize for physiology or medicine which the authors received together with Maurice Wilkins in 1962. The British physical chemist Rosalind Franklin, whose research provided a valuable base for determining the structure of DNA, had been dead for four years by the time. Since the rules for the award of Nobel prizes do not allow them to be conferred posthumously, Mrs. Franklin does not appear among the laureates. In 1980 a Nobel Prize went to Berg for his work on recombinant DNA and to Gilbert and Sanger for their determination of the order of bases in nucleic acids. This won Sanger his second Nobel Prize. Most recently of all - in 1989 - Altmann and Cech were honoured with a Nobel Prize for chemistry for their discovery of the catalytic properties of ribonucleic acids. Since both the scientists who determined the structure of proteins and of nucleic acids were awarded Nobel prizes, it was to be expected that anyone revealing the structure of nucleic acid protein complexes would be well in the running for the same reward. The development of crystallographic electron microscopy enabled Klug (Nobel Prize for chemistry, 1982) to determine the three-dimensional structure of such complexes, e.g. chromatin, and to contribute to a considerably more profound understanding of genetic processes at the molecular level.

Other Nobel Prizes which might be regarded as belonging to the realm of biochemistry went to Virtanen, Calvin, Leloir and Mitchell. Virtanen's studies on nitrogen assimilation in plants made it more economical to produce protein-rich basic fodder and his method of fodder preservation using mineral acids during silage making has won recognition in agriculture worldwide. Modern analytical methods helped Calvin to make a revolutionary breakthrough in discovering the «material steps» involved in photosynthesis. The Germans Deisenhofer, Huber and Michel were received into that select group of Nobel prize winners for chemistry in 1988 as a reward for discovering the exact arrangement of more than 10,000 atoms comprising the protein complex of a photosynthesis centre.

Leloir scored a pioneering achievement in the biochemistry of carbohydrates when he discovered sugar nucleotides and revealed their role in the biosynthesis of oligo- and polysaccharides. He was awarded the 1970 prize for his efforts. Following decades of scientific debate Peter Dennis Mitchell of Great Britain was finally able to state in his 1978 acceptance speech that his chemosmotic theory explaining the mechanisms by which energy is generated in the mitochondria of living cells and transferred by biological means had gained general acceptance. Mitchell's research is one of the few examples in which theoretical work was found worthy of recognition with a Nobel Prize.

From the list of Nobel Prizes awarded in the area of biochemistry it can be seen that in the 20th century outstanding achievements in the principal areas of biochemical research have been well reflected when it came to selecting the winners of the Nobel Prize for chemistry.

Let us now return to Table 4. The most conspicuous difference compared with

Version 1 is to be found in Version 3 with regard to polymer chemistry and biochemistry. The increase in the number of prizes awarded in the area of polymer chemistry is due first and foremost to their deduction from the category of biochemistry. Achievements in the field of biopolymers are attributed to polymer chemistry. This method of classification accords with the views of Flory, prizewinner in 1974 for his contribution to the physical chemistry of macromolecules. He stated his view as follows: «The tendency to allocate biopolymers and technical polymers to different categories is prejudicial to a better understanding of both. If molecular biology is to rest on a solid molecular foundation, logic demands that this foundation be formed by the science of polymer molecules. For this purpose a polymer science is required which concerns itself with the fundamentals of the behaviour of molecules in the broadest sense» [5].

The classification in Version 3 of the work carried out by 22 Nobel Laureates in the field of polymer chemistry underlines the fact that the chemistry of polymers has developed to become a mainstay of research over the past 60 or 70 years.

The awarding of Nobel Prizes focuses the attention of experts and laymen alike on certain areas of research and certain branches of science. It enhances the prestige of these branches and that of the prizewinning scientists. Robert Huber, one of the team awarded the 1988 Nobel Prize for chemistry, stated: «As I see it, the conferring of the prize ... gives an enormous boost to a broad field: to the subject of biochemistry, the narrower subject of structural biology and the still narrower subject of photosynthesis» [6].

The advancement of physical chemistry was greatly encouraged in the early 20th century by the prizes awarded to its outstanding representatives. The fact that it was not a leading figure in organic chemistry, like Adolf von Baeyer or Emil Fischer, who was the first to be awarded a prize, but to Jacobus Henricus van't Hoff, a representative of the fledgling science of physical chemistry, led to a major growth in the importance of this discipline. Many researchers turned their attention to such domains in view of the promise they held of more lucrative projects to come. Since there is sometimes a considerable time lag before outstanding achievements are rewarded and not all work which might deserve a Nobel Prize can be honoured in this way - there are simply too few prizes - the prizes are only suited to a limited extent to draw attention in good time to emerging focuses of research.

Such research strategy objectives are better served by thorough analyses of the projects cited. The well-known science historian Garfield discovered that Nobel Prize winners cannot always be found among the most cited authors. On the other hand, what he did find in the list of the 300 most cited authors between 1961 and 1976 were 26 Nobel Prize Winners, including 6 winners of the prize for chemistry and three authors (Brown, Hoffmann and Berg) who received the Nobel Prize for chemistry after 1976 (1983 analysis) [7].

The most cited works include first and foremost such as provide the key to a new method or technology with numerous applications. Also cited quite often are theoretical projects which are not universally accepted from the start by the scientific community but rather call for control tests. I would mention as an example a work by Peter Mitchell, the 1978 Nobel Prize winner for chemistry. Completed in 1966 and entitled *Chemiosmotic coupling in oxidative and photosynthetic phosphorylation,* the work was cited 1619 times up to 1986 [8]. Even though the fact of being «most cited» is not an absolute criterion for awarding a Nobel Prize, analyses of citation' frequencies do, of course, present a useful basis for the selection of candidates.

My discussion of the elite among chemists may have created the impression that we owe progress in the field of science to a chosen few. I should like to put this in perspective by quoting Emil Fischer, the first German Nobel prize winner for chemistry. During his acceptance speech back in 1902 he said: «The advancement of science today rests not so much on works of genius by individual researchers as the planned cooperation of many observers» [9].

Table 1

Nobel Prizes for Chemistry, 1901 - 1990

The <u>82 Nobel Prizes for chemistry</u> awarded in this period went to <u>115 persons</u> (3 women, 112 men):

56 Nobel prizes for chemistry to one individual = 56 persons
19 Nobel prizes for chemistry to two persons = 38 persons
7 Nobel prizes for chemistry to three persons = 21 persons

<u>Postscript:</u> The female Nobel prize winners were: Marie Curie-Skodowska (1911), Irene Joliot-Curie (1935), Dorothy Crowfoot- Hodgkin (1964).

Table 2

Distribution of Chemistry Nobel prize winners 1901-1990 by countries
Total number of prize winners: 115. Number of countries: 18

Country	Number of prize winners	Percentage
USA	35	= 80 %
Germany	27	
Great Britain	23	
France	7	

Sweden	4	
Switzerland	4	
Canada	3	
Netherlands	2	
Argentina, Belgium, Finland, Italy, Japan, Norway, Austria, Soviet Union, Czechoslovakia, Hungary, one each	10	= 20 %

Table 3

Key-words for research achievements honoured with the Nobel Prize for chemistry. Assignment of the accomplishments to subject areas as per version 1, compare table 4.

TECHNICAL CHEMISTRY: High pressure processes.

POLYMER CHEMISTRY: Theory of macromolecules, polymerization of olefins, physical chemistry of macromolecules.

ORGANOMETALLIC CHEMISTRY: Grignard reagent, sandwich compounds, boranes, organoboron compounds.

INORGANIC CHEMISTRY: Noble gases, fluorine, inorganic complexes, determination of atomic weights, boranes, transfer of electrons in metal complexes.

NUCLEAR CHEMISTRY: Decay of elements, radium, polonium, isotopes, mass spectrograph, deuterium, new radioactive elements, nuclear, fission, transuranium elements, C-14 – method.

ORGANIC CHEMISTRY: sugars, purines, dyestuffs, hydroaromatic compounds, alicyclic compounds, hydrogenation of organic compounds, plant dyestuffs, quantitative organic microanalysis, bile acids, sterols, vitamins, haemin, chlorophyll, carbohydrates, vitamin C, carotinoids, flavins, vitamins A and B, sexual hormones, polymethylenes, terpenes, alkaloids, synthesis of dienes, synthesis of nucleotides, synthesis of natural substances, conception of conformation, stereochemistry of organic molecules and reactions. Wittig-reaction, ylides, solid-phase peptide-synthesis, host-guest-chemistry, synthesis of natural substances like prostaglandins and leukotrienes.

BIOCHEMISTRY: Cell-free fermentation, fermentation of sugar, fermentation enzymes, conservation of animal feeds, crystallization of enzymes, making pure enzymes and virus proteins, electrophoresis, serum protein, partition chromatography, biochemical sulphur compounds, polypeptide hormones, three-dimensional structure of proteins (α-helix), carbon dioxide assimilation, protein-structures: myoglobin and haemoglobin, sugar nucleotides, ribonuclease, activity centres in ribonuclease, enzyme-catalyzed reactions, vectorial metabolism, recombination of DNA, base sequence of nucleic acids, nucleic acid-protein complexes, centre of photosynthesis, catalytic properties of RNA.

PHYSICAL CHEMISTRY: Chemical dynamics, osmotic pressure, electrolytic dissociation, catalysis, reaction kinetics, synthesis of ammonia, thermochemistry, colloid chemistry, disperse systems, surface chemistry, dipole moments, diffraction of X-rays and electrons, chemical thermodynamics, behaviour of substances at low temperatures, chemical bond, structural elucidation of complex compounds, reaction mechanisms, polarography, structural elucidation by X-ray-analysis, chemical bond: MO-method, fast reactions, thermodynamics of irreversible processes, electronic structure of molecules, especially of free radicals; dissipative structures, method of frontier orbitals, orbital symmetry, direct methods of determination of crystal structures, dynamics of chemical elementary reactions.

Table 4

Options for classifying the Nobel Prize winning achievements for chemistry (1901-1990) by subject areas

Subject area	Number of Nobel Prize Winners per subject area		
	Version 1	Version 2	Version 3
Technical chemistry	2	2	2
Polymer chemistry	4	2	22
Organometallic chemistry	4	7	5
Inorganic chemistry	6	6	6
Nuclear chemistry	12	12	12
Organic chemistry	28	27	26
Biochemistry	31	30	14
Physical chemistry	28	29	28
Total	115	115	115

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