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The Phenomenal Hyperspace

A Study of the Dimensional and Spatio-temporal Structures of Phenomenal Space and Binding

Abstract: *The dimensional structure of phenomenal space and its relation to the brain have not been widely focused on in brain and consciousness studies. This paper postulates that focusing on the dimensional structures displayed in the relation between phenomenal space and the brain is necessary for understanding the integration of distributed brain events in binding. A related issue is why items and events of phenomenal space and consciousness as they appear in experience seem to be beyond the reach of natural scientific empirical observation. The proposed solution to these issues is postulated to require a fourth spatial dimension. A transcendence principle of detection (TPD) is introduced, which states that transcendent degrees of freedom of an n+1 dimension are a necessary condition for experiencing or detecting an n-dimensionally extended physical structure as an n-dimensionally extended phenomenal structure. It is postulated that the phenomenal outcome of binding, i.e. the three-dimensionally distributed and extended phenomenal structure of human experience, is the expected first-person outcome of three-dimensionally distributed neurophysical structures being monitored at the domain of a fourth spatial dimension.*

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1. Introduction

This paper is a study of the relation of phenomenal space to the brain as it is realized in the binding event. It focuses on the basic dimensional and spatio-temporal structures of phenomenal and physical spaces in line with Chalmers' (1995) suggestion that searching for the 'psychophysical principles connecting properties of physical processes to the properties of experience' can provide the bedrock for a science of consciousness. Obviously, the search for law-like general principles leads to generalized expressions that describe the essential core and structure of the relations involved. Bearing this in mind, it is appropriate to stress that what lies behind these technical expressions is normal human experience and its elementary structures familiar to everyone in everyday life.

The enigmas of explaining consciousness and relating it to phenomena described by the natural sciences are a persistent challenge. A blind spot detected in the field of consciousness studies could nevertheless provide a path to resolve these problems. When looked at carefully, one realizes that there is one largely ignored and unrecognized structure that appears repeatedly when different aspects of the structures displayed by phenomenal consciousness are explored. This repeatedly emerging structure is the spatio-temporal structure of a three-dimensional plane of simultaneity.

In human everyday experience, on the phenomenal level, the three-dimensional plane of simultaneity is displayed in phenomenal space and one's volumetric body experience. One experiences external items and locations of the body as three-dimensionally extended and distributed. On the neurophysical level, the three-dimensional plane of simultaneity is a necessary condition for binding. For binding to take place, one has to have a simultaneous experience of events at three-dimensionally distributed neurophysical locations (Revonsuo, 1999; Smythies, 2012). A strong isomorphism is displayed. Human everyday awareness involves the simultaneous experience of distributed phenomenal items and yet the integration of three-dimensionally distributed neurophysical events in the binding process eludes empirical explanation.

A major issue arises when one realizes that the three-dimensional plane of simultaneity, even an infinitesimally small one, is an explicitly forbidden structure in the scenario of relativity physics (Minkowski, 1909). The main theme of this paper is how the relationship between the three-dimensionally situated phenomenal structures

of human experience and the three-dimensionally distributed neurophysical structures of the brain can be described and how this issue relates to the basic principles of relativity physics.

2. Views on Spatial Structures Related to Consciousness

2.1. Basic views

A prevailing view in scientific texts is that phenomenal space displays the spatial structure of 'ordinary' three-dimensional space (e.g. Velmans, 2009). This view essentially holds that the experienced three-dimensional volumetric extension of phenomenal space is a straightforward indication of phenomenal space being three-dimensional (*ibid*.). At face value, no problem seems to arise. However, some researchers and scientists have paid attention to the specious relation between the physical and phenomenal spatial domains.

Descartes (1641/2013) famously asserted that the defining nature of the mind is thought, which he saw as an incorporeal substance that is not located in space and lacks the spatial attributes of the extended body and physical objects. He asserted that neither shape nor extension, nor local motion in the physical sense, can be attributed to mental events. He held that the mental and the physical are mutually exclusive categories.

Colin McGinn (1995) states that consciousness (phenomenal events) does not fit well with the ordinary spatial world. He maintains that events of consciousness cannot be observed from the third-person perspective, that they neither occupy particular places nor have detectable spatial properties, and that the perceived solidity of material objects has no application to mental phenomena. In the face of these anomalies, he asks how something non-spatial (non-extended) in the physical sense can emerge from spatially extended neurophysical events and configurations and calls for a revision of our basic conception of space.

Henri Poincaré (1905) regarded geometrical (physical) and representative (phenomenal) spaces as distinct structures. He saw items of representative visual space as reproductions of our sensations that cannot be arranged in the same framework as external objects in three-dimensional geometrical space. He saw the apparent three-dimensional structure of representative space as a convention, i.e. as a kind of a conclusion one has reached by being educated by experience.

Having analysed the structures of geometrical and representative spaces, Poincaré concluded that the structure of representative space cannot be said to be three-dimensional. However, he gave no explicit definition of the dimensional structure of representative space.

Andrei Linde (1998) has suggested that consciousness has intrinsic degrees of freedom that deviate from those of the 3+1-dimensional physical reality. He states that neglecting these degrees of freedom leads to a fundamentally incomplete description of the universe. He considers the possibility of introducing a space of elements of consciousness, e.g. 'my red, my blue, my pain', which could be in a sense even more real than the material objects of natural scientific observation. His suggestion that consciousness has degrees of freedom of its own and that there is a space of elements of consciousness suggests that physical and phenomenal spaces are not equivalent or identical structures.

To summarize, these authors have expressed views according to which phenomenal space and first-person phenomenal experiences display spatial structures and phenomena that are not identical to structures and phenomena of the 'ordinary' three-dimensional space of classical physics.

2.2. The Broad-Carr-Smythies hypothesis

To tackle the apparent incompatibility of physical and phenomenal spaces and to address problems related to the ontology of phenomenal items and events, some philosophers and scientists have proposed the existence of higher-dimensional structures.

C.D. Broad (1923) proposed a model where 'sensa' of all kinds and scientific objects literally have places (are located) in a common higher-dimensional quasi-space. In Broad's scenario, physical and phenomenal spaces are sections of this higher-dimensional quasi-space. Broad proposes two modes of time. Phenomenal space is seen as consisting of the three standard spatial dimensions plus one dimension of real time — i.e. the 'now'. This four-dimensional cluster is seen to be in motion along the time axis of the 3+1-dimensional physical (block) universe, which constitutes the human experience of 'now' and the passage of time.

Bernard Carr (2015) has proposed a multidimensional model where physical and phenomenal spaces are cross-sections of a higher-dimensional communal space (see Smythies, 2014a). Carr relates mental space to the Randall-Sundrum version of M-theory, which

regards physical space as a four-dimensional (3+1-dimensional) brane in a higher-dimensional bulk (Carr, 2021). In addition to sense-data-based phenomenal space, Carr's model incorporates esoteric and supernatural experiences, dreams, out-of-body experiences (OBEs), and near-death experiences (NDEs) which are not based on physical sense-data, and suggests that these experiences correspond to real events that take place in sections (or branes) of the higher dimensions of communal space.

In a similar move, John Smythies (2003) has presented a theory of 'material dualism' whose basic suggestions are in line with the theories of Broad and Carr. Smythies (2014a) cites Carr's view of four-dimensional phenomenal and physical spaces as cross-sections of a five-dimensional universal structure. Smythies suggests a distinct consciousness module that is located outside the physical realm of the brain in a dimension of its own. In this scenario, neurophysical events of the brain are causally related but not identical to the contents of phenomenal space. Smythies suggests that the consciousness module encloses phenomenal space which is composed of sensory and image fields and intersects physical space in a higher-dimensional common (communal) space. All human experiences are suggested to occur exclusively in these sensory and image fields which can neither be detected nor assigned locations in physical three-dimensional space. The cross-section of phenomenal space and the neurophysical structures located in physical space is thought to be the physical interface for causal bidirectional interactions between physical and phenomenal spaces.

The above theories share essentially the same view of the structures displayed in the relationship between physical and phenomenal spaces. Smythies (2014a) coins this shared view the Broad-Carr-Smythies hypothesis. The scenario presented in the Broad-Carr-Smythies hypothesis, especially the views of Carr, suggests multi-dimensionality that is not confined to one higher spatial dimension. However, the aim of this paper is not to explore the whole array of human mental phenomena including dreams, NDEs, and OBEs. Rather, the focus is on the most elementary necessary condition of the binding event and the subsequent emergence of the spatio-temporal structure of phenomenal space. This is postulated to require at least one transcendent spatial dimension. This is not meant to imply a position regarding the total number of dimensions that could be associated with phenomenal consciousness or physical space.

A shared view of this study with the Broad-Carr-Smythies hypothesis as presented by Smythies (*ibid*.) is that phenomenal space and phenomenal items cannot be detected or outlined as parts of physical space or assigned verifiable locations in that space (Broad, 1923; Smythies, 2014b; McGinn, 1995). This can be seen as an elementary arrangement indicating that phenomenal space displays higher dimensionality. What this study adds to this picture is that the spatio-temporal structures involved in binding and experienced in phenomenal space constitute another strong indication of higher dimensionality.

The Broad-Carr-Smythies scenario does not explicitly focus on the spatio-temporal structure of phenomenal space or advocate explanations of binding. In Smythies (2012, pp. 229–30), one paragraph can be found where he refers to the integrative properties of phenomenal space as a solution to the binding problem. He states that 'whereas different aspects of a visual sensation are processed in widely separated regions of the brain, the phenomenal visual outcome is (re)presented as an integrated whole' (*ibid.*). He takes notice of the integrative properties of phenomenal space without, however, analysing the spatio-temporal structure of phenomenal space or focusing on the dimensional-structural necessary condition of these integrative properties.

2.3. The combination and independent significance of spatial and temporal information

This paper acknowledges, in line with Broad, that the 'now' is the necessary temporal framework for human first-person experience and the emergence of phenomenal items and structures (see Broad, 1923; Carr, 2021). However, the main focus of this paper is on the spatial aspect of human everyday experience. At the heart of this approach is the notion of volumetrically distributed neurophysical events being phenomenally experience-detected[2] simultaneously in first-person experience.

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[2] I use the phrase 'experience-detected' and its associated terms to express the basic arrangement displayed in human first-person experience, whereby one does not experience (detect) neurophysical events or neuro-anatomical structures *per se* but by way of detecting phenomenal events and items in the phenomenal field. Experiencing phenomenal events and items in the phenomenal field is the only available way one can 'detect' one's neurophysical structures and events in one's first-person experience. In this sense, an experience is a kind of detection of neurophysical events.

When the basic postulates of the space-time concept of relativity physics (Minkowski, 1976) are applied to this approach, its basic notion of space and time as inseparable is essential and must be taken into account. Minkowski writes: 'The objects of our perception invariably include places and times in combination. Nobody has ever noticed a place except at a time, or a time except at a place', and 'Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality' (*ibid.*). Despite this, he acknowledges that '…I still respect the dogma that both space and time have independent significance. A point of space at a point of time, that is, a system of values x, y, z, t, I will call a world-point' (*ibid.*).

In this scenario, mere spatial or temporal information cannot describe an actual neurophysical event. Both spatial and temporal aspects are elementary parts of the description of neurophysical reality. In line with this, a logical step is to postulate that first-person integration of information of actual neurophysical events and structures in binding implies an integrating phenomenal relation to both their spatial and temporal aspects. This can be seen to require a first-person perspective that displays both spatial and temporal degrees of freedom. On the temporal aspect, for the additional time-dimension (degree of freedom) of the moving 'now' that integrates the scattered times of relativity physics into a unified experience, and the associated (phenomenal) quasi-space that moves along the time-axis of the block universe, see Broad (1923). However, the focus of this paper is on the 'other side of the coin' — the spatial aspect of human experience, and in particular the spatially efficacious degree of freedom necessary for integration of information of distributed neurophysical events in binding. This degree of freedom is called the fourth spatial dimension.

2.4. On the fourth spatial dimension

In this paper, the fourth spatial dimension is not seen as something one can observe or detect in three-dimensional space or illustrate in terms of three-dimensional structures (see Hinton, 1902), but as a degree of freedom that enables a perspective and a subsequent integrating phenomenal mechanism relative to three-dimensionally distributed neurophysical events and configurations. The postulated transcendent 'direction of extension' of the fourth spatial dimension that enables this integrating perspective cannot be illustrated in terms

of a right-angle direction relative to the three ideal directions of 3D space, which would be the traditional way of defining a spatial dimension. No such direction can be demonstrated. In line with this, it is well-established (McGinn, 1995; Smythies, 2014b) that phenomenal space and phenomenal items cannot be assigned verifiable locations in physical three-dimensional space. The direction of extension of phenomenal space is, like that of the fourth spatial dimension, imaginary in respect to 3D space and empirical third-person natural scientific detection (McGinn, 1995; Smythies, 2014b).

2.4.1. Poincaré's proposal, bodily experience, and binding

Henri Poincaré (1905, pp. 79–81) proposed imagining the fourth spatial dimension as a visual perspective on a three-dimensionally extended volumetric structure viewed simultaneously from multiple angles without having to change position in relation to it. A point of view that enables such multi-perspectival visual observation cannot be located in 3D space, while, somewhat surprisingly and paradoxically, the structure of experience it enables is familiar to everyone. An exemplar displaying this multi-perspectival structure is bodily experience which, however, doesn't come through vision but via an array of sensory experiences. The phenomenal body appears as a volumetric structure with one all-revealing gaze of experience, cast simultaneously from internal and external loci without the point of observation having to change position in relation to the body to sense and experience its opposite sides, volumetric extension, and outward and inward structures simultaneously.

Poincaré's suggested multi-perspectival view on volumetric structures and bodily experience are isomorphic. When the multi-perspectival structure of detection and experience is actualized in relation to the brain, the necessary condition of binding is satisfied. Neurophysical configurations and events at distributed anatomical locations of the brain are experienced, like distributed locations and events of the phenomenal body, simultaneously, from a perspective that enables an all-encompassing integrating relation to neurophysical structures.

3. The Basic Spatio-temporal Structures of Physical and Phenomenal Spaces

The focus of this paper is the elementary spatio-temporal structure of human everyday experience. The aim is not to understand or interpret

what it is that one observes, detects, or experiences, but to describe the basic spatio-temporal structure implied by the fact of conscious experience. In this vein, it is reasonable to postulate that the human experience of the body and of external objects displays the structure of experiencing spatial volumetric extension in a moment of 'now'. Another reasonable assumption is that the multimodal array of human phenomenal everyday experience at any given moment of 'now' (see Dainton, 2004), constituted at multiple volumetrically distributed neurophysical locations, provides an uncontroversial indication of the integrative function that binding and human phenomenal experience display in relation to distributed neurophysical events and configurations (Revonsuo, 1999; Smythies, 2012). This integrating function implies volumetrically distributed neurophysical locations being experienced simultaneously, i.e. as located on a volumetric plane of simultaneity. Understanding this integrating function is one of the central challenges of consciousness studies. It eludes being described in the scenario of relativity physics where the plane of simultaneity is categorically forbidden as a physically implemented structure (Minkowski, 1909).

3.1. The separability principle

The separability principle (Howard, 1989) is an elementary description of the structure of observable physical reality in the scenario of classical relativity physics. The core of this principle is expressed in Einstein's (cited in Fingelkurts, Fingelkurts and Neves, 2010) statement that 'An essential aspect of arrangement of things is that they lay claim, at a certain time, to an existence independent of one another, provided they are situated in different parts of space'. For Howard, this means that the contents of any two (or more) regions of space-time separated by a non-vanishing spatial-temporal interval constitute different physical systems (Howard, 1989). A fundamental implication of this arrangement is that, since in the classical view information transfer between even infinitesimally close physical locations can be achieved only by physical mechanisms that have limited velocities, the speed of light being the uppermost limit, there can be no physically implemented plane of simultaneity between even infinitesimally close physical locations (Minkowski, 1909). Even a non-vanishingly short delay in the transfer of physical information between infinitesimally close locations is enough to overturn absolute simultaneity.

3.2. Phenomenal space and direct realism

In strict physical description, detections of external events and objects are delayed local events that take place at neurophysical locations of the relevant sensory organs and sensory nervous system as a consequence of receiving signal information from external physical sources. The temporal gap between the sending of a signal and it hitting the boundary of the relevant sense organ implies that physical and phenomenal items are necessarily distinct entities (see also Hatfield, 2011, 2.6). In line with this, direct (naïve) realism, the view that the observer is somehow in direct undelayed contact with external physical sources of information, has largely been refuted. What is experienced is not the external physical objects or sources of information themselves, but virtual phenomenal replicas of them constituted by neurophysical processes at locations of the sensory neural system (see Smythies, 2014b, pp. 185–7). Phenomenal virtual items cannot be assigned locations or detected in classical 3D physical space as some kind of delayed reflections of the 'original' physical objects or events. They do not signal in any physically meaningful or detectable way and are experienced in absolute simultaneity despite the apparent spatial separation between the observer and the experienced phenomenal item. There is nothing physically describable 'out there' outside the boundaries of sense organs and locations of the sensory neural system that could physically correspond to one's phenomenal experience of an external item located in the depth direction, outside the brain, in absolute simultaneity (Hatfield, 2011, 3.3; Smythies, 2014b).

3.3. The problem of phenomenal simultaneity

Here we confront an essential problem that concerns our everyday experience of volumetric extension and of phenomenal items experienced to be located as spatially separate in the depth direction. Our everyday experience displays six spatial degrees of freedom, i.e. ideal directions of outward extension in which an object can be detected to move, be located, or extended. These six degrees of freedom are manifested as the directions back/forth, left/right, and up/down. Jointly these directions constitute one's everyday experience of phenomenal volumetric extension in three ideal directions represented by the x, y, and z coordinates in a system of coordinates.

When one believes, as is most commonplace in everyday life, and in the spirit of direct (naïve) realism, that one is experiencing and describing the structure and degrees of freedom of external physical

space (Poincaré's geometrical space), one is in fact experiencing and describing the structure and degrees of freedom of phenomenal space (Poincaré's representative space), i.e. the three-dimensional plane of simultaneity one experiences as a volumetric structure and which extends phenomenally in the six directions of depth (see Smythies, 2014b, p. 186; Lehar, 2004). The fundamental problem is that, according to relativity physics, the phenomenal spatio-temporal structure, i.e. spatially spread simultaneity extending in the six ideal directions of depth, is a structure that cannot be implemented physically in 3D space (Hatfield, 2011, 3.3). One's empirical relation to space concerns in the first place the experienced structure and degrees of freedom of phenomenal space and, only secondly as a structurally and functionally valid conclusion, external physical space (see Poincaré, 1905).

3.4. The separability principle and phenomenal space

A core implication of the separability principle with respect to the relation between phenomenal and physical structures and spaces is that in whatever spatial direction you experience the spatial extension of a phenomenal item or structure, however minuscule, the way the item is experienced doesn't correspond to a plane of simultaneity between locations of the observed physical structure or between the observer and the external physical object. The general principle would be: the experienced n-dimensional extension of a phenomenal structure does not correspond to a physically actual plane of simultaneity realized between loci of the corresponding n-dimensionally extended physical structure. (1) The detected plane-like two-dimensional phenomenal extension of a visually observed surface-like configuration, (2) the volumetric extension of the phenomenal body, and (3) the experienced three-dimensional volumetric extension of phenomenal space and its spatial extension in the depth direction are all structures that don't correspond to physically realized simultaneity between loci of the detected or experienced corresponding physical structure. Despite this, one experiences spatially distributed points of experienced phenomenal structures simultaneously in everyday phenomenal experience.

3.5. The multimodal phenomenal space

It is common to equate phenomenal (perceptual) space with the visual field. In this regard, one background assumption of this paper must be

made explicit. In this paper, the volumetric structure of phenomenal first-person experience is not seen to be confined to any specific sensory modality, e.g. vision. On this issue, see for example Dainton's (2004) and Chalmers' (1995) descriptions of the multimodal scenes of human everyday experience. Rather, the whole array of human sense-data-based multimodal experience — body experience, vision, the auditory field, touch, and taste/smell — can all be seen to be situated and experienced in a volumetrically extended general framework, i.e. phenomenal space. For instance, the auditory field can give information about the locations and movements of sources of information situated outside the visual field, e.g when you hear somebody speak or move behind you. Likewise, body experience gives us information of anatomical loci inside or at the backside of the body, from sources outside the visual field (see Section 2.4.1). Focusing on the spatial structure and geometry of one specific sensory mode (vision) would miss the point of overall volumetric extension as a pervasive feature of all human sense-data-based phenomenal experience.

3.6. The elementary difference between physical and phenomenal spaces

In this paper, the three-dimensional space of classical physics and the phenomenal three-dimensional plane of simultaneity of human experience are postulated to be fundamentally different kinds of structures. Therefore, the concept of phenomenal space as three-dimensional is replaced by the concept of phenomenal space as a three-dimensional phenomenal plane of simultaneity. We have thus:

(1) The three-dimensional space where physically actual objects are located and where signals and impulses originating from those objects travel with limited velocities and hit the sense organs (Poincaré's geometrical space).
(2) The phenomenal space of human experience, the phenomenal three-dimensional plane of simultaneity, where one experiences unsignalling external items in the depth direction and distributed loci of the phenomenal body in absolute simultaneity (Poincaré's representative space).

This paper postulates that the phenomenal space of human experience, which allows us to locate and monitor spatially extended and distributed items as situated on a three-dimensional phenomenal plane of simultaneity, displays dimensional structures and degrees of free-

dom that transcend those of the 'ordinary' three-dimensional space of classical physics.

4. The Transcendence Principle of Detection (TPD): Detecting and Experiencing Dimensional Structures

4.1. The TPD and the story of Flatland

The main postulates of this paper are derivations from the idea that there is an elementary relation between an experienced phenomenal dimensional structure and the spatial degrees of freedom necessary for that experience. The core idea is that experiencing or detecting a physical structure as spatially n-dimensionally extended and distributed is enabled by degrees of freedom of an n+1 dimension, which enable an integrating perspective to the observed n-dimensional structure. This aspect is central to Abbott's classical story *Flatland* (1884). In the story of *Flatland*, degrees of freedom of the spatial domain of Flatland determine and explain how an inhabitant of Flatland sees and perceives external objects. The spatial degrees of freedom of two-dimensional Flatland allow for detecting external objects as one-dimensional lines. To see the two-dimensional extension of Flatland and its objects as two-dimensionally distributed, the observer has to move in the direction of the transcendent third spatial dimension. The degrees of freedom of the third spatial dimension enable this to happen. This seems to be indisputably and intuitively self-evident. According to this arrangement, detecting Flatland as a two-dimensional plane-like structure is proof of the detection taking place at a locus in the direction of the third spatial dimension. This arrangement exemplifies the core of the empirical and observational-structural principle introduced in this work, coined the 'transcendence principle of detection' (TPD). The TPD states that the necessary condition of detecting an n-dimensionally extended physical structure or configuration as an n-dimensionally extended phenomenal structure is realized by the transcendent degrees of freedom of an n+1 dimension.

4.2. The ladder of dimensions

The principles of the TPD are realized in how the conscious human observer ideally experiences dimensional structures in his or her phenomenal field. Human detections and experiences of phenomenal structures based on physical sensory information (vision) are seen to

be dependent on the perspective that opens at the dimensionally determined locus of observation.

A locus of observation located in a line-like one-dimensional spatial world catches signals moving in the one direction of extension constituted by that world. When hitting the point of observation it creates (ideally) a phenomenal zero-dimensional point-like trace. A point-like structure can also be understood as the boundary of one-dimensional space. A line-like space ends at a point and, when monitored at a locus of the first dimension, produces ideally zero-dimensionally spread point-like information in the phenomenal field of the observer-experiencer.

A locus of observation located in the direction of the second spatial dimension enables the observing of a one-dimensional physical configuration as a one-dimensionally extended phenomenal line-like structure. Signals, i.e. photons, can reach the eye from directions that create a line-like structure in the phenomenal field. Spatially separate points of the one-dimensional structure are detected as located on a one-dimensional phenomenal plane of simultaneity, i.e. simultaneously and as spatially distributed in the one ideal direction of a one-dimensional structure. The one-dimensional line-like structure can also be understood as the boundary of two-dimensional space. Two-dimensional space ends at a line-like structure and, when monitored at a locus of the second dimension, produces one-dimensionally spread information in the phenomenal field of the observer-experiencer.

A locus of observation located in the direction of the third spatial dimension enables the observing of a two-dimensional physical configuration as a surface-like phenomenal structure extended in the two ideal directions constituted by it. Signals can hit the eye from directions that form a surface-like structure in the phenomenal field. Spatially separate points of the phenomenal two-dimensional structure are detected as located on a two-dimensional plane of simultaneity, i.e. simultaneously and as spatially distributed in the two ideal directions of a two-dimensional structure. A plane-like structure can also be understood to be the boundary of three-dimensional volumetric space. Three-dimensional volumetric space ends at a plane-like structure and, when monitored at a locus of the third dimension, produces two-dimensionally spread information in the phenomenal field of the observer-experiencer.

Together, the TPD and the ladder of dimensions build up a coherent picture. A consistent general pattern can be seen to emerge, i.e. essentially the same integrative pattern (function) is seen to recur

when the view of the ideal observer moves from a lower-dimensional to a higher-dimensional spatial domain.

The use of the letter 'n' in the following presentation of the principles of the TPD is based on the general nature of the integrative relations detected within the domain of first-person experience. Since the ideal human observer experiences spatial extension in three ideal directions (dimensions), the letter 'n' can be assigned values ranging from 0 to 3.

(1) The necessary condition for detecting an n-dimensional physical structure (configuration) as an n-dimensional phenomenal structure is a locus of observation at the domain of n+1 dimensions, which implies
(2) detecting or experiencing a physical n-dimensional structure as an n-dimensionally extended phenomenal structure takes place in an (at least) n+1-dimensional space, and
(3) monitoring an n-dimensional structure at a locus of an n+1 dimension creates n-dimensionally distributed information in the phenomenal field of the observer.

When we expand the ladder of dimensions one dimension further, we see that straightforward extrapolation leads to a consistent description of the emergence of the elementary structure of human spatial experience.

A locus of observation-experience located in the direction of the fourth spatial dimension enables the observing of a three-dimensional physical configuration as a phenomenal three-dimensional volumetric structure. Spatially separate points of the phenomenal three-dimensional structure are detected as located on a three-dimensional phenomenal plane of simultaneity, i.e. simultaneously and as spatially distributed in the three ideal directions of a three-dimensional structure. A volumetric structure can also be understood to be the boundary of four-dimensional space. Four-dimensional space ends at a volumetric structure and, when monitored at a locus of the fourth dimension, produces three-dimensionally, i.e. volumetrically, spread information in the phenomenal field of the observer-experiencer.

4.3. A note on M-theory

Further extrapolations and dimensions (values of 'n' bigger than 3) would exceed the scope of ordinary first-person experience of spatial extension and are not addressed in the model at this point.

Subsequently, the question of the number of dimensions (values of 'n') that could ultimately be associated with the model is left open, as is the possible relation of the postulated fourth spatial dimension to the extra dimensions of M-theory. Humans experience spatial extension in three ideal directions, so it is unclear how to relate further extrapolations and higher dimensions to human spatial experience. Nevertheless, exploring the relation of the presented model to the dimensional structures postulated by M-theory and its seven compactified spatial dimensions is an intriguing challenge. On the issue of compactified extra dimensions, see Greene (1999). At this point, some substantial questions arise: (1) do the (any of the) postulated compactified extra dimensions display transcendence relations akin to those displayed in our 'ordinary' 3D world and described by the ladder of dimensions?, (2) are (any of) the compactified extra dimensions sufficient for accomplishing integration of neurophysical information on the brain scale?, and (3) can (any of) the compactified extra dimensions enable the scale of human first-person phenomenal experience of spatial volumetric extension? Hasty generalizations and conclusions on these issues are not warranted at this point. Further enquiry is needed.

5. On Binding

5.1. Binding and emergence

An essential notion in contemporary consciousness and brain studies is that there is no physical locus ('Cartesian' consciousness centre, see Dennett and Kinsbourne, 1992) or a single anatomical hub (Baars, Franklin and Ramsoy, 2013) in the brain where neurophysical signals and impulses would have to arrive in order to 'reach' consciousness located in that centre and be thereby bound together and experienced. The prevailing view is that the brain is an uncentred structure, i.e. that at any moment of the dynamical evolution of psychological time, the evolving 'now', one experiences simultaneously volumetrically distributed neurophysical events that don't display detectable mutual or multilateral undelayed connections at the moment of being simultaneously experienced. Binding thus understood as integration, i.e. a simultaneous experience-detection of events at spatially distributed neurophysical locations, is a necessary condition of all brain-based human experience.

Classical connections and interactions between locations on an n-dimensional plane in line with the separability principle and the basic principles of relativity physics cannot constitute a physically realized n-dimensional plane of simultaneity on the n-plane. When this principle is extrapolated and applied to the relation between phenomenal space and neurophysical structures of the brain, it states that the volumetric three-dimensional phenomenal plane of simultaneity displayed by phenomenal space and distributed items in it, constituted by three-dimensionally distributed neurophysical events, does not correspond to a physically actual three-dimensional plane of simultaneity realized between neurophysical locations. This makes the outcome of binding, the volumetric three-dimensional phenomenal plane of simultaneity of human everyday experience, constituted by three-dimensionally distributed neurophysical events, a strongly emergent structure in relation to classically realized connections and interactions between neurophysical events and locations.

5.2. Discussion on absolute simultaneity and binding

The multimodal array (vision, hearing, touch, taste) of human phenomenal experience at any moment of the evolving 'now' indicates that one experiences, as a phenomenal outcome of binding, simultaneously events at multiple sensory areas in the brain. In this respect, it is noteworthy that the structure of a plane of simultaneity and the concept of simultaneity, seen as necessary for binding, is an 'all or nothing' notion that, strictly speaking, entails absolute spatially spread simultaneity between neurophysical loci. Temporal delays that are negligibly small in the scale of human temporal experience, and thus not detected, are, despite this, physically real and raise eventually all the problems that arise if information is seen to occupy only one location at any moment. This is well illustrated in the Minkowski space-time diagram (Minkowski, 1909). However gently the ascending world line of a moving item climbs relative to the time-axis (the time-direction), i.e. however short the time needed to move from a point in space to another, the item will always, at any moment, correspond to only one location on the space axis. Only a world line parallel to the space-axis covers multiple locations at any moment, i.e. only unlimited velocity enables physically implemented spatially distributed simultaneity in the Minkowski representation.

If one is committed to classical physical explanations, an elementary issue is to assign a time and a place for an event being explained. If, in

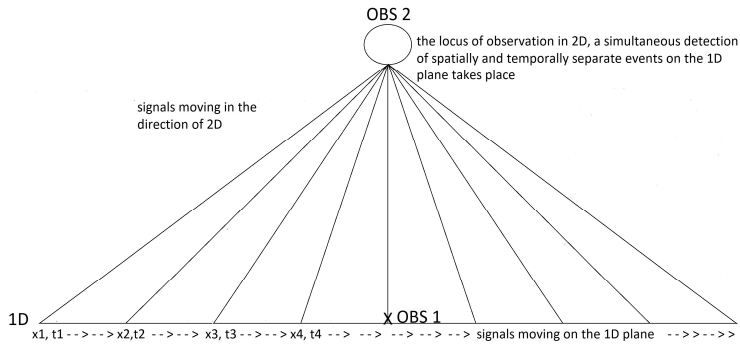
line with this, first-person integration of information of distributed neurophysical events is seen as an event describable in classical terms, one confronts the unresolved enigma and problem of when and where, at which point or points in space and time, the overwhelming multiplicity of bi- and multilateral neurophysical information transfer going on in the brain at any moment becomes integrated and physically 'enters' phenomenal consciousness (Dennett and Kinsbourne, 1992). Such specification in terms of the Minkowskian system of spatial values x, y, z, and the temporal value t, is, at least in principle, required if one aims to describe and explain becoming conscious, or 'entering consciousness', as a classical physical event taking place at a world-point of 3+1-dimensional space (see Minkowski, 1976).

It is well-established that integration of events at multiple neurophysical locations, that (binding and) phenomenal first-person experience display(s), cannot be described as an event taking place at a single point or a single anatomical hub in the brain (Dennett and Kinsbourne, 1992; Baars, Franklin and Ramsoy, 2013). In this paper, it is assumed that the structure of a plane of (absolute) simultaneity is somehow realized in the relation of phenomenal consciousness to the brain. If classical connections and interactions between neurophysical loci fail to accomplish this integrating structure, we are left with the option that this structure is accomplished by a psychophysical mechanism (principle) that does not require classically implemented simultaneity between neurophysical loci. This paper postulates that a transcendent locus where events in the brain are monitored and experienced as a phenomenal plane of simultaneity enables such a mechanism.

5.3. Integration of an uncentred structure: a schematic illustration of the TPD in 2D

The apparent physical separation and unconnectedness of neurophysical events that constitute the contents of consciousness at any moment can be seen as a major source of embarrassment surrounding the problem of binding.

The diagram below demonstrates an elementary arrangement in 2D that enables the simultaneous observation of space-like separated events on a 1D plane although signals carrying information about them don't 'know' of each other in any physically verifiable way on that 1D plane at the moment of detection.



Signals x1…xn, having the same constant velocity, carrying information of the corresponding events x1, x2, … xn happening at times t1, t2, … tn, are sent simultaneously to two observation points located in one- and two-dimensional worlds. Signals originating from spatially and temporally separate events on the 1D plane hit the locus of observation in 2D simultaneously from different angles (directions) thus making possible the delayed simultaneous phenomenal visual detection of spatially and temporally separate events on the 1D plane.

Because the route x1–x2–OBS2 is longer than the route x1–OBS2, signal x2 must, in order to hit OBS2 simultaneously with signal x1, be sent before information of x1 has hit its locus of emission. Emission of signal x2 happens thus outside the signal (light) cone of x1.

Because signal x2 is sent before signal x1 hits its locus, it is detected before x1 at the locus of observation (OBS1) on the 1D plane. Signals carrying information from spatially and temporally separate events x1…xn that hit the observation point in 2D simultaneously from different angles, and are thereby distinguished spatially in the visual phenomenal field, are distinguished temporally on the 1D plane by hitting a locus of observation on the 1D plane at different times.

The locus of observation enabling the detection of one-dimensional line-like extension cannot be located on the 1D plane. Classically realized connections and interactions between loci on the 1D plane give no basis for concluding that such a simultaneous detection takes place in 2D. There is no physical event on the 1D plane which would indicate the moment of simultaneous detection of signals x1…xn in 2D.

The diagram illustrates an arrangement whereby the spatially extended simultaneous phenomenal observation of events on the n-

plane is enabled by degrees of freedom of n+1 dimensions. The structure of this arrangement is essential to the problem of binding.

The diagram shows that the simultaneous detection of signals x1…xn in 2D does not require an integrating 'Cartesian' gathering locus in 1D. The signals being simultaneously detected in 2D do not have to meet or 'know of' each other in 1D by classical physical mechanisms at the moment of simultaneous detection in 2D. Here we have a demonstration of how separate loci of an uncentred structure in 1D can be detected simultaneously and as spatially distributed and extended in 2D. This is a simplified picture of the essential structure of the strong emergence displayed in binding. When generalized and extrapolated, this is a structure of detection and experience in accord with the prevailing notion of the uncentred brain and the respective problem of binding which cannot be detected as an event taking place at an integrating 'Cartesian' locus (Dennett and Kinsbourne, 1992) or a single anatomical hub in the brain (Baars, Franklin and Ramsoy, 2013).

5.4. Binding as experience-detecting the brain as a boundary of four-dimensional hyperspace

In the scenario described by the TPD and the ladder of dimensions, the detection of a physical object or structure as n-dimensionally extended is a first-person experience of an observed n-dimensional boundary of n+1-dimensional space, the detection of which produces n-dimensionally distributed phenomenal information in the phenomenal field of the observer. When this principle is extrapolated and applied to the binding event, it states that the elementary phenomenal outcome of binding, the three-dimensional (volumetric) spatial distribution of phenomenal items constituted by three-dimensionally distributed neurophysical events, is the expected outcome of an act of experience-detection where events and structures of the three-dimensional volumetric brain are being monitored at the spatial domain of a transcendent dimension. In this scenario, the physically actual three-dimensional brain is seen as a three-dimensional boundary of a four-dimensional hyperspace, i.e. phenomenal space. In line with the principle that observing-experiencing an n-dimensional boundary of n+1-dimensional space creates n-dimensionally distributed information in the phenomenal field of the observer, this scenario predicts that an experience-detection of three-dimensionally distributed neurophysical events and structures of the brain at the domain of a

transcendent dimension produces three-dimensionally distributed information in the phenomenal field of the experiencer. This scenario describes and explains the elementary spatial-structural relation between neurophysical events of the brain and the three-dimensionally extended phenomenal structures one experiences. This scenario also explains the strong isomorphism between the spatio-temporal structure of the binding event and the subsequent phenomenal spatial and bodily experiences: monitoring and experiencing simultaneously volumetrically distributed neurophysical events of the brain at the domain of the transcendent fourth dimension creates simultaneously experienced, volumetrically distributed information in the phenomenal field of the observer-experiencer.

6. In a Nutshell

The phenomenal domain of human first-person everyday experience displays efficacious degrees of freedom that enable binding, an integrating perspective to volumetric configurations of the brain in the same vein as three-dimensional space enables integrating perspectives to one-dimensional line-like and two-dimensional plane-like structures. It is efficacious in ways that a fourth spatial dimension would be expected to be by straightforward extrapolation.

Time is treated as the fourth dimension in relativity physics. Somewhat like time, the transcendent spatial dimension postulated in this study cannot be detected, measured, or outlined as three-dimensional spatial extension in 3D space. Despite this, it gives rise to the human phenomenal everyday experience of volumetric extension (see the TPD and the ladder of dimensions, Section 4.2).

Here are some essential points supporting the view that the transcendent spatial dimension of a hyperspace constitutes the domain of phenomenal space where phenomenal events and structures of consciousness are bound together and experienced.

(1) Simultaneous phenomenal experience of spatially distributed items and experiencing spatial extension in a moment of ‘now’ display the structure of a plane of simultaneity, which is a spatio-temporal structure that cannot have a physical implementation in the scenario of relativity physics. TPD offers a general scenario where the forbidden structure of an n-dimensional plane of simultaneity can be phenomenally experience-detected as an outcome of monitoring an n-dimensional physical structure at a transcendent locus of the n+1-dimension.

(2) The brain is known to be an uncentred structure. The coming together in binding of phenomenal structures constituted by three-dimensionally spread neurophysical events is an event that cannot be physically detected or assigned a location in the 3D volumetric space of the brain (Dennett and Kinsbourne, 1992; Baars, Franklin and Ramsoy, 2013). Section 5.2 presents an elementary arrangement whereby an uncentred structure, i.e. spatially distributed events of an n dimension that don't have a 'Cartesian' gathering locus in that dimension, can be phenomenally detected simultaneously and as spatially distributed at a locus of the transcendent n+1 dimension. Applying straightforward extrapolation this structure of experience-detection displays the necessary condition of binding by allowing for simultaneous detection of volumetrically distributed neurophysical locations while no undelayed physical connections or interactions between those locations can be detected in 3D at the moment of experiencing them simultaneously.

(3) Phenomenal space and phenomenal items cannot be assigned verifiable locations in three-dimensional space. They seem to be totally absent in third-person natural scientific observation. The dimensional-structural description gives a consistent and coherent scenario where phenomenal items and structures not being detectable or outlineable in physical 3D-space is a straightforward indication of the transcendent dimensional structures that phenomenal space and items in it display in relation to 3D space.

(4) According to the TPD, detection of an n-dimensional boundary of n+1-dimensional space creates n-dimensionally distributed information in the phenomenal field of the observer. The basic structure of phenomenal space, the phenomenal three-dimensional distribution of phenomenal items, constituted by three-dimensionally distributed neurophysical events and structures, is the elementary spatial structure that can be expected to be experience-detected when events and structures of the brain, a three-dimensional boundary of four-dimensional hyperspace, are thought to be monitored at the domain of the transcendent fourth dimension.

(5) The TPD states that the necessary condition of detecting and experiencing a phenomenal n-dimensional plane of simultaneity is a locus of observation at the spatial domain, i.e. in the 'direction' of an n+1 dimension. An experience of phenomenal n-dimensional extension would thereby be proof of the detection

taking place at a locus of an n+1 dimension. When this principle is extrapolated and applied to the human detection and experience of a phenomenal three-dimensional plane of simultaneity, it states that the three-dimensional plane of simultaneity of human experience is empirical proof of human first-person experience taking place at the domain of the transcendent fourth spatial dimension.

7. Conclusion

The volumetric structure of the basic human everyday experience cannot be denied, no more than the existence of phenomenal items that cannot be assigned locations in physical 3D space. The TPD gives a general framework for understanding and explaining these structures and arrangements. If the TPD is a valid statement, then our everyday experience of three-dimensional spatial extension and volumetric distribution of phenomenal items would be empirical proof of phenomenal consciousness being bound together and experienced at a locus of a transcendent fourth spatial dimension. The existence of a transcendent, at least four-dimensional, spatial domain would be proven in the context of exploring human phenomenal consciousness as displayed in everyday experience, not in natural scientific empirical observation, as perhaps would be expected.

8. Prospects for Further Enquiry

8.1. The problem of the mechanism of information spread

> A common hypothesis in current use in this field is the idea that to solve the problem of how NCCs and phenomenal events are related it will be sufficient to pile up more data about each separately and more temporal correlations between them… However this is a category mistake. It will provide evidence that the two *are* correlated, and details of *which* events are correlated: but it does not explain the *mechanism* that is involved in this correlation. (Smythies, 2014b, p. 196)

It has been shown in this paper that the spatio-temporal structures of classical physical mechanisms, e.g. signalling displayed in 3D and described jointly by relativity physics and the separability principle, cannot constitute binding, simultaneous experience-detection of distributed neurophysical locations as an event taking place in 3D. Nevertheless, undeniably, somehow, by some mechanism, information of spatially distributed separate neurophysical events spreads to an

integrating spatial domain where these events are experienced simultaneously and where this information constitutes an experience of three-dimensionally extended and distributed items and structures. This spatial domain — phenomenal space — cannot be assigned a location or outlined in three-dimensional space and the mechanism directed to that spatial domain cannot be physically implemented transmission of signals directed to a locus, i.e. a consciousness centre in three-dimensional space.

Straying into the question of the mechanism by which information of three-dimensionally spread neurophysical structures is mediated to and experienced in phenomenal space exceeds the scope of this paper. The problem that arises is an intriguing starting point for further enquiry.

8.2. Mental time

A core issue in this paper has been to recognize and define the necessary condition of human spatial experience in dimensional terms. However, the question of what is sufficient for the emergence of an experience of existence in the first place is not examined in this paper. A starting point for such an enquiry is again given in human everyday experience.

One experiences spatial structures in the temporal framework of the 'now' (Broad, 1923; Carr, 2021; see also Minkowski, 1976). Mental time is another fundamental cornerstone of human everyday experience. Our most familiar everyday experience gives a firm and well-based incentive and starting point to explore and analyse the issue of mental time and its relation to the presented model.

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