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Explanation: Psychological nature, role in scientific investigation

La explicación: Su naturaleza psicológica y su papel en la investigación científica

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ABSTRACT

Customarily explanations in scientific situations are envisaged as a process of departing from events investigated to move toward abstractive constructions. The standard and most appealling procedure is to symbolize and mathematize events. Essentially, explanation is regarded as very different from description of events.

By contrast, to grant the necessity of clinging to events, explanation is simply a more analytic reference to things and events than ordinary description, but still explanation is esentially description. While maintaining contact with events, explanation consists of relating things and events in a more elaborate way than superficial examination.

Because of the prominent place of linguistics and symbolic factors in description and explanation, the role of such features are briefly examined as they contribute to the total process in science and common affairs.

DESCRIPTORS: Explanation, scientific research, interbehavioral psychology.

RESUMEN

Usualmente, las explicaciones en las situaciones científicas son vistas como un proceso de separarse de los eventos investigados para pasar hacia construcciones abstractas. El procedimiento estándar y más atractivo es el convertir los eventos en símbolos o en el lenguaje de las matemáticas. Esencialmente, la explicación es vista como algo muy diferente de la descripción de los eventos.

En contraste, para reconocer la necesidad de apegarse a los eventos, la explicación es simplemente una referencia más analítica a las cosas y los eventos que la descripción ordinaria, pero la explicación es todavía esencialmente una descripción.

Debido al lugar preminente de la lingüística y de los factores simbólicos en la descripción y la explicación, se examina brevemente el papel de tales rasgos, conforme contribuyen al proceso total en ciencia y en los asuntos comunes.

DESCRIPTORES: Explicación, investigación, científica, psicología interconductual.

EXPLANATION AS IMPROVED ORIENTATION

In the hierarchy of human interbehaviors, explanation must be accorded a high position among the cognitive, ie. the orientational, activities. Explanation must be regarded as a deepened awareness of the nature and functions of the things and events of the invariable surroundings, both on the level of everyday living and of scientific research. To a considerable extent, explanation is a mark of sophistication and understanding.

Unfortunately, there is a deficiency of inquiry into the nature of explanation. Either the subject is ignored or it is badly misconstrued. Undoubtedly, this circumstance is owing to the prevalence of a mistaken philosophy based on the supposition that there exist two worlds, a psychic or phenomeno logical one and a material and natural one, the former being populated with absolutes, universals, abstractions, a prioris, and other supernatural "realities". Knowledge in general is not considered as a type of behavior nor scientific investigation as a natural enterprise, an attempt to adapt to ambient circumstances. In general, the disturbing influence here is the insufficient absorption of a naturalistic psychology and philosophy.

EXPLANATION AS DESCRIPTION

From the standpoint of natural science, explanation is an advanced mode of description. Explanation indicates the extreme and intimate relationship between (1) reacting individual and (2) objects, single, or objects and events in contact with other objects and events. The relationship is ascertained through a series or ordinary inspections and complex analysis. In the simpler forms of description, individuals casually relate to a gross event or to one or more of its various constituents.

Explanation, then, concerns special types of contact of persons with things and events. One the simplest level, persons may merely see and appreciate the presence of some object or situation. Then the reacting individuals may name or classify the object interacted with. On a higher or more complex level, he dissects, analyzes, and synthesizes things with a more or less elaborate report concerning things interacted with. Also, on the highest level, he may interpret and evaluate those objects, that is, perform a more compex and intimate interaction with things. The more complex interactions with things include their interrelation with other things and conditions. The reports of the various contacts are descriptions of the objects and of the reactions to them, and eventuate in comprehensive laws, theories, and other scientific explanatory descriptions.

To challenge the descriptive construction about explanation is tantamount to a departure from concrete events and translating descriptive procedures into formal verbal or mathematical procedures called rational inferences or deductive processes (Feigl, 1949). It is to embrace a psychistic philosophy

of absolutes and certainty attainable only through verbalistic terminology which includes arbitrary hypothetical deduction, a hierarctical string of verbal abstractions. Those who abide by the data and procedures of actual events ask, what can the formulae of science signify, for example H_2O, $G = MM'/r^2$, $W/Q = V$, H_2SO_4, and so on plus all laws, but descriptions of things and events? Consider Newton's axioms or Laws of Motion.

> (1) Every body continues in its state of rest, or of uniform motion in a right line, unless compelled to change that state by forces impressed upon it.
> (2) The change of motion is proportional to the motive force impressed; and is made in the right line in which that force is impressed.
> (3) To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal and directed to contrary parts.

The same descriptive significance is to be ascribed to definitions, propositions, and all other scientific constructions.

In sum, descriptions in general are based on the results of varying interbehaviors with things and events and thereafter constitute the raw materials of all intellectual orientations.

EXPLANATION IN THE DOMAIN OF SCIENCE

Science as a quest for knowledge and understanding requires stable records of achievement. For the most part, the scientific treasury of accomplishments is crystallized as explanations, that is, analytic reports concerning the things and events studied. These explanations are couched in the form of theoretical propositions and laws which represent the experiments, the research, and the findings of investigation.

If we adopt the view that scientific investigation is a process for developing valid orientations with respect to things and events, we may regard explanation in science as a more elaborate form of orientation than is available generally with respect to nonscientific contacts with things and events. As a working hypothesis, we propose that experimentation is simply a form of description on the basis of a larger number of relationships between observers and various objects and different situations.

Scientific explanation, then, basically concern the work of investigators who describe things and events on the basis of knowledgeable procedures and the employment of various surrogates for seeing and handling. Prominent surrogates that aid in precise and sufficient description run through the gamut of scales, calipers, microscopes, telescopes, and various sorts of measuring and calculating instruments, more recently reaching the important and useful computers of various types.

EXPLANATION AS PSYCHOLOGICAL INTERBEHAVIORS

The psychological analysis of explanation consists primarily of the type of relation sustained by individuals with respect to a particular type of subject matter or stimulus object as the psychologists would call it. In the following paragraphs, we attempt a hieratical arrangement of such interrelations of persons and things.

Simple explanation. On this level explanation consists of the description or enumeration of the surface properties of things. For example, water is explained or described as colorless fluid with distinctive wetting and dissolving properties. Blood is a red fluid with various sorts of particles and substances floating in it. It may be added too that blood is necessary for the various metabolic processes.

Various grades of description. Immediately above the simple surface properties, descriptions becomes protoanalytic. The contacts of the individual with objects result in the description of their structure or organization of elements. In the case of explaining about water, there is the enumeration of the chemical constituents and perhaps some description of the origin or the fusion of the gases called hydrogen and oxygen. In general, the contacts of the describing individual may involve elaborate surrogates such as electronic apparatus. To describe explanations of an elaborate scientific sort, one may need to go into the description of complex laboratory situations, that is, the enumeration and report of hypotheses and the various means of testing them for relatively permanent description.

From the standpoint of scientific psychology, there is a definite continuum as between ordinary perceiving and manipulating objects and the researches of science. In scientific situations there are many and more complicated performances as compared with nonscientific circumstances, but no break in the continuity of responses in the two types of situation. Similary, there is a definitive continuum in the surrogates employed. Eye glasses and telephones are simple and elementary tools that reach out to elaborate computers and cyclotrons. Other items of behavior complicate scientific work, for example, much elaborate calculation may be involved with the resulting use of abstract numerical and quantitative terminology.

EXPLANATION AS SPECIFIC DESCRIPTIONS

Explanation as concrete interbehavior obviously differs as the situations and circumstances vary. Explanation or description in physics differs from explanation in biology and in psychology. In the ensuing paragraphs, suggestions are presented as to the variations in descriptions.

Psysics and the Inorganic Sciences. In the inorganic disciplines there are two outstanding types of description. On the one hand, there is the extreme

abstraction in which mathematical symbols and models are substituted for the concrete things and events studied, while on the other, concrete models or working analogies are employed.

Biological Disciplines. Biologist of various persuasions make great use of structures and functions as descriptive means. Structures are derived from unit cells with specialized actions of supporting, secreting, flexing, contracting, reproducing, and conducting functions. The functions are described in biochemical terms.

Psychological Studies. Descriptions in psychology are first based on the historical evolution of adaptations of individual organisms to their environments. In general, psychological descriptions or explanations are guided by the ecological aspects of biology. Psychological descriptions make use of the more frequent and more elaborate occasions for adaptation.

Humanistic Discipline. A very distinctive feature of the descriptions in the societal disciplines is the relative proportions of influence as between the describer or the subject matter. Apparently it is difficult for socialogists, anthropologists, and historians to free themselves from the preconceptions developed in their unique cultures. Accordingly, explanations are more autistic than appear necessary for physicists, chemists, and geologists.

In all the circumstances mentioned, it is now assumed that the descriptions have superceded mystical and transcendental forms of description. The forces and powers of physics, the vitalisms of biology, and the psyches of psychology are presumed to have been passed over.

HISTORICAL SUCCESSION OF EXPLANATORY TYPES

That explanation is description or is based on description is very well supported by the evolution of science from its early beginnings to the present. The history of science can be symbolized by a series of developmental periods as follows.

Scientific Inception. Science and scientific philosophy stem from the development of the interest of human beings in the process of orientation. With the advent of sizable communities, specialization, and divisions of labor, there arose individuals who became interested in their surroundings, including persons and their relationships. And being thinkers and talkers, they proceeded to describe their living places and to build up explanations about themselves, their origins, and their destinies. Because the earliest thinkers were intellectually immature and ignorant, they fabricated descriptions and explanations on the pattern of themselves. Gods, creators, and law givers were persons, but more powerful and more omniscient than actual people. It is not surprising then that they dabbled with transcendents, miracles, and mysticisms.

Greek Objective Science. By the time of the Greek period of Western European Culture, a simple but authentic science was developed. A great and profound interest was developed in the world of nature and the principles of

knowledge. While as yet, no distinctive specializations of disciplines were evolved, keen interest was displayed in the structures, constitutions, and motions and changes of things and events. While Greek science revealed little deep understanding of many types of constituents of their ambience including human beings, what they reported was based on events and direct observation.

The eminent psysicist Schrödinger (1954) complained that the early scientists of the Greeks, as they turned away from the mystical legends of old, described things and actions on the basis of sensory knowledge and left out sophisticated spirit and consciousness. The world of the Greeks he mistakenly declares was without colors, tastes, ideals, beauty, and reason (p. 93 ff). Clear it is that Schrödinger and the other scientists who share his views think in terms of the more recent philosophy and psychology based on the spiritistic postulates of the religious thinkers of the prehellenic period.

Spiritistic Reality. A decidedly new order set in with the destruction of the civilizations of Greece and Rome. Among the grandeur of the antique cultures was the freedom from spiritistic beliefs about hominids and their world. For the science which the Greeks cultivated was now to be substituted a spiritistic tradition. A fallacious dualism was invented which separated human organisms into souls and bodies and made it possible to neglect the research into things and events. With a world beyond space and time explanations could be made not in the way of descriptions but rather by means of autistic verbalisms. It is this type of philosophy and psychology that Schrödinger along with most modern and current thinkers cultivate.

EXPLANATIONS VALID AND SPURIOUS

No valid explanation can fail to be based upon anything less than on interbehavior with things and events. But since explanations or descriptions are constructions, there is sufficient scope for wide gaps between constructions and things and events described. This gap can then be filled by invalid or spurious descriptions. Explainers, instead of describing things and events on the basis of their structures and functions, do so under the influence of traditional prejudices. In consequence, the descriptions and explanations are autistic. It is a melancholy circumstance that the entire history of psychology has not evolved as descriptions of organisms in their adaptations to their environments, but as imaginary psychic states and processes.

Instead, under the influence of cultural circumstances, the complex nature of organism has been treated as transcendental states of mind or brain which regulates and determines the movements and actions of bodies. Things interacted with have been regarded as phenomena created by the mind or localized in consciousness.

A glaring example of spurious explanation is the mentalistic construction of stimulus error. Titchener (1912) who follows Wundt in the acceptance of the spiritistic metaphysics of the early experimental psychology period made

use of the description –explanation difference to account for the compability of mind or consciousness and material objects. The problem arose in connection with the view of Fechner and other psychophysicists that spirit could be manipulated and measured.

In a psychology experiment, a subject is brought into contact with a stimulus object, for example, an aesthesiometer in order to see how well the subject reports a single mental or double point when the point of the instrument are certain distances apart. Now the question arises for the mentalistic psychologist how to get at the pure consciousness without admixture with psysical things. It is a great error to attribute to the spiritual units the sensations, properties that belong only to the stimulus object. To do so is to commit the stimulus error. To avoid the error, one must keep distinct two phases of consciousness. To deal with the sensations is to describe (beschreib) the event while the object consciousness is psychic inference an explanation (Kundgabe) or information.

This example concerns a wholly imaginary situation which is completely alien to actual things and events. Even Boring (1933), the arch-Titchener structuralist, had to assert that "there is not a green sensation, except as a learned relation, a specific response to a specific stimulus." (p. 230).

VARIATIONS IN EXPLANATORY PROCEDURE

As a type of human interbehavior, explanatory procedures vary in many ways depending upon scientific circumstances. This situation merits consideration as it illuminates the nature and operation of a very powerful type of intellectual orientation. Knowledge grows through various stages and as it is enlarged it makes for more efficient applications and general adaptations to the surrounding worlds and oneself. The following listing indicates the the range, type, and scope of common procedures.

Rhetorical and Evidential Explanation. A fairly obvious differentiation can be made between explanations of a linguistic or rhetorical type and explanations made on the basis of valid or invalid evidence.

In the former class, we place the simple forms of description sucha as naming, categorizing, and classifying things and events. Among the more complex forms are the analytic descriptions in mathematical equations, formal syllogism and so on. Evidential procedures cover the confluence of direct descriptions or the equivalent in photographs, records, tracings by various instruments. A number of substitutes for direct observations are available.

Explanation by Reduction or Association. A distinctive class of explanations is made by reducing things and events to parts of themselves, such as the atomic units in physics and chemistry or sensations in traditional psychology. Alternative ways of explaining things are to point to associates of things, acts, and conditions. Concrete examples are the substitution of the

brain for mental processes or the reduction of interbehavior to nervous systems performances.

Analogical and Model Explanations. Substitutional explanation escalates to an enormous expanse of analogical presentations. Things and events are explained as like some other kind of thing. Students of psychology are familiar with the historical comparison of psychological events as static and dynamic physics (Herbart, 1776-1841), Wundtian atomic and molecular chemistry, and the functional notion of consciousness as in the biology of James (1842-1910), Dewey (1859-1952), Angell (1869-1949) and many others. The greatest scope of substitutional description such as the miniature structures and blueprints of architects and engineers have led to descriptions and explanations in terms of mathematical and graphic models of various types.

DEFINITION AS TENTATIVE EXPLANATION

Definitions, the constant and prominent features of scientific work, may be regarded as the first step in explanation and as significant evidence that explanation is a definite form of description. Definitions in science serve as descriptive identifiers of a subject matter whether a thing, a motion or movement, action, condition, relation or other object of investigation. True it is that definitions may function only as tentative or elementary knowledge and orientation, but they are nevertheless descriptions in the form of classifications, representations, primary indicators.

Definitions may be of two general types, either constructional or objective. In the case of constructional types, the subject matter investigated may be entirely built up as in the case of geometrical objects constructed on the basis of abstract relations. Excellent examples are, of course, the Euclidean definitions in the Elements. Objective definitions are developed upon observed, and analyzed objects of nature. Newton's fourth definition in his Principia is illustrative.

> An impressed force is an action exerted upon a body,
> in order to change its state, either of rest or of
> uniform motion in a right line (Cajori, 1946).

It is clear that all of the above follows upon the adaptation of a naturalistic attitude toward every feature of explanation although only specialized situations can be illustrated. A distinctive difference between a naturalistic and a mentalistic view is illustrated in the notion that some things cannot be defined or explained. A classic illustration is the statement that the good like yellow resists definition or that there exists a world of indefinables. When dealing with events instead of just words, all things can be defined on the basis of interbehavior with these objects, conditions, and relations. But definitions must not be regarded as simply verbal formulas. The lack of verbal constructions does not signify that the English language is impotent with res-

pect to future events. It is only necessary to observe how speakers of English dialects do refer to such events.

LINGUISTIC ASPECT OF EXPLANATION

No feature of explanation is equally or powerfully involved as language, since all reference to events and all formultions concerning the conditions related to events are made and conveyed by speech and by symbology.

Language, however, is not to be confused with any other aspect of explanation. It is a medium for dealing with events but not the events themselves. As speech, language is a unique event on its own account. It is a type of behavior though an extremely important one from the standpoint of an observer, whether the performer or someone else. In scientific work, language plays the part which Gibbs ascribed to mathematics when he said, "Mathematics is a language" (Wheeler, 1951). Similarly, Mach (1907-1949) held to the representational function of language when he asked what have vibrations to do with circular functions or the motions of falling bodies with squares? (Mach, 1907).

Although it is obvious that language plays a great role in description and explanation, it is still worthwhile to consider the specific function performed by language behavior in explanatory circumstances. Certainly, as we have already noticed, in scientific explanation, the process could not proceed without language. In the first place, there is the crystallization, the making of substantive material for all the work of hypothesizing, the operation, and the recording of the results in the form of plain description or laws. Then, there is the process of intercommunication of the results and the methods when these features of scientific work are published. Now, as language is a form of interbehavior, there is the problem of style. The records may be presented in conventional language terms or in terms of symbols as in mathematical equations. In sum, linguistic factors interpenetrate in every aspect of definition, description, and explanation.

Of the many functions performed by mathematics in science, an outstanding one is the objectification and embodiment of the operations and findings of investigation. The employment of symbolic representations not only imparts clear and precise information, but also objectifies science by translating descriptive constructions into independently existing entities. It is in performing this function that symbols support the contention that physics is or is contained in the Handbook of Physics.

Not the least important function of mathematical or symbolic representations of events when applicable is that the precise descriptions and representations of events supply stable evidence for the advancement of scientific work.

Though the use of symbols may encourage a misleading sense of fixity and staticism and perpetuate attitudes, the harm done hardly matches the advantages gained. Every tool, appliance or apparatus is employed

with some hazards involved unless prevented by the skill and alertness of the user.

Probably the greatest advantage of the symbols, formulations, and statements of science lies in the emphasis of conditions, since it is conditions in various combinations that make up events. However, no specification or descriptions of conditions in any form or manner can allow language to be identifical with things or events or the swallow up things and events. Many things and events can be constructed but only by operations different from linguistic ones. Never should the line be erased between linguistic events and things they refer to or represent.

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