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Modelling explanation in the space of multiple representations of the flow of time

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Abstract. Explanation is an integral component of philosophical, scientific, and everyday thinking. Consequently, modelling explanation and understanding the sources of its variability hold significant importance in philosophy, the behavioural and natural sciences, as well as in the narrativisation of societal events through mass media. To explore one of the sources of explanatory variability, this study examined the modelling of explanation within the space of multiple cognitive representations of the flow of time. Formal modelling was used as a method based on existing theories of explanation, and the role of the cognitive representation of the explanans (the explaining factors) and the explanandum (the thing being explained) was made clear in the dimension of time. This approach was combined with an analysis of experimental studies on the influence of cognitive representations of the flow of time on object evaluation, followed by the integration of theoretical models and experimental findings. Based on theories of explanation, it was concluded that despite their diversity, they explicitly or implicitly rely on the unfolding of events over time, with the flow of time playing a crucial role. Given the cognitive system's capacity to generate multiple representations of the flow of time and the fact that shifts in these representations determine variability in the perception of the surrounding world – and consequently in the explanans and explanandum – the transition from the conventional singular flow of time in explanatory theories to its representation as a set of distinct, independent cognitive representations with specific properties was substantiated. For various explanatory theories, the significance of this transition from the conventional model of the singular flow of time to the conceptualisation of time as a multiplicity of cognitive representations was explored. The proposed introduction of multiple representations of the flow of time opens new avenues for further theoretical inquiry. In practical terms, it brings explanatory models closer to actual human thought and behaviour, thereby enhancing their reliability and predictive value

Keywords: theory of explanation; cognitive representation of time; multiplicity of time representations; variability of thought; cognitive systems

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Introduction

The study of the structure of explanation, primarily scientific explanation, constitutes a distinct area of philosophical inquiry. Within this field, a range of theories of explanation are discussed, namely C. Hempel's deductive-nomological theory, W. Salmon's statistical theory of explanation, a theory of explanation that relies on mechanistic causality, and P. Kitcher's unification approach. The existence of diverse theories of explanation, as well as current debates regarding their further development, highlight the relevance of the proposed study. The human mind explains the surrounding world because, compared to an unexplained world, an explained world is perceived by the individual as not only comprehensible but also safer and more reliable.

Alongside the production of explanations, opportunities for transforming the world emerge. Even if an explanation is false, its stabilising function persists due to belief in its validity. Examples of this include a range of explanations, both social, medical, and natural phenomena, that have been proposed throughout human history. Equally striking examples are found in religious thought: the medieval idea of going to hell for sins and the possibility of avoiding hell through money paid to the church; the justification of the Inquisition's right to kill for heresy as a form of dissent. Furthermore, the human mind can spontaneously generate explanations that, from the perspective of formal logic, may be incompatible yet are socially acceptable and adopted by the individual for application. Explanations are initially formed by the cognitive system independently of whether they are true or false or whether they will ultimately be accepted by the subject and society. The next action of the mind involves evaluating events and objects. This is crucial for affirming the validity of the chosen explanation and/or for assessing courses of action to establish norms for living. Beyond everyday thinking, when it comes to scientific thinking, for example, in medicine, law, or economics, the formation of explanations acquires even greater significance (Petrov, 2022). The explanations of phenomena developed in social life form the basis for the development of regulatory norms, predictions, and standardised protocols for action. Scientific explanations are presented as theories, as specific relationships between qualitative and quantitative characteristics of objects and processes, and as natural laws. However, several important questions can be raised. Is there a universal theory of explanation or a universal model for forming explanations? How does the conceptualisation and mental representation of metaphysical categories influence the production of explanations, their stability, and their reliability? In this context, it is proposed that the study of cognitive representations of basic categories is a factor that will contribute to the development of existing theories of explanation.

A. Skiles & K. Trogdon (2021) argue that grounding has an explanatory component in the sense that metaphysical explanation is a form of grounding. Metaphysical explanation establishes a connection between facts. On the other hand, it should be noted that what constitutes a fact is determined by the current set of metaphysical categories; any connection, being an extension, is reflected in the dimension of time. Consequently, there is a need for a deeper investigation into the origins of grounding. M. Kortabarria & J. Giannotti (2024) consider the relevance of explanation as a marker of grounding, primarily focusing on scientific grounding. They raise questions about the role of grounding in metaphysics and the nature of grounding within metaphysics. They distinguish between grounding and scientific explanation, noting their certain (a) independence and (b) instrumental role of grounding. The contribution of M. Kortabarria & J. Giannotti (2024) lies in their original argument that grounding holds a special status in science. They analyse the conventional view of metaphysical explanation as a guide to grounding. They note that grounding plays a key role in the scientific understanding of reality, not just in metaphysics. In their understanding, the

concept of grounding is both deterministic and explanatory.

D. Kim (2025) highlights the relationship between metaphysical modality, essence, and explanation. In doing so, attention is paid to essence as a super-explanatory property. However, he points out the problematic nature of using the category of essence for explanation. It is worth noting that both essence and modality can be presented as dependent on a temporal variable. Essence is defined as a time-invariant characteristic and, therefore, is defined, among other things, through time. Modality reflects becoming in time. Therefore, within this approach, the need to study the role of time in explanation becomes evident.

N. Barrett (2023) highlights the role of value in explanation, revealing the connection between the former and affect. From research on intertemporal evaluation and intertemporal decision-making, it is known that value and effect are modulated by the flow of time. Furthermore, the explanation itself must also be modulated. Therefore, in this case, there is a need to study the role of the mental representation of the flow of time in modelling explanation. Explanation, regardless of the theory upon which it is based, is grounded in a specific set of metaphysical categories, including space and time. These categories not only define the boundaries of perception but also determine the range of experience available for explanation. Creating explanations without these categories and outside the boundaries they establish is difficult to imagine. However, it is important to emphasise that despite such a fundamental role of metaphysical categories, they themselves are difficult to explain. A striking example is the question "What is time?" – a subject of philosophical debate for more than two thousand years.

L. Ross (2023) raises the question of limitations in explanations, including scientific explanations. Conventionally, two main types of limitations on explanations are identified, namely, explanations based on (a) the distinction between the possible and the impossible, and (b) explanations based on limitations of the mechanism of the phenomenon being explained. The former explanations rely on a boundary that defines what is impossible. The latter focuses on the functional or structural limitations of a specific mechanism that underlies the explanation. For example, the perception of colours by the organ of vision is determined by the functional properties of the retinal receptor cells and their distribution across the retina of the eye. L. Ross (2021) proposes a new typology of explanations and distinguishes the following types of explanations: (1) limitations defined by laws, (2) mathematical limitations, and (3) causal limitations. In her view, this classification of limitations better reflects the uniqueness of limitations regarding the production of explanation.

The thesis that the cognitive system can generate a multitude of time representations, each with different properties, creates a foundation for reconceptualising time as a philosophical category, as a category used in the natural sciences, and, most importantly, renews its understanding in cognitive research. Therefore, the problem lies in determining whether the multiplicity of cognitive representations of time acts as a factor that creates a basis for the further development of theories of explanation. Given the universality of the category of time and its widespread use in modelling regularities, the problem posed concerns the entire range of the aforementioned theories of explanation. The subject of this research was the multiplicity of cognitive representations of the flow of time as a factor that constitutes explanation and influences the theoretical modelling of explanation. In this research, following J. Woodward's (2018) explanation was viewed as a sentence that connects the explanandum (the explanatory target) and the explanans (factors that do the explanatory work) and reveals the interdependence of the former and the latter. This article aimed to reveal the potential of introducing multiple representations of the flow of time into various theories of explanation and to clarify the potential advantages in modelling explanation when transitioning from a conventional singular to multiple representations of the flow of time.

Literature Review

P. Audi (2012), highlighting the constitutive role of the explanans concerning the explanandum and explanation as such, states that the proposal of the explanandum consists of nothing other than the creation of an explanation: "It is natural in such cases to say that the explanans or explanantia are constitutive of the explanandum, or that the explanandum's holding consists in nothing more than the obtaining of the explanans or explanantia." Later, M. Raven (2020) points out the need to reveal the nature of grounding itself. It is noted that grounding also relates to non-causal but determining explanations. Such an explanation is designated as constitutive.

Explanation and the representation of knowledge occur in a multidimensional space of basic concepts, such as time, space, mass, value, essence, phenomenon, and so on. Basic categories determine how the phenomena under investigation are represented and explained. This involves a dependence on basic categories for the explanation of natural phenomena, events in social life, and personal experience. Time is one of those fundamental categories that is used in a range of explanations and the formulation of the laws of nature and social life. As B. Dainton (2001) notes, time is conceptualised in philosophy in at least three different ways: eternalism, possibilism, and presentism. Despite significant differences between these models of time, C. Callender (2010) believes that from an empirical point of view, they are similar, with the divergence between them lying in their explanatory potential regarding temporal data.

The temporal dimension forms the basis for developing research methods in various sciences, interpreting data, and modelling diverse processes and complex social relations. These, in turn, create a demand for the production of explanations. Most metaphysical categories, it is generally believed, are not susceptible to actual rational definition. However, this does not preclude posing the question of how the reconceptualisation of a basic category, such as time, will affect the modelling of explanation. Therefore, this article examined the impact of the reconceptualisation of the category of time on the modelling of explanation. The argument stems from the proposition that time and the experience of the flow of time are products of information processing by the human cognitive system. Of course, the proposition of time as a product of the human mind is not entirely new. Aristotle already pointed to the role of the individual in comprehending the flow of time. St. Augustine believed that time is not real but exists only in the human representation of the world. The contemporary philosopher B. van Fraassen (1985) sees the basis of time in the human mind's ability to form judgments. C. Callender (2010) and several other researchers also emphasise the role of the subject through whom the experience of the flow of time is formed. C. Callender (2011) suggests that time can even be removed from the physical model of the world. Given the absence of a specific organ in the body for perceiving time, J. Gibson (1975) also points out that time is constructed by the cognitive system itself. Taking into account the role of the subject in forming temporal experience and the experience of the flow of time, considering the variability of approaches in defining the category of time and the different conceptualisations of the flow of time, the proposition is made that the cognitive system can form more than one representation of the flow of time. This ability is also indicated by experimental studies (Polunin, 2011).

The importance of the temporal dimension is also highlighted in the publication by I. Kolvoort *et al.* (2024). They model the variability of causality assessment. In doing so, they note that this involves within-participant variability. The researchers explain this variability through a multitude of Bayesian Mutation Samplers, which reflect the cognitive processes involved in forming a conclusion about the presence of a causal link. Given the important role of time in establishing causal relationships, the question arises: does the cognitive representation of the flow of time contribute to such variability? Time

and temporal experience, due to their dynamic nature, could well be a source of within-participant variability.

X. Wang *et al*. (2023) directly point to the importance of the temporal dimension for producing explanations. They state that humans view the world through a "lens of causality". Therefore, in their opinion, modelling causality is particularly important in learning and reinforcement learning (positive stimulation of learning). The temporal plan of reinforcement determines the success of learning, and the temporal dimension defines the boundaries of establishing causality. From this perspective, the role of causal explanation as a factor in learning is revealed.

The dominance of causal explanations in scientific research does not preclude research related to non-causal explanations. The study of A. Wayne (2022) is dedicated to asymmetry in non-causal explanations. The violation of symmetry is considered a key factor in the explanation. The proposed resolution of asymmetry relies on the Counterfactual Theory of Explanation. The essence of counterfactual thinking necessarily relies on the determination of "before-after" relationships and thus on determination in time. Therefore, this article also underscores the importance of studying time as a factor in the production of explanation. The elements of any non-causal explanation, in their existence, necessarily contain extension. One of the metaphysical categories that reflects extension and is included in most grounding is time. At the same time, it is necessary to distinguish between theories of time, cognitive representations of time, and the direct experience of the flow of time (Polunin, 2011). J. Freyd (1987; 1992) demonstrated that even static stimuli at the level of cognitive representation have a temporal dimension. Based on this proposition, it is necessary to recognise the presence of a temporal dimension for the components of both topological and noncausal explanations.

In addition, it should be noted that the laws of nature and human-created regulatory norms, as well as relationships of causality, are conceptualised within a temporal dimension. Also, the boundary of "possible-impossible", interpreted as the boundary of being, has a temporal reflection. The temporal dimension of thought determines the boundary of the being of the object of thought and, therefore, the boundary of the possible. Objects thought of outside of time are rather thought of as being outside of existence. The latter indicates the dependence on time and limitations for explanation. An additional factor is the uncertainty of time itself, namely the open question "What is time?" and the potential uncertainty of temporal relationships between events – this represents an additional important limitation in the production of explanation.

From a generalisation of the works cited, the significant role of time in the production of explanation becomes evident. The temporal dimension of experience forms the space in which the explained event, the explanans, and the disclosure of the connections between them through the formulation of explanation are represented. At the same time, grounding, the description of explanatory properties, the disclosure of essence and modality, the boundaries of the reality of explanation, and the concept of causality all rely on time, making a deeper study of the role of time in theories of explanation urgent.

Materials and Methods

As a research method, the author relied on: conceptual analysis and formal modelling of explanation based on existing theories of explanation and psychological experiments on the cognitive representation of the flow of time; analysis of experimental studies to understand the specific features of the influence of the cognitive representation of time on the representation of an event in the flow of the subject's experience of explanation; integration of theories of explanation from philosophy and experiments on intertemporal decision-making from psychology. The first revealed a common feature of most explanations, namely their modelling in the temporal dimension; the key role of time for the representation of the

explanandum and explanans was demonstrated. The analysis of experimental studies helped to prove the coexistence of several representations of time, each of which can influence the description of the explanandum and explanans. As a result, the multiplicity of representations of the flow of time creates a basis for the variability of the reflection of the same event in the flow of experience and, therefore, for the variability of explanation. Summarising the arguments presented, the author proposed the proposition that it is necessary to improve theories of explanation, taking into account the multiplicity of representations of the flow of time.

Given the theoretical nature of the study, particular attention was paid to the analysis and synthesis of existing scientific works, philosophical concepts, and empirical data concerning the cognitive representation of time and theories of explanation. To achieve this, a method of comparative analysis was used, which allowed for the identification of commonalities and differences between various approaches to understanding the flow of time and its impact on the formation of explanations. Additionally, a method of conceptual modelling was employed, enabling the creation of abstract models that reflect the key aspects of the phenomenon under investigation. These models were utilised to demonstrate the possibility of the existence of multiple representations of the flow of time and their influence on the variability of explanations. Furthermore, a critical analysis of existing experimental studies concerning the cognitive representation of time was conducted to identify their methodological limitations and opportunities for integration with theoretical models of explanation.

The starting point of the research was the proposition that the experience of the flow of time is a product of the cognitive system's activity. Subsequently, relying on previous research, the cognitive system's ability to produce a range of qualitatively different mental representations of the flow of time was demonstrated. As a next step, the idea of the multiplicity of cognitive representations of time was taken as a foundation for the further development of theories of explanation. In this way, the prospect of further development of explanation modelling and the development of relevant theories was substantiated.

Results and Discussion

Time as a dimension of thought and key theories of explanation

Despite recent research indicating the necessity of studying time in theories of explanation, this problem was established much earlier. It stems from the role of time as a metaphysical category in modelling events and thus in explaining the world. Metaphysical categories are described by their stability and prolonged immutability throughout years of research. Therefore, it is appropriate to turn to earlier theories of explanation, which remain influential to this day. Contributions to the theory of scientific explanation are presented in the works of C. Hempel (1965), W. Salmon *et al*. (1971), and P. Kitcher (1989). In the last century, C. Hempel & P. Oppenheim (1948) and C. Hempel (1965) proposed the deductive-nomological model (DN model) as an approach to developing explanations. According to this model, an explanation consists of an explanandum – a sentence describing the phenomenon to be explained – and an explanans – a set of sentences that convincingly reveal the explained phenomenon. According to this model, an explanation must reveal why the explained phenomenon (explanandum) occurs, must specify the conditions $C_1, C_2, \ldots, C_k$ under which it occurs, and through the action of which laws ($L_1, L_2, \ldots, L_r$) it becomes possible. According to C. Hempel & P. Oppenheim (1948) and C. Hempel (1965), laws play a key role in the explication of the concept of explanation. Later, P. Kitcher (1989) developed a unification approach to explanation. According to him, generalisations (laws) and deductive structures are necessary conditions for the successful construction of an explanation. Generalisations in the sense of P. Kitcher (1989) rely on the concept of the flow of time and the timeline.

Most laws in the natural and social sciences rely on the concept of a singular linear flow of time. Agreeing that laws are defined regularities that satisfy certain conditions, it should be pointed out that the establishment of any regularity relies on basic categories, primarily time and space. It is also worth considering the contribution of J. Freyd (1987; 1992), who experimentally demonstrated that any cognitive representation includes a temporal dimension. Therefore, any law, being reflected in the human mind, must explicitly or implicitly include a temporal dimension, the dimension in which it unfolds and acts. The cognitive representation of the circumstances and conditions of the explained phenomenon is also subject to the influence of the current representation of the flow of time. Therefore, the explanandum and explanans, as well as the properties of relevant objects – all of them are presented in a specific representation of the flow of time. Moreover, they may be dependent on the latter at the level of subjective representation. In this regard, the reconceptualisation of time as a metaphysical category and changes in the representation of time in the cognitive system of the thinking subject is very likely to lead to the reformulation of certain laws, at least in the sense of the DN model of explanation and the unification approach to modelling explanation.

Although C. Hempel & P. Oppenheim (1948), C. Hempel (1965), and other proponents of the DN model do not consider the category of causality to be key, several modern scientific explanations cannot do without the use of this category. Time is the dimension in which the connection between cause and effect is established. Events linked in time form a causal chain. Therefore, it is appropriate to consider that the category of causality may also be influenced by the reconceptualisation of the concept of time. Contrary to C. Hempel, at the level of both everyday and scientific thinking, the decisive role of the category of causality in constructing explanations is evident in most cases in Western culture. It is necessary to distinguish between causality studied at the perceptual level and causality reflected at the level of cognitive representation. This article deals with the concept of causality, which goes beyond perceptual processes and relies on the cognitive representation of the flow of time.

The explanation is typically a sentence describing past experience. K. Craik (1943), J. Freyd (1992), and F. Keil (2006), and therefore psychologists and philosophers, believe that explanation originates from the past but is created to predict and control the future. It is appropriate to consider that this linking of the past, present, and future in explanation is a manifestation of a cognitive mechanism to ensure subjective certainty, a manifestation of cognitive assurance of the constancy of an individual's existence. The latter is based on the picture of an already understood world, formed through explanation. The explanation of the past has another function. The explained past can be "set aside" as an understood experience. It loses urgency, no longer "disturbs" the present, and thus frees up cognitive resources for processing current information and information relevant to predicting the future. In this sense, the explained past, to some extent, frees the individual from the burden of the past. The future, presented through a clear and acceptable explanation, not only makes expectations more understandable but also indicates a path to action to achieve the future. All this at least partially reveals the role of the representation of time in constructing explanations and modelling causality. At the same time, as the research of O. Polunin (2011) proves, it is advisable to consider the ability of the cognitive system to form separate and divergent cognitive representations for the past and future modes of time.

Both causal relationships as such and objects or events included in causal relationships are subject to the flow of time, namely modulation through the action of a specific cognitive representation. The properties of the cognitive representation of the flow of time determine how an object or the relationships of objects will be presented at different temporal distances. This

dependence on the representation of an object or relevant relationships on the current cognitive representation of the flow of time leads to possible changes in the reflection of both the object and the relationships. For example, O. Polunin (2011) described the process of proposition ageing, which significantly reduces the subjective value of an object or event. This ageing may result in the removal of this object (or event) from the list of candidates for the role of cause. Similarly, a certain event could be eliminated from the list of candidates for the role of effect. Even if one agrees with the view of W. Ahn *et al*. (1995) that when searching for the cause of an event, a person first seeks information that uncovers the relevant mechanism rather than information about covariate factors, it is still reasonable to assume that each mechanism is represented in the temporal dimension, meaning its functioning may depend on the current representation of the flow of time. This dependence of explanation and causal relationships on the representation of the flow of time indicates possible variations in the conceptualisation of the former in the event of a change in the current representation of time and its reconceptualisation.

Conventional concept of time and multiplicity of representations of the flow of time

The idea of modularity proposed by J. Fodor (1983) has gained widespread acceptance. For example, S. Dehaene *et al*. (2003) successfully apply it to describe modules for processing numbers. A. Öhman & S. Mineka (2001) rely on it to describe a subsystem for processing emotions. L. Hermer & E. Spelke (1996) use this idea to study a module responsible for processing spatial information. Similarly, a module responsible for processing temporal information should be identified in the cognitive system. According to the proposition of modularity, mental phenomena arise in the course of information processing. H. Barrett & R. Kurzban (2006) develop the proposition of modularity and introduce the assumption of the presence of functionally specific cognitive mechanisms. Therefore, it is appropriate to identify a functionally specific module responsible for processing temporal information, including the formation of a cognitive representation of the flow of time. Moreover, this module of the cognitive system can generate not one but several representations of the flow of time.

To test this thesis, a series of experiments were conducted (Polunin, 2011; 2016), which studied the change in the value of an object (money) depending on its representation in different representations of the flow of time. Cognitive representation is activated by a specific formulation of the problem situation for the test subject. In this case, the mathematical model of the studied moment of time remains unchanged. Based on the results obtained, the author identified several cognitive representations of the flow of time, for example, the flow of time modelled from the first person perspective and the flow of time modelled from the third person perspective, situational and propositional flow of time, and some others. Each of the mentioned representations of the flow of time is described by its own characteristics and, therefore, in a specific way, influences the intertemporal presentation of a particular object in the cognitive system. The representations of the flow of time from the first person perspective and the third person perspective outline the difference between the value of a time interval modelled "for oneself" and "for another". The representations of the situational and propositional flow of time differ to some extent, similar to how the ancient Greek gods of time, Kairos and Cronos, differ. Situational time flow reflects an individual's existence at a specific moment under particular conditions and possibilities. Movement within situational time occurs in "jumps" from one situation to another. In contrast, propositional time flow emphasises continuity, a gradual flow, and the connection of this flow to a proposition or an object's properties. The research examined the value of a monetary proposition. It was found that within situational time flow, the proposition's value remains relatively stable, whereas

within propositional time flow, the proposition's value undergoes significant changes, specifically decreasing towards zero. Consequently, the explanatory potential of the proposition, as a factor influencing an individual's behaviour, varies depending on its representation within different time flow frameworks. The same monetary proposition, when presented within a situational time context, might encourage an individual to accept it, whereas the same proposition, when presented within a propositional time flow, holds no interest for the individual and, therefore, does not alter their behaviour.

It is worth noting that L. Boroditsky & A. Gaby (2010), L. Boroditsky (2011), M. Chen (2013) and other researchers also point to the ability of the cognitive system to produce different representations of the flow of time. However, all these studies concern either the production of different representations of the flow of time in different cultures or differences in the representation of time depending on the languages used in different groups of test subjects. On the other hand, O. Polunin (2016), in his experiments, showed the possibility of producing different representations of the flow of time in people who speak the same language and belong to the same culture, which is a significant difference from the mentioned studies of colleagues and emphasises the novelty of the presented approach. These results indicate that the same cognitive system can produce several representations of the flow of time, which can be activated as independent cognitive formations.

Each representation of the flow of time determines the reflection of temporal processes for the same object in its own way. In this context, a temporal process is understood as a change in the cognitive representation of an object caused by the subject's current representation of the flow of time. In this sense, the temporal properties of an object become dependent on the current representation of the flow of time. It should be emphasised that the subject, under certain conditions, can also assume the role of an object in the current representation of the flow of time. Because of this, as shown by O. Polunin's (2011) research, the representation of the subject itself in their own cognitive system can change significantly. In general, cognitive representations of the flow of time specifically manifest their properties concerning: (a) the subject themselves, (b) other people, (c) the situation as a whole, (d) an external isolated object of inanimate nature, (e) the parameters of a proposition, which can be (e1) temporal in nature (time mode, time distance, direction of time flow) and (e2) non-temporal in nature (absolute or relative characteristic). It should be emphasised that the multitude of different representations of the flow of time is not evenly distributed on the conventional abstract timeline. This means that several different representations of the flow of time can be applied to different segments of the conventional timeline. The latter is determined both by the properties of the representations of the flow of time and by the real and/or imaginary position of the subject on the timeline, as well as by the mode of time used to describe the problem.

The activation of a particular representation of the flow of time is determined both by the parameters of the description of the stimulus situation and by the personal perspective on viewing the situation in the temporal dimension (the subject's location on the abstract timeline). The formal properties of the verbal description of the problem situation, namely the time mode, temporal distance, properties of the objects and subjects involved, focusing attention on the situation as a whole or a specific object, determine which representation of the flow of time will be activated by the cognitive system to process the current problem task. Thus, before applying a particular representation of the flow of time, the cognitive system analyses the current task for several markers: time mode, the temporal meaning of individual words (for example, growth, decay, expectation), markers of general and local time flow, and markers of situational or propositional time flow. It is assumed that when activating a

particular representation of time, the cognitive system first determines the distinction between situational and propositional time flow, then determines the perspective from the first or third person, and only then considers other parameters.

Multiplicity of time representations and theories of explanation

The regularities of human behaviour are the focus of researchers in a wide range of disciplines – Psychology, Psychiatry, Sociology, Anthropology, Economics, Philosophy, and Cultural Studies. Most of these regularities are described based on the concept of time. Therefore, the reconceptualisation of time and the introduction of multiple representations of time will affect the establishment, description, and interpretation of these regularities. For example, regularities that rely on the activation of situational time flow should not coincide with regularities determined by the activation of propositional time flow. Similarly, differences in behavioural regularities established on the representation of the flow of time from the first person perspective and the third person perspective should be expected. Such differences are based on the specificity of processing temporal information within each of the representations of its flow. At the same time, the relativity of the description of an event and its dependence on the current representation of the flow of time is demonstrated.

However, the question remains: what exactly does the introduction of multiple representations of time bring to theories of explanation? This innovation carries additional explanatory potential in cognitive science and philosophy. T. Lombrozo (2006) believes that explanation includes two properties: "explanations accommodate novel information in the context of prior beliefs, and do so in a way that fosters generalisation". The introduction of multiple representations of time marks another path. Replacing the previous conventional use of a singular flow of time opens up new ways to model explanation. There is a transition from the singularity of explanation to its predetermined multiplicity with the possibility of finding the optimal explanation. In this case, multiplicity is assumed from the very beginning of the formulation of the explanation through the multiplicity of representations of the flow of time. For example, in the unification approach, regularities will take on a significantly different appearance if they are formulated separately for time flowing as situational and for time flowing as propositional. In statistical theories of explanation, the accumulation of statistical information will also depend on the representation of the flow of time used. The outlined influence of the representation of the flow of time on the formulation of explanation also has epistemological value because it reveals the contribution of the cognitive system's property to the act of cognition. A new aspect of the relativity of explanation is also opened up, namely through possible transitions between different representations of the flow of time. This is not just abstract relativity but relativity that can be verified by empirical methods.

At first glance, the introduction of multiple representations of the flow of time leads to an increase in the variability of the content of the explanatory text, to the expansion of the array of explanans. The initially singular factor – the flow of time – is replaced by a whole array of specific representations of the flow of time, the properties of which are not isotropic and which, moreover, are not equally involved along the imaginary timeline. Each of these representations of time has its own impact on the reflection of the explanandum and explanans in the cognitive system. However, since each individual representation of time is characterised by a more precise specification of its properties than the conventional singular flow of time, it is expected that the reflection of the explanandum and explanans in time will be more accurate. Of course, the introduction of multiple representations of time instead of a singular time leads to an increase in computational operations for justifying the explanation, but in the modern digital age, this is not an insurmountable problem. For example, when considering an explanation from psychology, sociology, economics, or

law, one might ask: will this explanation improve with the introduction of multiple representations of the flow of time? In the author's view, multiple representations of time will help identify temporal processes relevant to the explanandum and explanans, the conditions of their course at the level of cognitive representation. Ultimately, this will help to create several competing models of explanation and choose among them the most optimal, closest to real behaviour.

The multiplicity of temporal processes, described by an array of representations of the flow of time, increases the variety of subjective intertemporal evaluations of an object. Instead of a conventional singular correspondence between different moments in time, multiple correspondence arises in the representation of the object. As a result, multiple descriptions and, consequently, multiple explanations of the same phenomenon become possible. Given the multitude of existing theories of explanation, the question also arises as to whether the multiplicity of representations of the flow of time can be applied to each of the theories of explanation. If one agrees with the conclusions of J. Freyd (1992) regarding the temporal dimension of cognitive representations and her view that each explanation has its own cognitive representation, then the application of multiple temporal representations to any theory of explanation must be accepted. Of course, the question of the level of influence on a particular theory of explanation must be resolved in each individual case, including by methods of experimental philosophy. However, this task is beyond the scope of the present article.

Conclusions

The reflection of actions in time and the presentation of knowledge in time is a fundamental property of the human mind. This reveals the meaning of changes associated with the reconceptualisation of time and the introduction of multiple representations of the flow of time into the modelling of explanations. The proposed multiplicity of time representations determines intraindividual variability in the reflection of the world. It also describes differences in behavioural reactions to the world. Through the multiplicity of representations of the flow of time, a basis is created for the multiplicity of perceptions of the same event or connection between events. Thus, a basis is formed for the multiplicity of their explanation within one cognitive system. In this sense, the representation of time should be understood as a "servant" of the mind created by the mind to ensure flexible behaviour, adaptive modelling, and understanding of the world. The proposed introduction of multiple representations of the flow of time redefines the temporal connection between the explanandum and the explanans. The explanans and the explanandum can be represented in different representations of the flow of time. This creates a significant discrepancy in their temporal representation, which opens up a new horizon for further theoretical and empirical research. Namely, it concerns the modelling of explanation, its perception by the individual, research on the modelling of causality, and intertemporal properties of explained phenomena and objects in the space of multiple representations of the flow of time.

At first glance, the conventional concept of a singular flow of time appears to be a universal thought. Its universality is based on the impression that it itself is beyond the influence of time. This atemporality in the understanding of time can be dangerously misleading. On the one hand, the timeless, almost eternal truth of singular time guarantees the stability of everyday existence and the constancy of world development. On the other hand, it reduces the likelihood of going beyond convention and becomes an obstacle to the creation of new knowledge, new modelling of the world and a new organisation of human existence. Interpreting time as a category created by the cognitive system for modelling the world and as a tool for better information processing, and therefore for better adaptation in the world, one cannot exclude further development in the modelling of dynamic processes by the cognitive

system, including overcoming the indicated atemporality of time. It is already about modelling not through singular time, but through multiple representations of the flow of time. Such a step, for example, makes possible a new understanding of the nature of spontaneity as a transition between representations of the flow of time opens up new horizons in the modelling of explanation, causality and dynamics. In applied sciences such as psychology, law, economics, and political science, this allows for the raising of new theoretical questions from the perspective of the described multi-temporality.

Modern explanations of patterns of thinking and behaviour have been developed within the framework of a conventional singular flow of time. However, the multiplicity of representations of the flow of time expands the boundaries of the known intertemporal variability of explanation. It adds, at the very least, a special form of variability in the representation of the subject and the objects under study in the temporal dimension. As a result, the array of possible explanations is significantly expanded. One of the important limitations of the proposed approach cannot be ignored. The proposed approach, to some extent, does not apply to mathematical explanations, at least until they include time as a variable. The fact is that mathematical explanations are, in most cases, considered non-causal and independent of time. The introduction of multiple representations of the flow of time opens up new opportunities for research on explanation within such a new direction as experimental philosophy. First of all, the satisfactoriness of the explanation, the conditions under which the explanation is acceptable to the subject, should be investigated here.

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Conflict of Interest

None.

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Моделювання пояснення в просторі множинних репрезентацій плину часу

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Анотація. Пояснення становить невід'ємну складову як філософського, наукового, так і повсякденного мислення. Тому моделювання пояснення та розуміння джерел його варіативності набуває значної ваги в філософії, в поведінкових та природничих науках, а також у наративізації суспільних подій через мас-медіа. Для розкриття одного з джерел варіативності пояснень у статті досліджено моделювання пояснення в просторі множинних когнітивних репрезентацій плину часу. В якості методу використано формальне моделювання на підставі наявних теорій пояснення, експлікація ролі когнітивної репрезентації експлананта та експланандума в часовому вимірі. Останнє виконувалось у комбінації з аналізом експериментальних студій щодо впливу когнітивної репрезентації плину часу на оцінку об'єкта з подальшою інтеграцією теоретичних моделей й експериментальних результатів. З огляду теорій пояснення зроблено висновок, що вони, попри все розмаїття, експліцитно або імпліцитно покладаються на розгортання подій в часі, й плин часу в них відіграє істотну роль. Виходячи зі здатності когнітивної системи до продукування множинних репрезентацій плину часу та того, що зміна репрезентації плину часу визначає варіативність у відображенні навколишнього світу, а отже, й експлананта та експланандума, обґрунтовано доречність переходу від конвенційного

сингулярного потоку часу в теоріях пояснення до подання його множиною окремих, самостійних когнітивних репрезентацій зі специфічними властивостями. Для різних теорій пояснення розкрито значення переходу від конвенційної моделі сингулярного плину часу до концепіювання плину часу через множину когнітивних репрезентацій. Запропоноване введення множинних репрезентацій плину часу відкриває новий горизонт для подальших теоретичних досліджень. У практичному сенсі воно наближає використовувані моделі до реального мислення й поведінки особи, а тому підвищуватиме їх надійність та прогностичну цінність

Ключові слова: теорія пояснення; когнітивна репрезентація часу; множинність репрезентацій часу; варіативність мислення; когнітивні системи