# Memes and their Themata

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**Abstract**- A meme is characterized as a phenotype when it is instantiated as a neuronal state. A thema is an instantiation of a meme as a thought (a thought-meme). It is a Platonic primitive with no attributable location, and it serves as a canonical representative of a class of memes. This class may have both physical and ideal (Platonic) instantiations. The pairing of this memetic phenotype characterization with the Platonic thematic primitive is an example of other pairings in nature that we identify, and in particular, it informs a description of the pairing of the unconscious mind and manifestations of consciousness. An example is given that shows how a neuronal array generates a specific concept (thema).

## 1. Introduction

We describe a correspondence between the pairing of synaptic with neuronal functioning and the pairing characterized by the genotype-phenotype relationship. An extension is made to a pairing correspondence for memetics. A meme is an idea or concept as well as any instantiation of that idea or concept [Dawkins 1999, Blackmore 1999]. Its customary characterization is that of a selfish replicator, spreading culturally from brain to brain. We shall modify this characterization and describe the meme as a phenotype when it is instantiated by a neuronal state, that is, a neuronal array at an instant of time. The instantiation may be real, that is a literal neuronal state, or it may be ideal (Platonic), corresponding to an abstract model of that state. Taken together, these pairings inform a characterization of the unconscious mind and manifestations of consciousness as a corresponding pairing between a neuronal state and what we call a thema. A thema is an instantiation of a meme as a thought, a thought-meme. It is strictly a Platonic primitive with no attributable location. The thema serves as a canonical representative of the memes belonging to a specific class, and so, it can be viewed as the subject, the literal theme of that class. Although Platonic, an example of a thema is developed by employing a model neural net and results of axiomatic set theory [Aczel 1988, Zuckerman, Miranker 2008].

In Sect. 2, we describe the firing of a neuron to be the result of a competition with selection among neurons, thereby enabling characterization of the pairing of synaptic with neuronal functioning as a genotype-phenotype correspondence. The neuronal afferents, comprising the genotype of a successful neuron (one that fires) are selectively strengthened by a Hebbian process [Haykin 2007]; this process characterized as a competitive survival or propagation effect for both the neuron (the phenotype) and the afferents (the genotype). We view this synaptic-neuronal interaction as a process at increasing scales: synapse-neuron-neuronal assemblies of

increasing size. The adjustments to synaptic weights inform a process of recording of information at these different scales.

In Sect. 3, we observe that a meme, taking form (instantiation) as an input to a neural assembly, generates a recording of information in the afferent synaptic weights, that information likewise instantiating that meme. Such information representations inform a competition among neurons for firing, and so they inform as well, a process of selection among afferents for differential strengthening. So the meme's neuronal representation array is viewed as a memetic analog of a phenotype. We see that the meme is instantiated as a particular associative memory that is recorded in the neuronal array whose synaptic weights embody the encoding. So the possible memetic instantiations, one of which is this neuronal array, are phenotypes. The relevant array of synaptic weights takes the role of the memetic genome, and so, in analogy to the gene, to this array's recorded information may be attributed the status of a replicator.

In Sect. 4, the various pairings discussed so far are related to issues of the appearance and evolution of biotic matter, including the associated appearance and evolution of consciousness. We then ask if the pairing of the two different and specialized mind agencies of consciousness and unconsciousness supplies a favorable quality for that evolution. Themata are introduced to address this question. They supply corresponding notions of the phenotype-genotype pairing, a competition with selection, replicators... A notion of a winning thema is introduced, and with it a consciousness thesis. Interpretations and speculations regarding this thesis are developed; in particular the relationship between a thema and a consciousness manifestation is described.

In Sect. 5, we introduce the construct (taken from axiomatic set theory [Aczel 1988]) of an accessible pointed graph and its labeled decoration. We use a result for associating the state of a neural network with such constructs [Miranker, Zuckerman 2007]. Such constructs generate an abstract set associated with a class of neural network states. Indeed that set is the Platonic thema of the class of memes associated with the corresponding states. Using these developments, we construct an example of a collection of memes (with both physical and Platonic members) and its Platonic thema. The notion of a neural correlate of a consciousness manifestation (equivalently of a thema) is introduced. We conclude with observations that connect memes and themata to genetics and differentiation in taxonomic development.

## 2. The selfish synapse

### 2.1 A synapse strengthening as an analogy to a gene replicating, a cohort of synapses

While the gene is described as a replicator, indeed, a selfish replicator, the synapse is not. However both genetic replication and synaptic strengthening are processes that increase the effectiveness of an actor, the gene or synapse, as the case may be. We take the view, that the stronger the synapse, that is, the greater its synaptic weight, the more effective it is. Genes don't strengthen; rather they express their effectiveness through replication. When synapses are joined in a cohort, increasing effectiveness of the cohort is accomplished cooperatively, usually by strengthening some of its members while possibly weakening others.

## 2.2 A neuron firing corresponds to a phenotype succeeding

A gene has fulfilled its role, so to speak, if the phenotype it is a part of succeeds at a competition for survival and reproduces, thereby replicating the gene. We shall say correspondingly that a synapse fulfills its role if the neuron of which it is an active afferent fires. On this view a neuron takes the role of a phenotype. It is deemed to be successful in a competition with other neurons in its environment (the latter specified by neuronal connectivity and activity) for being able to fire if and when it does fire.

## 2.3 Selection

According to Hebb's rule, an afferent synapse increases/decreases in strength if that synapse's activation is positively/negatively correlated with the neuron's firing. We shall argue that this is a selection process. As noted in Sect. 2.2, we say that the neuron is successful as a phenotype if it fires. If an afferent synapse correlates with the firing, we say that it has fulfilled its role (as in Sect. 2.2) in contributing to the production of a successful phenotype. Such synapses are selected from among all the neuron's afferents to be strengthened according to Hebb's rule. An afferent that is negatively correlated with the firing decreases in strength, also according to Hebb's rule. Repeated decreases may lead to the elimination of that synapse, i.e., its extinction. Sustained quietude of a neuron (an expression of persistent lack of success in competing to fire) can likewise lead to its elimination (apoptosis). So we view this Hebbian strengthening/weakening protocol of a synapse as part of a neuronal process of natural selection on its appropriate scale.

## 2.4 Propagation

We shall say that successful synapses propagate, in the sense that they strengthen and endure as described in Sect. 2.3. The synapses that propagate increase their influence on the neuron's functioning in the sense that the neuronal inputs and the array of afferents, counting strength (these features constitute the neuronal analog of the environment for a biotic phenotype), informs neuronal firing, that is, it informs that neuron's success. This is in analogy to how the genes that propagate shape the corresponding phenotype's literal form or functioning during phenotypic development, as we shall see in the following Sect. 3.

## 2.5 Recording of information

Genes and groupings thereof represent the recording of information at different scales[1]. We similarly view the synaptic-neuronal interaction that we have been describing as a process at increasing scales: synapse-neuron-neuronal assemblies of increasing size, and it is known that the adjustments of synapses (strengthening or weakening) inform a process of recording of information at these different scales. Indeed the associative memories stored in the brain are recorded in just this way. Not only memory recording, but also the movement and modification of information by a neuronal assembly is performed by a processing of neuronal activity flowing through the assembly, that processing informed by the afferents, their connectivity and their strengths.

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[1] In malarial infections hundreds of genes participate in such a grouping [Su, Wellems 1996].

## 3. Memes

### 3.1 The meme as phenotype

A meme may be instantiated (encoded) as a distributed input to a neural assembly, the latter then generating a recording of information representing that meme at one or another scale (as described in Sect. 2.5), the scale depending on the meme's complexity. This information array, the recording in the neuronal assembly, specifically an encoding in the synaptic weights, is a distributed representation of the meme. We have seen that such representations play a central role in the competition among neurons for firing, and that these features inform a process of selection among synapses for strengthening/weakening, as the case may be. So the meme's neuronal representation array may be viewed as a memetic analog of a phenotype, a phenotype at one or another scale. The synaptic weights in this array can also be viewed as a memetic analog of a genome, since just as the information recorded in the biotic genome is part of and contains a specification for the biotic phenotype; the information stored in the synaptic component (via the weights) of the neuronal array (that recording constituting what we shall call the memetic genome) encodes and can be exploited to reproduce, that is, to retrieve information in order to copy the meme. Of course the copy, also a phenotype, may take one of many different forms (memetic instantiations), such as another neuronal construct, speech, writing, a physical construction... So there is the customary blurring of the genotype-phenotype relationship[2] in the meme-neuronal pairing. In the latter case there is somewhat of a sharing of roles. Competition and survival are neither conventionally defined nor as cleanly separated as they are in the customary biotic context. These differences may be due in part to a difference of both temporal and spatial scales at which the respective associated dynamics (replication and/or instantiation) develop. We shall see that this blurring feature will elaborate as we progress with our descriptions.

### 3.2 Storage and retrieval of memetic information

The distributed nature of memetic information storage makes for a richer context than the customary biotic genome-phenotype arrangement; the latter may be likened to a random access memory (RAM). The memetic genotype-phenotype arrangement just described may be employed a number of times to record other inputs, that is, to record other memes, all this in a multiplexed manner. So, a number of different memes may share a single neuronal array, that is, they may share a memetic genome and phenotype. While genes may be viewed as fixed[3], their memetic counterparts, the synaptic strengths are in flux. This plasticity in the neuronal assembly-meme context is due in part to a difference of time scales at which the respective dynamics play out. On the other hand, while we certainly do not now know how the biotic phenotype is constructed given its genome, we may expect to recover that is, read out the meme from the memetic phenotype, more explicitly, from the relevant neuronal information array. Of course this requires that an approximation to the encoding of the meme

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[2] While the biotic genotype and phenotype are regarded as complementary, the former is in fact a material part of the latter.

[3] Both genetic replication and Hebbian synaptic dynamics are subject to disturbances. Mutation is the term given to the former and noise to the latter. Of course, genes may be exchanged in reproduction (cross-over).

be used as an input cue to that array. Is there a correspondent to such cuing that is involved in activating and/or deactivating the genes that drive differentiation in phenotypic development?

### 3.3 The memetic replicator

The meme is conventionally described as sharing with the gene the characteristic of being a selfish replicator. From Sect. 3.2, we see that the memetic replicator is manifest in the associative memory, the neuronal array, explicitly in the collection of weighted synapses that encodes the meme. On this picture, all of the possible memetic instantiations, one of which is the relevant neuronal array, are phenotypes and not replicators. We might allow the memetic genome, the relevant array of synaptic weights, the status of a replicator, in analogy to the genetic case.

## 4. Scales, mind and themata

### 4.1 Scales in evolution

Biotic matter first appeared four billion years ago at the molecular scale with simple proteins[4]. With evolution, the scale of complexity in the biotic organization increases until the simplest form with a partitioning into a genome and phenotype pairing is arrived at. This pairing could be identified with the appearance of eukaryotic cells two billion years ago[5]. We can conclude from Darwinian principles that the separation and specialization of roles characterized by this pairing appeared and endured through competition and selection as a favorable arrangement for survival and propagation. Memes may be admitted to the picture when the biotic complexity increases to the level of neurons (memetic phenotypes) and their afferent arrays (memetic genomes), as we have seen. The pairing of a neuron and its afferent synapses also comprises an evolved partitioning of roles (phenotype and genome or alternatively, information processing and instantiation of that information as described in Sect.1) likely favorable to the selection process of evolution. Did memes appear in primitive neuronal organizations or only when assemblies of an adequately elaborated such pairing structure developed? Could memes appear before neurons?

### 4.2 Mind and its consciousness manifestations, other pairings

The mind could be described as the workings within the brain of an individual. While some regard the mind to supervene not only upon the brain but also upon the entire nervous system; some the entire body; some include the environment; some an even grander frame [Chalmers 1996], we shall for reasons of clarity, start with the conventional view that mind supervenes on brain. However we shall see that it is the entire physical body and in some sense the environment as well that is in play. These workings are the processing and movement of information in some neuronal assembly. As this assembly increases in complexity so may the relevant workings. This is a picture of operation at various scales, and we ask what degree of complexity in the

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[4] Some consider certain crystalline structures and prions to be primitive or proto biotic forms [Belkin 2003].

[5] Some consider symbiosis as the critical aspect in the formation of eukaryotes [Margulis 1991].

unconscious workings in brain-mind is required for the emergence of the manifestations associated with consciousness? Examples of such manifestations are

Vision: three-space with its illusion of depth, colors, textures, shadings…
Touch: pain, wetness, cold…
Feelings: fear, joy, love, hope…

We do not rule out the possibility that consciousness in some form could arise with the organization of the first biotic matter [Miranker 2005, Sheets-Johnstone 1998]. Is there a favorable quality obtained for evolution (for selection, strengthening/replication) by such a separation and specialization of function of the two mind agencies of consciousness and unconsciousness[6]? For example, are the manifestations of consciousness a representation of information in a form to make the storage (encoding) and processing of that information more efficient and/or more robust? Can this pairing be described as another variant of the genotype-phenotype type of relationship that we are propounding? If so, what is the concomitant competitive-selection advantage for the underlying phenotypes and their associated representatives? What, in particular, are the replicators, and what is the process of their strengthening? To start to address these questions, we turn to the notion of themata[7].

### 4.3 Themata

Consider the information associated with a neuronal array that we referred to as a component of the mind in Sect. 4.2. We use the term *thema* (thought-meme; see Sect. 1) to describe this information as a virtual construct, that is, a Platonic and not physical instantiation. A thema might be viewed as kind of virtual photographic negative of a meme, and as a phenotype, the associated instantiating neuronal array may be viewed as a kind of print of that negative. An exogenous stimulus supplies the input required to initiate a Hebbian synaptic altering process in the possibly elaborated neuronal array (phenotype) that instantiates the meme upon which the thema supervenes[8]. This associative storage of information is multiplexed, and so, we expect that strengthening one memory record, that is, one meme may degrade others. This type of tradeoff is present at the lower synaptic scale also, where in a collection of synapses, such as the memetic/thematic genome corresponding to the meme being strengthened, some synapses increase while others might decrease in strength (see Sect. 2.1). This information tradeoff is certainly present at larger scales, it being interpretable as an aspect of the methodology of the evolution of organisms.

Themata compete to be strengthened, which is their way of propagating (as with synapses in Sect. 2). Let us propose that there is a winning thema, for definiteness, say the one that corresponds to the array with the most firing neurons, this being one measure of the most active or successful memetic phenotype. We take consciousness to be an ideal quality (a Platonic primitive), and we propose the following consciousness thesis based upon this hypothesized competition among themata.

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[6] Consciousness and unconsciousness may each represent layers of differentiated mental agencies.
[7] Where shall evolution go beyond consciousness/unconsciousness with this paradigm of pairings?
[8] The relationship between meme and thema has a reflexive aspect.

**Consciousness thesis:** The winning thema generates a manifestation of consciousness representative of that thema.

**Interpretation, an agency for propagating the mind:** The generation of a manifestation of consciousness requires an appropriate cue, an exogenous sensory input. Here we see the mind supervening not only on the entire physical body, but on the environment as well, the latter being the source of the cue. If this cue produces a winning thema then, according to the consciousness thesis, the latter's phenotype; a neuronal array that we might call this thema's neural correlate generates a representative manifestation of consciousness. Because of its form, one might speculate that the neural correlate interprets this manifestation of consciousness as a supplementary sensory input[9]. We suppose that this putative input reinitiates the neuronal processing in question, and so further strengthens that thema through its memetic genome (the relevant synapses) via Hebbian processes (as in Sect. 2.3). That is, the underlying meme is further strengthened/propagated. In this scenario, we see that a function of consciousness as an evolutionary development is as an agency for strengthening and enlarging the unconscious, i.e., as an agency for propagating the mind.

### 4.4 Speculations on manifestations of consciousness

We claim that creating the manifestations of consciousness is a learned ability. This creating ability is used repeatedly to develop a repertoire of interpreted (and interpretable) manifestations of consciousness. Referring to the photographic negative-print metaphor of Sect. 4.3, the prints that are the constituents of the repertoire are stored multiplexed within various neuronal arrays as associative memories. The corresponding themata, being Platonic primitives, have no attributable location. Even adults with a highly developed manifestation creating ability and a corresponding repertoire can be presented with a sensory cue that is not readily, indeed if at all resolvable. That is, the information in such a cue defies being parsed into an understandable or logical concept (see Sect. 3.3), neither one that's in the repertoire, nor one that can be taken as a candidate for augmentation of the repertoire[10].

O. Sacks' patient Virgil supplies an illustration of these features [Sacks 1995]. Blinded as a child, a surgery restored Virgil's sight when he was in his fifties. At first, he was unable to fathom (parse) the cues (light flashes and colors) that were presented to his newly functioning visual system. Slowly he developed some of the requisite abilities and a related repertoire of manifestations of visual consciousness, but never to the degree of a normally sighted individual. He never became comfortable with his reacquired visual ability, preferring to sit in the dark using Braille and preferring to rely on his cane to get about.

The machinery of memes and their themata, including the competition in which they engage, is an evolved functionality. This machinery is used in the learning how to develop the repertoire of manifestations of consciousness. We are all invested at building such a repertoire and learning how to manipulate it. The rare cases of feral children demonstrate some of the subtleties of and limitations to this process. Language reveals another aspect.

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[9] Similar reentrant perceptual-like processes are described by O. Sacks, one example of which is referred to as "release" hallucinations, a second as cross activation [Sacks 2007].

[10] In the jargon of formal grammars, the cue is not a (currently) legal sentence.

Some speakers of one language cannot hear certain sounds used in another language. Such sounds cannot be heard in a conceptual sense, that is, their corresponding memes cannot be parsed. How the manifestations of consciousness in the repertoire take the forms so familiar to us remains an open question. (See the list of examples in Sect. 4.3.)

## 5. A Representative for a thema

A given meme may have many forms (phenotypes), both physical and ideal (Platonic). The thema, being Platonic, could have a virtual representative. In this section we present a method for generating one and develop an example.

### 5.1 Themata and APGs

An accessible pointed graph (APG) is a mathematical construct consisting of a collection of nodes with directed edges between certain pairs of those nodes. There is a distinguished node called the point of the APG. Accessibility means that every node in the graph is reachable from the point by a connected path composed of directed edges. (See Fig. 5.1b for an example of such an APG.) Each instantiation of a meme can be made to correspond to an APG, the graph depicting a kind of parsing of that meme. A node is called the parent of its children, namely those other nodes in the APG that are linked to the parent by a directed edge from the parent. So the children of a node correspond to memes upon which the parent's meme supervenes. The leaves of the APG are those nodes that have no children. So leaves may be considered to be memetic primitives. Decorating an APG is a way of associating a unique collection of sets (the decoration) with the APG, one set of the decoration with each node. Call $\Theta$ the set in the decoration of this APG that corresponds to the point. The decorated APG is called a picture (a kind of representation) of $\Theta$. See [Aczel 1988] for details among which is the assertion that the APG in Fig 5.1b is a representation of the concept of the Von Neumann ordinal 2. Different decorated APGs with a common $\Theta$ will represent different phenotypes of a common meme. $\Theta$ is a Platonic representative of these memetic phenotypes, i.e., the construct for the thema we seek. In fact, all of these constructs are Platonic, but as we shall see, some decorated APGs are models of a neural state, namely are examples of a model of a neural network at a specific moment of time. The actual neural state being modeled is a corresponding physical instantiation of the meme in question. (Of course, memetic phenotypes may correspond to physical instantiations other than those provided by a neural state.)

### 5.2 Example

Consider the model neural network composed of three McCulloch-Pitts neurons, *a*, *b*, *c* [Haykin 2007] with the synaptic weights $w_{ba}$, $w_{ca}$, $w_{bc}$ shown in Fig. 5.1a. We specify that neuron *a* is active, that is, its efferent voltage $v(a)=1$, while neurons *b* and *c* are inactive, that is , $v(b)=v(c)=0$. With these data specifications, the network becomes what we have called a neural state. In When the APG (shown in Fig 5.1b) associated with this neural state is appropriately labeled[11] with the specified weight and voltage data and then decorated, the diagram in Fig. 5.1b, a picture of a particular set $\Theta$ results [see Zuckerman, Miranker 2008

[11] Appropriately labeled means that certain sets induced by the weight and voltage data are associated with nodes of the graph [Miranker, Zuckerman 2007].

for details]. In particular, $\Theta = \{B,C\}$, where $B = \varnothing$ and $C = \{\varnothing\}$. Here $\{\varnothing\}$ denotes the set whose only element is $\varnothing$, the latter denoting the empty set. $\{B,C\}$ denotes the set with the two elements $B$ and $C$.

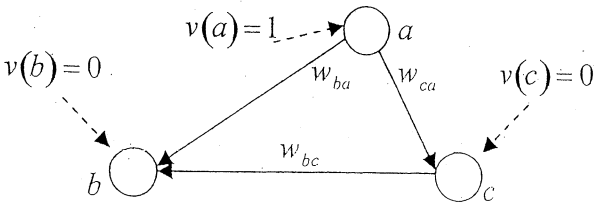


**Fig 5.1a:** Neural state with neurons $a$, $b$, $c$

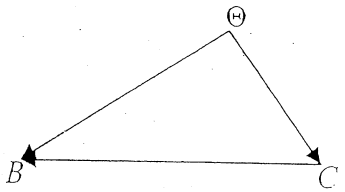


**Fig 5.1b:** Corresponding APG with point $\Theta$ and leaf $B$

**Memes and their thema, neural correlate:** The diagram in Fig 5.1b, illustrating a decorated APG, arises from the neural state in Fig. 5.1a. Since the APG in Fig 5.1b is a representation of the Von Neumann ordinal 2, *Fig. 5.1b is an instantiation of the concept (the meme) of the integer 2. The set $\Theta$ decorating the point is the thema of this meme.* The thema $\Theta$ along with the diagram in Fig. 5.1a are Platonic instantiations. The corresponding actual neural state being modeled (such as by the model in Fig. 5.1a), also a meme, is a physical instantiation of that meme. *Then such a (physical) neural state is a candidate in the competition for generating the manifestation of consciousness (see the consciousness thesis in Sect. 4.3) of the concept of the integer 2.* We shall say that the winning neural state is the *neural correlate* of the thema $\Theta$. (We do not preclude the possibility of a cohort of winners that result in an extensive neural correlate.)

### 5.3 Memes and genetics

We conclude with an observation connecting genetics and differentiation in taxonomic development to memes and themata.

**Memes and chromosomes:** Take a chromosome to correspond to the point of an APG. Take the point's children to be the chromosome's primary constituent groupings of genes. This along with the decoration of the APG generates a set, set-element relationship. Such groupings, which have a temporally changing character, are specified by the biology. Genes come in many types and groupings, so the parent-child relationship can produce several layers in the APG. Moreover, genes or a grouping thereof have a state of activity/inactivity. Other genes and epigenetic processes turn them on/off. This generates dynamics defined on the class of associated APGs, since genes or groupings thereof corresponding to nodes in the APG could be taken to be present only when that gene or grouping is active. This induces dynamics on the sets generated by the associated decorations. These dynamics cause a possible appearance/disappearance of loops inside such APGs, that is, a selected flipping among the associated sets' types (possibly a flipping of these sets between being well founded and not well founded). The appearance of these two set types suggests a connection of the present framework with a development of mathematical foundations of consciousness [see Miranker, Zuckerman 2007]. These authors have shown that those neural assemblies that may form a candidate neural correlate of a meme, generate in turn a collection of decorated

APGs each of which may serve as a memetic phenotype. As we noted in Sect. 5.1, the set $\Theta$ in the decoration that corresponds to the point of such an APG is a Platonic representative of the thema corresponding to the collection of memes in question. Indeed we asserted that this set $\Theta$ could be viewed as the thema itself.

**Differentiation in development:** The messenger RNA and the proteins encoded by the genes (or groupings) also enter into this framework. Such proteins, constituting a first stage in the production of the associated biotic phenotype, correspond to a leaf in an APG, the latter graph characterizing a hierarchy in the differentiated development of the phenotype that ensues.

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