Journal of Integrative Neuroscience

J. Integr. Neurosci. **2026**; 25(8): 52392
https://doi.org/10.31083/JIN52392

Hypotheses and Concepts

Superordinate Concepts – Semantic Sources, Cognitive Properties and Neural Representation

Rüdiger J. Seitz[1,*], Hans-Ferdinand Angel[2], Raymond F. Paloutzian[3]

[1]Neuroscience Network Düsseldorf, Department of Neuropathology, Heinrich-Heine-University Düsseldorf, 40225 Düsseldorf, Germany
[2]Institute of Catechetics and Religious Education, Faculty of Theology, Karl-Franzens University, 8010 Graz, Austria
[3]Department of Psychology, Westmont College, Santa Barbara, CA 93108, USA
*Correspondence: seitz@neurologie.uni-duesseldorf.de (Rüdiger J. Seitz)
Academic Editor: Bettina Platt
Submitted: 30 March 2026 Revised: 26 May 2026 Accepted: 26 June 2026 Published: 13 August 2026

Abstract

Concepts are cognitive constructs that are fundamental to neuroscience. Superordinate concepts such as world, life, and person are widely used in common language but typically ill-defined. In an interdisciplinary approach we present superordinate concepts as three-part accounts that encompass the articulated concepts of objects, events, and narratives. Thereby, superordinate concepts integrate the physical, relational, and narrated nature of our environmental information into comprehensive verbal expressions. Owing to their distributed representations in large-scale neural networks that in addition to the prefrontal cortex involve the temporoparietal cortex and subcortical structures such as the amygdala, superordinate concepts evolve in relation to language development in childhood. They may gain prominent emotional relevance and continue to mature throughout a person's lifetime. Conversely, they are susceptible to neuropsychiatric disorders of the brain that affect cortico-cortical connectivity. In conclusion, superordinate concepts are metastable descriptors of integrated verbalized information that provide a novel perspective on the mind-brain relationship.

Keywords: amygdala; beliefs; concepts; linguistics; prefrontal cortex; temporoparietal cortex; neuropsychiatry

1. Introduction

In the interdisciplinary research field of cognitive neuroscience, the notion of concept has been linked to the categorization of a sensory input [1]. Accordingly, a concept is a cognitive construct that is characterized by a set of specific attributes and typically is labelled with a descriptive term [2]. This is compatible with the notion of natural categories as advanced by Rosch [3]. For example, the categorical domains of color and form have been shown to apply to physical objects and transient events [4]. Importantly, the semantic content of both simple, low-level and complex, high-level concepts has been acknowledged to constitute the basis of the human vocabulary [2]. The notion of superordinate concepts was first coined by Richards [5] and has recently been stated to encompass articulated commonalities of similar low-level concepts [2]. Here, we expand on this proposal from the perspective of cognitive neuroscience and describe its semantic appearance and neural representation.

Neural functions such as perception, action, memory, reasoning, cognition, emotion, and language processing involve common and distinct brain areas as was shown by functional imaging techniques (for an introductory overview see [6]). Moreover, statistical methods have been applied to link the information coming from the external environment with people's internal affective states. This neuroscience-based, statistical approach has been termed active inference and allows us to model the integrated neural representations in the framework of the known cortical-subcortical circuits of the human brain [7]. As implied in our argument presented here, we develop the notion of superordinate concepts on the cognitive level further. Specifically, we describe that they integrate the articulated concepts of objects, events, and narratives and, thereby, encompass the multimodal information of ubiquitous phenomena in the environment. In fact, the terms for such concepts are widely used in various contexts in ordinary language. Thus, on the semantic level, they are tacitly assumed to be appropriate descriptors of such complex phenomena and to be self-explanatory, although usually they are hard to define. Moreover, the integration of three-part accounts to build superordinate concepts is likely to be mediated by large-scale circuits in the human brain that are central to the linguistic processing system.

Here, we first describe a universal categorization of environmental information on the cognitive, linguistic, and neural levels. Second, we review the possible semantic traps concerning the pertinent terms at the linguistic level before we elaborate the properties of superordinate concepts on the cognitive level. Then, we will describe on the neural level, in which way these comprehensive overarching entities rely on an extensive network type of implementation in the human brain. We will show that these networks involve the prefrontal and temporoparietal cortex as well as subcortical structures such as the amygdala. And we will show that they deteriorate insidiously as they are susceptible to neuropsychiatric disorders. Finally, we put this discussion into the perspective of an interdisciplinary discourse between the sciences and philosophy.

2. Natural Categories of Environmental Information

Humans interact constantly with their environment, for example, to protect themselves from physical threats, to retrieve food and to engage with other people for social cooperation. Fruit, vegetables, meat that makes up food, as well as the different tools used for hunting or cracking the shells of nuts or crabs are physical objects. Accordingly, physical objects belong to the first category of environmental information and have pragmatic, somatosensory, visual, olfactory, and gustatory properties. On the cognitive level, subjects employ tactile exploration to develop a probabilistic perceptual representation of the object comprising geometry, heaviness, surface properties, and pragmatic use [8,9]. This is a dynamic process by which the elements are reiteratively synthesized into multifaceted neural representations. Furthermore, bottom–up and top–down processing co-occur throughout this process such that the representations become shaped in a Bayesian sense [10,11,12]. Importantly, the processing speed of these operations is usually quite high, in the magnitude of some 20–40 milliseconds [13,14]. Depending on the contrast of an object against the actual context or on a longer duration of exposure, objects become more readily identifiable against a noisy background [15]. Importantly, there are general multimodal representations that correspond to the different sensory modalities [16]. At the neural level, these probabilistic sensory representations are maintained by local patterns of column-like brain activity, as was described in metabolic and electrophysiological studies [17,18]. Electrophysiological studies have shown that these representations occur in synchronously activated neural assemblies in the cerebral cortex [19,20]. Importantly, monkeys have been shown to be able to acquire differentiated coo-call sounds for different items [21], a phenomenon that has been shown to engage neural resources in close proximity to their perceptive and/or pragmatic representations [22].

In their environment, humans are not only confronted with static objects but constantly experience that whatever they observe may change over shorter or longer periods of time. In fact, these changes affect their own relation to different objects and the relation between different objects. These changes have been conceptualized as events with a beginning and an end [23]. Such events correspond to the second category of natural information. Notably, the perception of events relies heavily on attention and memory functions [24], thereby providing the cognitive capacity to assess the relations of external objects with each other and of different subjects with each other as well as the subject's relation to objects and other subjects. Furthermore, events may attain a motivating relevance, for example, when a human or a non-human primate realizes that the object can be used as a tool, e.g., to retrieve a piece of food. In fact, there is experimental evidence that non-human primates can use tools as if they were integrated into their own body schema [25]. Moreover, items that are ordinarily grouped are processed with greater efficiency than the same number of isolated objects, a process known as "clumping" [26]. Thus, humans and non-human primates have the capacity to perceive the relational fit of objects. On the cognitive level, this capacity can be extended to social interactions. For instance, brain areas have been described to be more engaged when people are observed interacting with each other compared to similarly placed but non-interacting individuals [27,28,29].

Narratives are events of special character. Typically, they are perceived by listening but can also be experienced by reading. They pertain to the universal human capacity to decode sequences of sensory signals such as music and language-based information [30]. Thus, narratives represent the third category of natural information. Specifically, humans are used to telling stories about their own and other people's past, their origins, and their goals, and the fate of a social group or society as well as about concepts concerning the broad spectrum of cultural life [31,32]. These narratives are conveyed by an elaborated linguistic code and are repeatedly presented to children by their grandparents, parents, siblings, and other family members or can be read in books or experienced in other media. The perception of a narrative involves a relatively long processing time, determined by the length and complexity of the stories, extending up to many minutes and even hours. In addition, the same narratives may be interpreted in different ways by different people, which is reflected by differences at the neural level. In recent research, in the participants for whom the narratives shared the same interpretation, the activations that occurred in functional brain circuits involving areas of the default-mode network, language, mirror-neuron, and emotion systems were similar. However, in the participants who interpreted the narratives in different ways, the activation patterns correlated with the magnitude of the differences in the interpretations [33,34].

3. Semantic Challenges in Neuroscience

In recent decades, cognitive neuroscience has made big advances because neuroimaging and electrophysiological methods allow us to observe neural processes and their functionality in the living human brain [6,35]. Many new insights have revolutionized our understanding of how humans think and act. A downside of this development has been that these neuroscientific findings were often explained using terms that do not belong to the semantic field of neuroscience. Many of them either are part of the vast pool of words used in ordinary everyday speech or belong to the realm of philosophy and, thus, have a long tradition of various interpretations. Consequently, at the intersection of behavioural or cognitive neuroscience on the one hand and philosophy and humanities on the other hand, there are numerous notions that have been oversimplified, misleading, or are even products based on false attributions.

From the neuroscience perspective, there are three categories of natural information as described above. They include objects and events that can be perceived with one's senses in the environment and are encoded in the human brain in a probabilistic fashion (Table 1). At the neural level, perceiving sensory information involves a number of different processing modalities and typically results in distributed neural representations that integrate the multimodal properties of objects, including the abstracted core. This abstracted core seems to reflect the general image-like appearance (German: "Gestalt") including the details that characterize the specific items [36]. Perception, including abstraction of the "Gestalt" is a fast, prelinguistic process that takes place outside conscious awareness [13,14]. When one becomes aware of a number of similar objects at the cognitive level, one has recognized their common features as an abstracted concept (German: "Begriff") and labelled them with a specific word. These cognitive processes are more complex, requiring additional neural resources and are, therefore, likely to cause a greater time demand. At the linguistic level, words are arbitrary and ready to use terms, while their meanings are determined by social convention [37]. So-called concrete words reflect the specific sensory perceptions of concrete physical objects and are established during a person's linguistic development in relation to sensorimotor experience [38]. These concepts can be specified into a number of subtypes, each of which encompasses a wide range of different items. This is straightforward for concrete items such as a tree, a building, a human being, or the sun. Note that the items are defined by the composition of their properties that can be perceived with the human senses or by the pragmatic use of the objects. As described above, events have been conceptualized to be made of concrete sensory perceptions with a clear beginning and end [23]. Examples are movements of a being, the tides, seasons, and fire. The corresponding individual items are steps, rising water, summer, and flame as listed in Table 1. The same constellation also holds for narratives and their constituting items that are acquired either acoustically by hearing or visually by reading (Table 1). As it concerns narratives, however, "Begriff" no longer describes the physical interaction of the subject with an object, but rather is a metaphoric expression. Notably, humans segment the continuously incoming information at natural breakpoints, which is referred to as chunking [39].

The interactions of individuals with objects, events, and narratives in their environment involve bottom-up sensory processing and top-down predictive processing. As outlined above, these processes result in the generation of probabilistic neural representations that include abstractions in the form of concepts. These concepts may become emotionally charged because they may be personally relevant to the given individual. Owing to the fact that people typically trust their intuition, they also believe their perceptions. Consequently, the categories of natural information pertaining to the processing of environmental information also apply to beliefs as detailed elsewhere [40].

In addition, there are so-called abstract words that are labels for specifically defined concepts of abstract content [41]. Such terms can reflect comprehensive subtypes of concrete items related to the modality of sensory perception (Table 1). Moreover, abstract words can be defined by narratives and are readily understood, such as those about autobiography, religion, politics, or even eternity. Nevertheless, there are also other terms widely used in ordinary language that comprise multidimensional aspects and, thus, turn out to be difficult to define. Such terms include notions like love, life, world, home, family, etc. Specifically, beyond physical properties, they comprise inherent relational aspects and conceptual dimensions. Thus, each of these aspects alone is insufficient to account for these terms in a comprehensive manner. Rather, one has to appreciate them simultaneously as superordinate integrations (see below). Thus, knowledge in non-neuroscientific fields like philosophy, linguistics, and hermeneutics makes it indispensable to acknowledge what role neuroscience has or will have for a proper understanding of, for example, life and especially human life. To make neuroscientific findings fruitful, however, some hidden traps need to be acknowledged and possibly avoided. First, the preconditions that are propositionally and emotionally embedded in any term have to be clarified on a meta-theoretical level, and second, the relationship between empirical findings and their verbal descriptions must be defined [42]. This will become particularly challenging if one steps beyond the borders of a language or a culture. Although these methodological challenges cannot be solved in a satisfying manner within the limits of this paper, it is necessary to address these semantic preconditions as done in what follows. Given the greater complexity of concepts as compared with items, it can be predicted that during childhood development the use and naming of concrete items occurs at an earlier age than that of abstract concepts.

4. Superordinate Concepts

4.1. Meta-Analytic Labels

Western languages include a number of terms for superordinate concepts that are broadly used in everyday speech and mediate an immediate and fundamental understanding of ourselves and our environment. Given the taxonomy of environmental information as described above, we propose that the superordinate concepts comprise the articulated contents of object-based and event-based concepts about their physical properties and their relational links with the environment. Both determine the personal experience of an individual in pre-linguistic terms [43]. They are com-

Table 1. Semantic terms for concepts and items of the three categories of natural information.

Categories	Concepts	Items
Objects	Tools (pragmatic, sensory, visual)	Hammer, Screwdriver, Knife, etc.
	Furniture (visual, sensory)	Chair, Table, Wardrobe, etc.
	Fruit (visual, sensory, olfactory)	Orange, Strawberry, Melon, etc.
	Noise (auditory)	Bang, Shouting, Engine, etc.
Events	Movements (pragmatic)	Step, Grip, Grimace, etc.
	Tides (visual)	Rising water, Falling water
	Sounds (auditory)	Song, Screaming, Bell, etc.
	Seasons (visual, thermal, olfactory)	Spring, Summer, Autumn, Winter
	Fire (auditory, visual, thermal, pain)	Flame, Ember, Smoke, etc.
Narratives	Stories (verbal)	"Peter Rabbit", "Hansel and Gretel", etc.
	Reports (verbal)	Observations, Experiments, etc.
	Literary works (verbal)	Drama, Novel, Poem, etc.

Legend: The terms reflecting the three categories of natural information are specified by the modalities of neural processing (parentheses). Note that this list is not exhaustive.

plemented by the content of language-bound concepts that reflect the abstract essential identities of narratives. In the next section, we present ten superordinate concepts but predict that there may be many more in Western languages and probably in other languages as well. Importantly, neither the object-based, event-based, nor narrative-based concepts alone are sufficient to appreciate such superordinate concepts in their completeness. Instead, a triadic integration of these three articulated concepts is necessary for us to understand such overarching, umbrella-like superordinate descriptors.

Although the view presented here concurs with the hypothesis that concepts are not codified in the mind but are anchored in materiality [44], we argue for a more specific cognitive neuroscience perspective according to which concepts are maintained by neural codes in the brain. This is so, including when people become aware of them, express their meaning verbally, and communicate it to other people. In fact, superordinate concepts signify conjunctions of neural representations that integrate the articulated content of the three concepts, when any one of them does not by itself suffice to describe or explain the given entity in an adequate fashion (Table 2). It is likely that this integrative function is achieved by means of working memory [45,46]. In comparison, the abstract generation of a concept/term (German "Begriff") departs from the empirical dimension of what has been perceived. Likewise, any reduction to materialism means that the thought pertains only to the here and now and neglects the conceptual dimension. Thus, superordinate concepts are meta-analytic labels for overarching neural representations that integrate both the material and the abstract accounts, which most likely is achieved by oscillatory electric activity in the brain (see below). Because superordinate concepts are triadic in nature, they also include the interrelations between these opposite material and abstract categories.

Table 2. Examples for superordinate concepts.

	Terms denoting natural information		
Concepts	Object-based	Event-based	Narrative-based
Love	Desire	Reciprocity	Charity
Life	Beings	Populations	Eternity
World	Earth/Environment	People	Reality
Home	House/Hut	Neighbourhood	Safety
Me	Body	Individuality	Self
Person	Human Being	Group Belonging	Responsibility
Family	Human Beings	Relatives	Group Identity
Country	Landscape	Citizens	Law
Food	Nutrition	Ingestion	Metabolism
Poison	Powder/Fluid	Victim	Toxicity

Legend: Superordinate concepts integrate the concepts that reflect the three categories of natural information each of them being labelled by ordinary verbal terms. Note that this list is not exhaustive.

4.2. Examples in Ordinary Language

Terms for superordinate concepts are readily used in common language but to define them requires efforts, including attention and working memory. An example of a superordinate concept is love as was realized already in ancient Greek (Table 2). There is the subjective bodily desire (*ἔρως* [*érōs*]), the interpersonal reciprocity of inclination (*φιλία* [*philía*]), and the principle of love, namely charity (*ἀγάπη* [*agape*]).

Another term used similarly and widely in various contexts in ordinary language is the superordinate concept of *life*. As a superordinate, triadic concept, it encompasses three components (see Table 2), which allows an individual to describe its conceptual properties to other people. The first is about the physical properties of a living being such as the warmth of a human body, regular movements of the body such as breathing, and locomotor activities - all of which can be assessed objectively by physiological measurements. In Antiquity, breathing was believed to be the first and most important aspect of human life. Breath was related to the soul in how it was discussed in ancient philosophy (Greek: *psyche*; Latin: *anima*). The second concept concerns the relationships between individuals within their social environment. This initially includes feeding and parental care and then expands to incorporate youngsters into the immediate small group (family), larger groups like friends, acquaintances, and ultimately in a society - all of which can be assessed objectively by physiological and/or behavioural measurements. The third concept is the essence that is expressed verbally by narratives reflecting the abstract notion of life beyond the individual being and across different species. In Christianity, for instance, there is the conceptual belief of an eternal life that is not understood as a prolongation of the kind of life we live on earth. Rather, it was influenced by Plato's understanding of eternity as "without time". In the contemporary scientific era one might instead ascribe it on the molecular level to the genetic code as realized in the DNA in the cell nuclei. Accordingly, to live one's life in a full way means to act in a caring manner consistent with the integrity of one's body, when behaving in the social environment, and with regard to personal success with short-term and long-term goals.

Two additional terms that are widely used in ordinary language to refer to someone's environment are *world* and *home* (Table 2). These terms include individuals' concepts about physical properties such as earth or house as well as about their placements in relation to other objects such as described by the heliocentric system and the neighbourhood, respectively. In terms of narratives, the world provides objective reality and the home provides the notion of safety. At the centre of the personal level, ordinary language has the expression "me" that encompasses the notions of a body, individuality, and the so-called narrative self (Table 2). But the modern concept of a "self" was not developed before the time of the Enlightenment [47]. This accords with the view that the self was considered as a superordinate schema that is involved in the processing, interpretation, and memory of personal information [48]. An important aspect of this idea is that the "self" was defined as an entity signifying the continuity of a person in spite of the continuous change of the person due to exposure to new information and aging [5]. Furthermore, the triadic notion of a body, individuality, and a so-called narrative *self* appears to be comparable to the "bodily self", "related self" and "autobiographical self" as outlined by Northoff and colleagues [49]. Likewise, the notion of "person" can be described as a superordinate, triadic concept with the properties of being human, belonging to a group, and responsibility (Table 2).

Also, the notion of family can be assessed when accounting for their members to be human beings that are relatives of each other and describe themselves as a specifically named group (Table 2). Beyond the family, there is the social construct of a country. A country is made up by the landscape, its humans who interact with the country's institutions and other humans in a formal manner, which is reflected by the term citizens. And finally the integrity of a country is provided by laws that constitute the narrative-based concept of the legal institutions of a country.

The term *food* is a superordinate concept that includes among others the concept *fruit* but evidently exceeds it as it integrates the nutritive substances such as fruit, vegetables, meat etc. with the event of their ingestion and the narrated concept of metabolism (Table 2). The term *poison* encompasses the three different components of superordinate concepts, namely powder or liquid as the physical object, the event of application signifying the poisoner-victim relation, and the narrated concept of toxicity (Table 2).

4.3 Neural Representations

Neural activity is a marker for information processing that can be assessed non-invasively in humans using functional imaging and encephalography-based techniques. For example, information from the environment is stored in memory as patterns of neural activity that represent both the multifaceted sensory and emotional information in distributed large-scale neural networks [46,50]. This encoding occurs so rapidly that it takes place before humans become aware of it [51,52,53]. In addition to the formal sensory information that is processed in the dedicated sensory cortical areas and the amygdala, emotional processing involves the cingulate cortex, the orbito-frontal cortex, and the mid-ventral prefrontal cortex [54]. The amygdalo-cortical connections have been shown to be highly conserved across different primate species, highlighting their important role in affective behaviour [55]. Likewise, the orbitofrontal cortex has been observed in rodents, non-human primates and humans to be related to inference-based behaviour and learning [56]. Moreover, subjective valuation of cognitive effort involved in working memory and speech comprehension has recently been shown to activate the dorsal anterior cingulate and the adjacent dorsal medial superior frontal gyrus relative to valuation of reward-related benefits [57]. Such compartmentalized processing needs to be orchestrated for any kind of higher-order integration. It should be emphasized that neuroimaging has shown that the language network activated in language production and comprehension differs from other networks that support problem solving, reasoning and mentalizing [58]. This is not mutually exclusive with the neurophysiology according to which the superordinate concepts are likely to have their cerebral representation in bioelectrical oscillations. Such a state of synchrony has been argued to be achieved by the so-called crossmodal binding through neural coherence [59]. Nevertheless, the segmentation of the continuously incoming information at natural breakpoints has been found to be associated with enhanced electroencephalographic activity over the parietal cortex [60]. Importantly, however, synchronized oscillatory activity has been reported to encode endogenously generated linguistic content over and above the exogenous or stimulus-driven information [61].

Furthermore, the posterior medial prefrontal cortex (mPFC) and superior frontal gyrus have been shown to exhibit schematic event patterns that generalize across different stories, subjects, and modalities. Accordingly, the neural patterns in the mPFC are sensitive to overall script structures such that the patterns in these regions predicted the script with high accuracy and temporally aligned multiple stories with a shared script [62]. Also, such compartmentalized computations are aligned via cortico-thalamo-cortical circuits that are organized as parallel routes and, thereby, can afford feedforward cortico-cortical communication [63]. Moreover, the integration of exteroceptive information with interoceptive states that is fundamental for social interactions has been reported to involve the temporopolar region [64]. The temporopolar region is part of an extensive functional anatomical network in the dominant left hemisphere that is centred around the temporoparietal region [65]. It involves the superior temporal cortex that endows a functional scaffolding to common representations across events in multisensory domains [65]. This functional network in the temporoparietal regions involves a horizontal axis from primary unimodal to higher-order, heteromodal and eventually paralimbic cortices, a radial axis from auditory, visual, and paralimbic areas to the temporopolar cortex, and a vertical axis involved in elaboration of words, objects, and interoceptive states. Importantly, a function of this network is to provide the transformation of unimodal percepts to multimodal concepts that are suited to lead to superordinate levels of recognition [65]. Most likely, there are strong functional connections to the so-called default mode network that has been found to be essential for broadcasting memory, language, and semantic representations [66].

The neurophysiological data reviewed above pertain to the adult human brain. However, formation of concepts about a person's social relations and physical environment begins early during infancy and has been proposed to lead to various biases [67]. Thereafter follows the establishment of concepts about the person's identity that have been referred to core beliefs or schemas [68]. Recently, it was proposed that so-called primals capture an individual's basic understanding of what sort of world this is [69]. On the neural level, these processes are paralleled by an increase of cerebral neurons and the evolution of well-organized oscillatory patterns of bioelectric activity in the human brain [70]. Articulated abstractions and their subjective loading with positive or negative emotions evolve gradually from childhood to adolescence. This development was shown to depend on the evolution of language differentiation, an increase of the capacity of abstraction, and the evolution of affect in adolescence [71,72]. It is paralleled by a profound change of cerebral network organization characterized by pruning mechanisms in cerebral grey matter in parallel to an increased neural network efficiency [73]. This framework is probably also the basis for the formation of superordinate concepts during adolescence. Upon reflecting about the match of inherent predictions with unforeseeable changes in reality, superordinate concepts can be assumed to be modified further during adulthood.

Conversely, there are abnormal situations when the understanding of superordinate concepts may fail. For example, judgements concerning the information that is perceived become liable to the occurrence of delusions when the exposure to stimuli is lower than 500 milliseconds [74]. Moreover, neuropsychiatric diseases have been shown to interfere with belief formation or to result in abnormal beliefs [75]. Specific examples are the spatial displacement illusions of the external environment due to cortico-cortical disconnections after stroke [76] as well as abnormal beliefs about one's own body parts in the alien limb syndrome resulting from patterned neurodegeneration [77]. Most likely the same holds for patients with Alzheimer's disease as they are inclined to make errors in superordinate or semantic terms resulting in a loss of concepts and associations that ultimately leads to a breakdown of semantic knowledge [78]. Moreover, in Alzheimer's disease, memory impairments preferentially affect concepts dealing with living things and abstract concepts compared to objects and verbs [79]. This is probably brought about by predominant deterioration of semantic processing in the left temporoparietal region. In addition, patients with Alzheimer's disease and with mild cognitive impairment show significant deficits in discourse comprehension that were found to be related to a longer naming latency and an impairment in abstraction, inferential thinking, and true/false judgments [80]. Thus, it is predicted that the linguistic deficits concerning the formation and articulation of concepts in early and advanced Alzheimer's disease are related to deterioration of the temporoparietal network in the language dominant left hemisphere.

In schizophrenia the situation is similar but the pathological causation less clear. Patients with schizophrenia have been reported to exhibit language impairments to an excessive degree, which are characterized by disorganization involving loose and peculiar sentences in addition to impoverishment and dysregulation [81]. Based on the hypothesis that there is no thought separate from language, the loss of propositional meaning that is characteristic of schizophrenia can explain why the delusions of such patients are false, impossible, and sometimes fantastic [82]. Although definite conclusions about the role of linguistic abnormalities in schizophrenia are not possible at this time, it may be predicted that the reduced intracerebral connectivity found in schizophrenia [83] renders it likely that such patients have difficulties in building up and maintaining reality related superordinate concepts.

5. Discussion

In this paper we have argued from a neuroscience perspective that the linguistic term superordinate concept is suited to denote complex cognitive notions. Specifically, they represent metacognitive integrations of the three universal categories of natural information in our environment, namely either objects, events, or narratives. On the linguistic level, they stand above ordinary terms in common language that reflect the multimodal concepts of either objects, events, or narratives or their constituting items (Table 1). On the cognitive level, each alone, however, is not sufficient to capture the complexity of superordinate concepts that encompass physical, transient, and verbal characteristics. This conceptualization accords with triadic notions that were common in ancient Greek. Besides the notion of love (Table 2), there is also the example of time that was revitalized by Alfred Whitehead as reviewed recently [84]: there are the measurable chronos (*χρόνος*), the right momentary event kairos (*καιρός*) and the narrated meaning of time aion (*αἰών*). Such superordinate triadic concepts are suited to reflect our human and environmental reality in a comprehensive manner, although typically only the narrated testimony underlying the concept [85] is used in daily communication. By virtue of the narrative-based concepts, superordinate concepts gain an essentially human connotation. Thus, it can be hypothesized that they may change as new insights in the sciences or technologies evolve. Nevertheless, on the linguistic level, superordinate concepts are labelled with convenient words whose meanings are widely agreed upon in social groups [37]. While the linguistic use of items is a fast process, it can be predicted that referring to concepts as listed in Table 1 involves additional neural resources and, therefore, is more time consuming. On top of that, superordinate concepts have been described to integrate the content of the three different types of concepts (Table 2). Therefore, their deliberate use can be predicted to require the greatest amount of time.

Language provides means to sculpt in a differentiated fashion each of the three semantic components that constitute superordinate concepts. It ought to be emphasized that we talk here about nouns that are open to being used both in a formal linguistic fashion for communication as well as in a functional fashion for cognitive manipulation [86]. Thus, our work pertains to the long-standing interdisciplinary discourse on how so-called knowledge systems are implemented in the human brain [87,88]. Recently, it has been proposed that there are seemingly opportunities to employ artificial intelligence for knowledge systems as well as to develop them further by artificial intelligence [89]. Moreover, it can be hypothesized that semantic decoding studies are suited to elucidate the representation of superordinate concepts on the neural level. Specifically, it is predicted that they engage large-scale neural circuits that connect sensory processing areas with other brain areas, including areas concerned with semantic memory. In correspondence with such a hypothesis, experimental studies have shown that lexical semantic information is represented in the heteromodal cortex as experiential information and that other brain areas beyond the traditional "semantic hubs" contribute to semantic cognition [45,50,62]. These observations are compatible with our grounding hypothesis, according to which the different items listed in Table 1 are defined by oligomodal properties and, therefore, are represented in the cortical brain areas that are engaged in processing sensory and motor modalities, whereas the multimodal concepts are represented in higher order cortical areas due to multimodal processing [45,90]. Although the integration of sensory and motor properties is supposed to be mediated by the inferior parietal cortex, multimodal representations have been reported to be located in the inferior temporal cortex as described by the hub-spoke model [91]. In more general terms, these heteromodal cortical representations are parts of large-scale neural circuits affording integrative semantic memory functions in different cognitive tasks including language comprehension [46,92]. Notably, semantics of contextual meanings have been shown to engage a left-lateralized neural network, while the syntactic information has a bihemispheric representation [93]. It can be hypothesized further that becoming consciously aware of superordinate concepts engages multimodal and supramodal cortical areas within brain circuits that mediate semantic representations of the concepts related to objects, events and narratives. Importantly, superordinate concepts are metastable coherent wholes representing an emergent new property as compared with their components, which accords with the notion of context-sensitive constraints [94]. It may be anticipated that this conscious cognitive integration is likely to happen by the so-called binding character of the brain's oscillatory bioelectric activity [19,59].

It is quite common that superordinate concepts may evoke higher emotions such as awe [95,96] that thereby become associated with these concepts. Accordingly, superordinate concepts can gain personal relevance that has been advocated to be an essential property of beliefs [43,97]. Although beliefs have been a focus of research in philosophy and theology from Antiquity until the present time [98,99,100], they have received virtually no attention in the sciences [101]. This lack of attention has recently changed, as beliefs have been appreciated as central phenomena in cognitive neuroscience [102]. Beliefs are the product of the neural processes that take place in the brain, integrating external information with the emotional state of the individual [103]. Typically, beliefs are highly emotionally charged, which is consistent with the long-standing discussion in philosophy that hypothesizes that cognition and emotion are heavily intertwined [104]. The physiological function of believing is to stabilize an individual's perceptions in terms of subjective relevance, which takes place rapidly and below the individual's conscious awareness. Believing has been said to be dependent on feedforward models that pre-

Table 3. Semantic representations of natural information.

Content level	Object-based concepts	Event-based concepts	Narrative-based concepts
Cognitive-Emotional Integration	Primal Beliefs (Personal Experience)		Conceptual Belief Systems (autobiographic, religious, etc.; Self-Identity)
Meta-Analytic Integration	Superordinate, Triadic Concepts		

dict the causes of sensory stimuli (inference) as well as the output of neural processing from inputs [105]. The profane beliefs about sensory perceptions are not dependent on language and, therefore, have been classified as primal beliefs (Table 3). They comprise the subjective personal experience. In contrast, conceptual beliefs are based on narratives primarily about autobiography and also about religion and politics [40]. They comprehend different themes and build up conceptual belief systems that reflect self-identity (Table 3). Because beliefs are not accessible directly but can only be inferred from a person's behaviour with a third person perspective [43], the cognitive neuroscience account of belief formation and updating is consistent with the epistemological characteristics of beliefs as described by Hacker [106]. Nevertheless, this view deviates from the propositional doctrine that argues for the primal cognitive character of beliefs [107].

In consequence, the formation of emotionally charged superordinate concepts was found to occur particularly in human adolescence due to the high degree of brain plasticity in this age range [71]. Because superordinate concepts are made up by three different conceptual categories, they differ from the notion of conceptual belief systems that accommodate a number of different conceptual beliefs (Table 3). For example, belief systems have been advocated recently for complexities such as deities, state, and market [108,109]. Similarly, Snyder [110] presented freedom as a conceptual belief system that includes five concepts such as sovereignty, unpredictability, mobility, factuality and solidarity as constituents. Furthermore, the term faith corresponds to a belief system that typically is based on different narratives, be they stories about miracles, revelations, or salvation. But the superordinate concepts as presented here should not be confused with the so-called primal world beliefs as propagated by Clifton et al. [111]. These primal world beliefs concern verbal descriptions of the environment as interesting, dangerous, safe, etc. Thus, they treat environment and world as equivalent items, neglecting that the term environment refers only to the physical dimension of the superordinate term *world*. Also, the notion of primal world beliefs has been criticized as an ill-defined verbal expression operating in an implicit Cartesian-split-mechanistic framework [72]. In this context, it is of relevance that rituals are of great importance for the formation of conceptual beliefs, as has been shown by cognitive neuroscience approaches such as, for example, attribution theory, theory of mind, and comparative cognition as well as placebo effects and reward prediction [112]. In fact, this view is comparable to the notion that evolution is a superordinate framework that encompasses the law of natural selection [113]. Thereby, it obviates the often purported mind-body-dualism.

Thoughts, concepts, and beliefs are inherently private to each person but can become apparent from a person's behaviour and can be communicated as propositional statements such that their contents may be shared with other people. As evident from a systematic and cross-cultural comparison of the Western languages with that of the Pirahã tribe in the Amazon area, language is a cultural good that reveals important cross-cultural differences in the spectrum of so-called concrete words and abstract concepts. It involves perceptual abstraction, memory, and phonology that have enabled people in Western countries to convey information across time, space, and changes in modality and to talk about the past, present, and future [114,115,116]. Consequently, cultural peculiarities can be expected to render translations between different languages difficult. Moreover, that different people agree upon the content of concepts is assumed to reflect empathic resonance between them mediated by the mirror neuron system in the inferior frontal and parietal cortices [117]. If such an empathic resonance has been built up, the people involved become increasingly confident that these verbal statements are true. Truth judgments have been shown to build up in relation to repetition rates of exposure, feelings like ease of processing, and consistency with information retrieved from memory [118]. It follows that truth is also a human inference with a third-person perspective. Importantly, the personal truth account that is inherent in believing is incompatible with the general, supernatural notion of truth that can be appreciated only by conscious awareness. On the basis of cognitive neuroscience, superordinate concepts—even if they apply to transcendent phenomena—are supposed to be within our earth-bound field of reach. It ought to be emphasized that they are subjective but nevertheless can be communicated and may be agreed or disagreed upon by different people. Thus, there is no need for absolute knowledge; people instead believe what they accept as reality.

Whereas the physical context of our environment changes to such a little extent that it appears stable to us, events lead to changes in the environment that become manifest in altered relations. To be able to appreciate such changes, repeated observations are mandatory to detect the event boundaries [60]. Quite differently, narratives can change rapidly and affect conceptual beliefs and, therefore, also superordinate concepts dramatically [119]. For example, new findings of the empirical sciences may no longer be compatible with hitherto held beliefs, thus demanding their modification. To illustrate, beliefs were said to change when the multidimensional utility of a new belief was greater than that of an old belief [120]. As a consequence, superordinate concepts may also undergo dynamic changes. For example, the primal beliefs reflecting personal experience may change due to disease related handicaps. Similarly, conceptual belief systems that reflect self-identity may change in relation to an encounter with new or previously unseen or unheard narratives. This view concurs with the notion of continuous scientific falsification as developed by Popper [121]. The revolutionary nature of Popper's thought is that justification was replaced with the notion of criticism, which rendered justification irrelevant to epistemology and, thus, fundamentally opposed to the analytical tradition of philosophy [122]. But Popper's view was criticised from other positions. For example, Fleck [123] challenged him over what might be a scientific fact. And Kuhn's view [124] that science evolves in controversy over paradigms that are held within the scientific community had vast influence. Generally, however, modern theories of knowledge and of science put individuals and social processes into the centre of belief formation and updating, which is in accordance with the theory of credition [43]. Thus, it is predicted that updating of concepts is an ongoing process that probably evolves throughout a person's lifetime.

6. Conclusions

We have described the notion of superordinate, triadic concepts to account for the comprehensiveness of terms widely used in ordinary language. The superordinate concepts integrate the articulated abstractions of stable and transient physical properties of the environment and of the narrated principles of such terms. Their encoding in large-scale networks in the human brain provides a link from the communication to the neural implementation level that evolves during brain maturation in childhood and adolescence. Whether narrated principles are products of human thinking or of transcendent origin goes beyond the scope of this paper.

Availability of Data and Materials

This is a theoretical paper based on empirical data available in the open literature.

Author Contributions

RJS: designing and writing the paper, HFA and RFP: editing the paper. HFA and RFP made substantial contributions to the concept of the paper and to the interpretation of the data. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

Acknowledgment

The constructive comments of an anonymous reviewer are gratefully acknowledged.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Clarke A, Tyler LK. Understanding What We See: How We Derive Meaning From Vision. Trends in Cognitive Sciences. 2015; 19: 677–687. https://doi.org/10.1016/j.tics.2015.08.008

[2] Layng TVJ. Tutorial: Understanding Concepts: Implications for Behavior Analysts and Educators. Perspectives on Behavior Science. 2019; 42: 345–363. https://doi.org/10.1007/s40614-018-00188-6

[3] Rosch EH. Natural categories. Cognitive Psychology. 1973; 4: 328–350. https://doi.org/10.1016/0010-0285(73)90017-0

[4] Mervis CB, Rosch E. Categorization of natural objects. Annual Review of Psychology. 1981; 32: 89–115. https://doi.org/10.1146/ANNUREV.PS.32.020181.000513

[5] Richards AD. The superordinate self in psychoanalytic theory and in the self psychologies. Journal of the American Psychoanalytic Association. 1982; 30: 939–957. https://doi.org/10.1177/000306518203000406

[6] Garrett B, Hough G. Brain & Behavior. An introduction to behavioral neuroscience. 6th edn. Sage Publications: London. 2021.

[7] Friston KJ, Parr T, de Vries B. The graphical brain: Belief propagation and active inference. Network Neuroscience. 2017; 1: 381–414. https://doi.org/10.1162/NETN_a_00018

[8] Binkofski F, Buccino G, Posse S, Seitz RJ, Rizzolatti G, Freund H. A fronto-parietal circuit for object manipulation in man: evidence from an fMRI-study. The European Journal of Neuroscience. 1999; 11: 3276–3286. https://doi.org/10.1046/j.1460-9568.1999.00753.x

[9] Bodegård A, Geyer S, Grefkes C, Zilles K, Roland PE. Hierarchical processing of tactile shape in the human brain. Neuron. 2001; 31: 317–328. https://doi.org/10.1016/s0896-6273(01)00362-2

[10] Dehaene S, Lau H, Kouider S. What is consciousness, and could machines have it? Science. 2017; 358: 486–492. https://doi.org/10.1126/science.aan8871

[11] Ryzhov IO, Chen Y. Bayesian belief models in simulation-based decision-making. In Tolk A, Fowler J, Shao G, Yücesan E (eds.) Advances in modeling and simulation. Simulation foundations, methods and applications (Chap. 10, pp. 181–217). Springer International Publishing: New York. 2017.

[12] Friston K. The free-energy principle: a unified brain theory? Nature Reviews. Neuroscience. 2010; 11: 127–138. https://doi.org/10.1038/nrn2787

[13] Bar M, Neta M, Linz H. Very first impressions. Emotion. 2006; 6: 269–278. https://doi.org/10.1037/1528-3542.6.2.269

[14] Sharan L, Rosenholtz R, Adelson EH. Accuracy and speed of material categorization in real-world images. Journal of Vision. 2014; 14: 12. https://doi.org/10.1167/14.9.12

[15] Takei S, Nishida S. Perceptual ambiguity of bistable visual stimuli causes no or little increase in perceptual latency. Journal of Vision. 2010; 10: 23.1–15. https://doi.org/10.1167/10.4.23

[16] Altieri N. Multimodal theories of recognition and their relation to Molyneux's question. Frontiers in Psychology. 2015; 5: 1547. https://doi.org/10.3389/fpsyg.2014.01547
[17] Juliano SL, Hand PJ, Whitsel BL. Patterns of increased metabolic activity in somatosensory cortex of monkeys Macaca fascicularis, subjected to controlled cutaneous stimulation: a 2-deoxyglucose study. Journal of Neurophysiology. 1981; 46: 1260–1284. https://doi.org/10.1152/jn.1981.46.6.1260
[18] Hubel DH, Wiesel TN, Stryker MP. Anatomical demonstration of orientation columns in macaque monkey. The Journal of Comparative Neurology. 1978; 177: 361–380. https://doi.org/10.1002/cne.901770302
[19] Gray CM, König P, Engel AK, Singer W. Oscillatory responses in cat visual cortex exhibit inter-columnar synchronization which reflects global stimulus properties. Nature. 1989; 338: 334–337. https://doi.org/10.1038/338334a0
[20] Clark SA, Allard T, Jenkins WM, Merzenich MM. Receptive fields in the body-surface map in adult cortex defined by temporally correlated inputs. Nature. 1988; 332: 444–445. https://doi.org/10.1038/332444a0
[21] Hihara S, Yamada H, Iriki A, Okanoya K. Spontaneous vocal differentiation of coo-calls for tools and food in Japanese monkeys. Neuroscience Research. 2003; 45: 383–389. https://doi.org/10.1016/s0168-0102(03)00011-7
[22] Iriki A, Taoka M. Triadic (ecological, neural, cognitive) niche construction: a scenario of human brain evolution extrapolating tool use and language from the control of reaching actions. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences. 2012; 367: 10–23. https://doi.org/10.1098/rstb.2011.0190
[23] Zacks JM, Tversky B. Event structure in perception and conception. Psychological Bulletin. 2001; 127: 3–21. https://doi.org/10.1037/0033-2909.127.1.3
[24] Güler B, Günseli E. The mosaic of experience: How individual differences in attention and working memory shape event segmentation. Cognitive Research: Principles and Implications. 2026; 11: 34. https://doi.org/10.1186/s41235-026-00729-7
[25] Maravita A, Iriki A. Tools for the body (schema). Trends in Cognitive Sciences. 2004; 8: 79–86. https://doi.org/10.1016/j.tics.2003.12.008
[26] Kaiser D, Peelen MV. Transformation from independent to integrative coding of multi-object arrangements in human visual cortex. NeuroImage. 2018; 169: 334–341. https://doi.org/10.1016/j.neuroimage.2017.12.065
[27] Isik L, Koldewyn K, Beeler D, Kanwisher N. Perceiving social interactions in the posterior superior temporal sulcus. Proceedings of the National Academy of Sciences of the United States of America. 2017; 114: E9145–E9152. https://doi.org/10.1073/pnas.1714471114
[28] Papeo L, Abassi E. Seeing social events: The visual specialization for dyadic human-human interactions. Journal of Experimental Psychology. Human Perception and Performance. 2019; 45: 877–888. https://doi.org/10.1037/xhp0000646
[29] Walbrin J, Downing P, Koldewyn K. Neural responses to visually observed social interactions. Neuropsychologia. 2018; 112: 31–39. https://doi.org/10.1016/j.neuropsychologia.2018.02.023
[30] Hauser MD, Chomsky N, Fitch WT. The faculty of language: what is it, who has it, and how did it evolve? Science. 2002; 298: 1569–1579. https://doi.org/10.1126/science.298.5598.1569
[31] Belzen JA. Religion and Self: Notions from a Cultural Psychological Perspective. Pastoral Psychology. 2010; 59: 399–409. https://doi.org/10.1007/s11089-009-0204-z
[32] Schnell T. Spirituality with and without religion—Differential Relationships with Personality. Archive for the Psychology of Religion. 2012; 34: 33–61. https://doi.org/10.1163/157361212X644495
[33] Yeshurun Y, Swanson S, Simony E, Chen J, Lazaridi C, Honey CJ, et al. Same Story, Different Story: The neural representations of interpretive frameworks. Psychological Science. 2017; 28: 307–319. https://doi.org/10.1177/0956797616682029
[34] Amft M, Bzdok D, Laird AR, Fox PT, Schilbach L, Eickhoff SB. Definition and characterization of an extended social-affective default network. Brain Structure & Function. 2015; 220: 1031–1049. https://doi.org/10.1007/s00429-013-0698-0
[35] Mesulam MM. Principles of behavioral and cognitive neurology. Oxford University Press: Oxford, UK. 2000.
[36] Love N. Science, language and linguistic culture. Language & Communication. 2009; 29: 26–46. https://doi.org/10.1016/j.langcom.2008.04.001
[37] Blewitt P. Word meaning acquisition in young children: a review of theory and research. Advances in Child Development and Behavior. 1982; 17: 139–195. https://doi.org/10.1016/s0065-2407(08)60359-6
[38] Mahmood F, Muraki EJ, Diveica V, Binney RJ, Protzner AB, Pexman PM. Abstract words are hard to acquire; Does social relevance help? Psychonomic Bulletin & Review. 2025; 32: 2926–2938. https://doi.org/10.3758/s13423-025-02719-0
[39] Norris D, Kalm K. Chunking and data compression in verbal short-term memory. Cognition. 2021; 208: 104534. https://doi.org/10.1016/j.cognition.2020.104534
[40] Seitz RJ, Angel HF. Belief formation - A driving force for brain evolution. Brain and Cognition. 2020; 140: 105548. https://doi.org/10.1016/j.bandc.2020.105548
[41] Shea N. Metacognition and abstract concepts. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences. 2018; 373: 20170133. https://doi.org/10.1098/rstb.2017.0133
[42] Bennett MR, Hacker PMS. Philosophical foundations of neuroscience. Blackwell: Malden, MA, USA. 2003.
[43] Angel HF, Seitz RJ. Credition and the neurobiology of belief: the brain function of believing. Academia Biology. 2024; 2: 1–5. https://doi.org/10.20935/AcadBiol7359
[44] Alessandroni N, Malafouris L, Gallagher S. An Ecological Approach to Conceptual Thinking in Material Engagement. Europe's Journal of Psychology. 2024; 20: 84–103. https://doi.org/10.5964/ejop.13227
[45] Conca F, Borsa VM, Cappa SF, Catricalà E. The multidimensionality of abstract concepts: A systematic review. Neuroscience and Biobehavioral Reviews. 2021; 127: 474–491. https://doi.org/10.1016/j.neubiorev.2021.05.004
[46] Meltzer JA, Braun AR. An EEG-MEG Dissociation between Online Syntactic Comprehension and Post Hoc Reanalysis. Frontiers in Human Neuroscience. 2011; 5: 10. https://doi.org/10.3389/fnhum.2011.00010
[47] Thiel U. The Early Modern Subject: Self-Consciousness and Personal Identity from Descartes to Hume. Oxford University Press: Oxford, UK. 2011.
[48] Rogers TB, Kuiper NA, Kirker WS. Self-reference and the encoding of personal information. Journal of Personality and Social Psychology. 1977; 35: 677–688. https://doi.org/10.1037//0022-3514.35.9.677
[49] Northoff G, Heinzel A, de Greck M, Bermpohl F, Dobrowolny H, Panksepp J. Self-referential processing in our brain–a meta-analysis of imaging studies on the self. NeuroImage. 2006; 31: 440–457. https://doi.org/10.1016/j.neuroimage.2005.12.002
[50] Fernandino L, Tong JQ, Conant LL, Humphries CJ, Binder JR. Decoding the information structure underlying the neural representation of concepts. Proceedings of the National Academy of Sciences of the United States of America. 2022; 119: e2108091119. https://doi.org/10.1073/pnas.2108091119
[51] Dijksterhuis A. Think different: the merits of unconscious thought in preference development and decision making. Jour-

nal of Personality and Social Psychology. 2004; 87: 586–598. https://doi.org/10.1037/0022-3514.87.5.586
[52] Dijksterhuis A, Bos MW, Nordgren LF, van Baaren RB. On making the right choice: the deliberation-without-attention effect. Science. 2006; 311: 1005–1007. https://doi.org/10.1126/science.1121629
[53] Soon CS, Brass M, Heinze HJ, Haynes JD. Unconscious determinants of free decisions in the human brain. Nature Neuroscience. 2008; 11: 543–545. https://doi.org/10.1038/nn.2112
[54] Pujol J, Reixach J, Harrison BJ, Timoneda-Gallart C, Vilanova JC, Pérez-Alvarez F. Posterior cingulate activation during moral dilemma in adolescents. Human Brain Mapping. 2008; 29: 910–921. https://doi.org/10.1002/hbm.20436
[55] Folloni D, Roumazeilles L, Bryant KL, Manger PR, Bertelsen MF, Khrapitchev AA, et al. Comparing the Limbic-Frontal Connectome across the Primate Order: Conservation of Connections and Implications for Translational Neuroscience. The Journal of Neuroscience. 2026; 46: e0377252026. https://doi.org/10.1523/JNEUROSCI.0377-25.2026
[56] Kahnt T, Schoenbaum G. Cross-species studies on orbitofrontal control of inference-based behavior. Behavioral Neuroscience. 2021; 135: 109–119. https://doi.org/10.1037/bne0000401
[57] Crawford JL, Brough RE, Eisenstein SA, Peelle JE, Braver TS. Generalized Encoding of the Relative Subjective Value of Cognitive Effort in the Dorsal ACC. The Journal of Neuroscience. 2024; 44: e0367242024. https://doi.org/10.1523/JNEUROSCI.0367-24.2024
[58] Fedorenko E, Piantadosi ST, Gibson EAF. Language is primarily a tool for communication rather than thought. Nature. 2024; 630: 575–586. https://doi.org/10.1038/s41586-024-07522-w
[59] Senkowski D, Schneider TR, Foxe JJ, Engel AK. Crossmodal binding through neural coherence: implications for multisensory processing. Trends in Neurosciences. 2008; 31: 401–409. https://doi.org/10.1016/j.tins.2008.05.002
[60] Ezzyat Y, Clements A. Neural Activity Differentiates Novel and Learned Event Boundaries. The Journal of Neuroscience. 2024; 44: e2246232024. https://doi.org/10.1523/JNEUROSCI.2246-23.2024
[61] Kaufeld G, Bosker HR, Ten Oever S, Alday PM, Meyer AS, Martin AE. Linguistic Structure and Meaning Organize Neural Oscillations into a Content-Specific Hierarchy. The Journal of Neuroscience. 2020; 40: 9467–9475. https://doi.org/10.1523/JNEUROSCI.0302-20.2020
[62] Baldassano C, Hasson U, Norman KA. Representation of Real-World Event Schemas during Narrative Perception. The Journal of Neuroscience. 2018; 38: 9689–9699. https://doi.org/10.1523/JNEUROSCI.0251-18.2018
[63] Sherman SM, Usrey WM. Transthalamic Pathways for Cortical Function. The Journal of Neuroscience. 2024; 44: e0909242024. https://doi.org/10.1523/JNEUROSCI.0909-24.2024
[64] Mesulam MM. Temporopolar regions of the human brain. Brain. 2023; 146: 20–41. https://doi.org/10.1093/brain/awac339
[65] Setti F, Handjaras G, Bottari D, Leo A, Diano M, Bruno V, et al. A modality-independent proto-organization of human multisensory areas. Nature Human Behaviour. 2023; 7: 397–410. https://doi.org/10.1038/s41562-022-01507-3
[66] Menon V. 20 years of the default mode network: A review and synthesis. Neuron. 2023; 111: 2469–2487. https://doi.org/10.1016/j.neuron.2023.04.023
[67] Oeberst A, Imhoff R. Toward Parsimony in Bias Research: A Proposed Common Framework of Belief-Consistent Information Processing for a Set of Biases. Perspectives on Psychological Science. 2023; 18: 1464–1487. https://doi.org/10.1177/17456916221148147
[68] Goldberg JF, Gerstein RK, Wenze SJ, Welker TM, Beck AT. Dysfunctional attitudes and cognitive schemas in bipolar manic and unipolar depressed outpatients: implications for cognitively based psychotherapeutics. The Journal of Nervous and Mental Disease. 2008; 196: 207–210. https://doi.org/10.1097/NMD.0b013e3181663015
[69] Lansford JE, Kerry N, Al-Hassan SM, Bacchini D, Bornstein MH, Chang L, et al. Development of Primal World Beliefs. Human Development. 2024; 68: 149–158. https://doi.org/10.1159/000534964
[70] Kaminska A, Eisermann M, Plouin P. Child EEG (and maturation). Handbook of Clinical Neurology. 2019; 160: 125–142. https://doi.org/10.1016/B978-0-444-64032-1.00008-4
[71] Casey BJ, Heller AS, Gee DG, Cohen AO. Development of the emotional brain. Neuroscience Letters. 2019; 693: 29–34. https://doi.org/10.1016/j.neulet.2017.11.055
[72] Mascolo MF. Theorizing "primal world beliefs": a relational-developmental account. Human Development. 2024; 68: 159–170. https://doi.org/10.1159/000540595
[73] Fleming LL, McDermott TJ. Cognitive Control and Neural Activity during Human Development: Evidence for Synaptic Pruning. The Journal of Neuroscience. 2024; 44: e0373242024. https://doi.org/10.1523/JNEUROSCI.0373-24.2024
[74] Bear A, Fortgang RG, Bronstein MV, Cannon TD. Mistiming of thought and perception predicts delusionality. Proceedings of the National Academy of Sciences of the United States of America. 2017; 114: 10791–10796. https://doi.org/10.1073/pnas.1711383114
[75] Seitz RJ. Beliefs: A challenge in neuropsychological disorders. Journal of Neuropsychology. 2022; 16: 21–37. https://doi.org/10.1111/jnp.12249
[76] Alves PN, Fonseca AC, Silva DP, Andrade MR, Pinho-E-Melo T, Thiebaut de Schotten M, et al. Unravelling the Neural Basis of Spatial Delusions After Stroke. Annals of Neurology. 2021; 89: 1181–1194. https://doi.org/10.1002/ana.26079
[77] Tetreault AM, Phan T, Petersen KJ, Claassen DO, Neth BJ, Graff-Radford J, et al. Network Localization of Alien Limb in Patients with Corticobasal Syndrome. Annals of Neurology. 2020; 88: 1118–1131. https://doi.org/10.1002/ana.25901
[78] Salmon DP, Butters N, Chan AS. The deterioration of semantic memory in Alzheimer's disease. Canadian Journal of Experimental Psychology. 1999; 53: 108–117. https://doi.org/10.1037/h0087303
[79] Chertkow H, Whatmough C, Saumier D, Duong A. Cognitive neuroscience studies of semantic memory in Alzheimer's disease. Progress in Brain Research. 2008; 169: 393–407. https://doi.org/10.1016/S0079-6123(07)00025-8
[80] Kokje E, Celik S, Wahl HW, von Stutterheim C. Can discourse processing performance serve as an early marker of Alzheimer's disease and mild cognitive impairment? A systematic review of text comprehension. European Journal of Ageing. 2022; 19: 3–18. https://doi.org/10.1007/s10433-021-00619-5
[81] Covington MA, He C, Brown C, Naçi L, McClain JT, Fjordbak BS, et al. Schizophrenia and the structure of language: the linguist's view. Schizophrenia Research. 2005; 77: 85–98. https://doi.org/10.1016/j.schres.2005.01.016
[82] Hinzen W, Rosselló J, McKenna P. Can delusions be understood linguistically? Cognitive Neuropsychiatry. 2016; 21: 281–299. https://doi.org/10.1080/13546805.2016.1190703
[83] Canu E, Agosta F, Filippi M. A selective review of structural connectivity abnormalities of schizophrenic patients at different stages of the disease. Schizophrenia Research. 2015; 161: 19–28. https://doi.org/10.1016/j.schres.2014.05.020
[84] Weber M. The ontological roots of temporality. In Campo A, Gozzano S (eds). Einstein vs. Bergson: an enduring quarrel on time (pp. 231–250). De Gruyter: Berlin, Boston, USA. 2021. https://doi.org/10.1515/9783110753707-014
[85] Ma S, Payir A, McLoughlin N, Harris PL. Scientific and reli-

gious beliefs are primarily shaped by testimony. Trends in Cognitive Sciences. 2024; 28: 792–803. https://doi.org/10.1016/j.tics.2024.04.014
[86] Mahowald K, Ivanova AA, Blank IA, Kanwisher N, Tenenbaum JB, Fedorenko E. Dissociating language and thought in large language models. Trends in Cognitive Sciences. 2024; 28: 517–540. https://doi.org/10.1016/j.tics.2024.01.011
[87] Patterson K, Nestor PJ, Rogers TT. Where do you know what you know? The representation of semantic knowledge in the human brain. Nature Reviews. Neuroscience. 2007; 8: 976–987. https://doi.org/10.1038/nrn2277
[88] Hjorland B. What is knowledge organization? Knowledge Organization. 2008; 35: 86–101. https://doi.org/10.5771/0943-7444-2008-2-3-86
[89] Bagchi M. Towards knowledge organization ecosystem (KOE). Cataloging & Classification Quarterly. 2021; 59: 740–756. https://doi.org/10.1080/01639374.2021.1998282
[90] Zhang Z, Zhou W, Zhang S, Li X, Zhang L, Li L. Neural feature alignment between large language models and brain activities: A knowledge-based framework for cross-modal analysis. Neural Networks. 2026; 201: 108916. https://doi.org/10.1016/j.neunet.2026.108916
[91] Kuhnke P, Beaupain MC, Arola J, Kiefer M, Hartwigsen G. Meta-analytic evidence for a novel hierarchical model of conceptual processing. Neuroscience and Biobehavioral Reviews. 2023; 144: 104994. https://doi.org/10.1016/j.neubiorev.2022.104994
[92] Kumar AA. Semantic memory: A review of methods, models, and current challenges. Psychonomic Bulletin & Review. 2021; 28: 40–80. https://doi.org/10.3758/s13423-020-01792-x
[93] Messi AP, Pylkkanen L. Tracking Neural Correlates of Contextualized Meanings with Representational Similarity Analysis. The Journal of Neuroscience. 2025; 45: e0409242025. https://doi.org/10.1523/JNEUROSCI.0409-24.2025
[94] Juarrero A. What does the closure of context-sensitive constraints mean for determinism, autonomy, self-determination, and agency? Progress in Biophysics and Molecular Biology. 2015; 119: 510–521. https://doi.org/10.1016/j.pbiomolbio.2015.08.007
[95] Gottlieb S, Keltner D, Lombrozo T. Awe as a Scientific Emotion. Cognitive Science. 2018; 42: 2081–2094. https://doi.org/10.1111/cogs.12648
[96] Stellar JE, Bai Y, Anderson CL, Gordon A, McNeil GD, Peng K, et al. Culture and Awe: Understanding Awe as a Mixed Emotion. Affective Science. 2024; 5: 160–170. https://doi.org/10.1007/s42761-024-00243-3
[97] Albarracin M, Pitliya RJ. The nature of beliefs and believing. Frontiers in Psychology. 2022; 13: 981925. https://doi.org/10.3389/fpsyg.2022.981925
[98] Schwitzgebel E. Belief. Stanford encyclopedia of philosophy (Ed: Zalta EN) Stanford University, USA. 2019. https://plato.stanford.edu/archives/win2021/entries/belief/
[99] Jong J. Experimenting with religion. The new science of belief. Oxford University Press: Oxford, United Kingdom. 2023.
[100] Wedgwood R. Rationality and Belief. Oxford University Press: Oxford, United Kingdom. 2023.
[101] Bell V, Halligan PW, Ellis HD. A cognitive neuroscience of belief. In Halligan P, Aylward M (eds.) The Power of Belief (pp. 3–20). Oxford University Press: Oxford, UK. 2006. https://doi.org/10.1093/med:psych/9780198530114.003.0001
[102] Van Leeuwen N, Lombrozo T. The Puzzle of Belief. Cognitive Science. 2023; 47: e13245. https://doi.org/10.1111/cogs.13245
[103] Seitz RJ, Paloutzian RF, Angel HF. From Believing to Belief: A General Theoretical Model. Journal of Cognitive Neuroscience. 2018; 30: 1254–1264. https://doi.org/10.1162/jocn_a_01292
[104] Schaefer DO. Wild experiment. Feeling science and secularism after Darwin. Duke University Press: Durham and London. 2022.
[105] Key B, Zalucki O, Brown DJ. A First Principles Approach to Subjective Experience. Frontiers in Systems Neuroscience. 2022; 16: 756224. https://doi.org/10.3389/fnsys.2022.756224
[106] Hacker PMS. An orrery of intentionality. Language and Communication. 2001; 21: 119–141.
[107] Griffith E. Towards a science of belief systems. Palgrave Macmillan London: UK. 2014. https://doi.org/10.1057/9781137346377
[108] Alcorta CS, Sosis R. Ritual, emotion, and sacred symbols. The evolution of religion as an adaptive complex. Human Nature. 2005; 16: 323–359. https://doi.org/10.1007/s12110-005-1014-3
[109] Grant D. Populism, artificial intelligence and law. A new understanding of the dynamics of the present. Routledge: London. 2024.
[110] Snyder T. On freedom. Crown: New York, USA. 2024.
[111] Clifton JDW, Baker JD, Park CL, Yaden DB, Clifton ABW, Terni P, et al. Primal world beliefs. Psychological Assessment. 2019; 31: 82–99. https://doi.org/10.1037/pas0000639
[112] Porot N, Mandelbaum E. The science of belief: A progress report. Wiley Interdisciplinary Reviews. Cognitive Science. 2021; 12: e1539. https://doi.org/10.1002/wcs.1539
[113] van Wijnen AJ, Lewallen EA. Natural selection and evolution: evolving concepts. Academia Biology. 2024; 2: 1–4. https://doi.org/10.20935/AcadBiol6245
[114] Frank MC, Everett DL, Fedorenko E, Gibson E. Number as a cognitive technology: evidence from Pirahã language and cognition. Cognition. 2008; 108: 819–824. https://doi.org/10.1016/j.cognition.2008.04.007
[115] Yoon JMD, Witthoft N, Winawer J, Frank MC, Everett DL, Gibson E. Cultural differences in perceptual reorganization in US and Pirahã adults. PloS One. 2014; 9: e110225. https://doi.org/10.1371/journal.pone.0110225
[116] Everett DL. An Evaluation of Universal Grammar and the Phonological Mind. Frontiers in Psychology. 2016; 7: 15. https://doi.org/10.3389/fpsyg.2016.00015
[117] Gallese V. The manifold nature of interpersonal relations: the quest for a common mechanism. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences. 2003; 358: 517–528. https://doi.org/10.1098/rstb.2002.1234
[118] Brashier NM, Marsh EJ. Judging Truth. Annual Review of Psychology. 2020; 71: 499–515. https://doi.org/10.1146/annurev-psych-010419-050807
[119] Seitz RJ, Paloutzian RF, Angel HF. Manifestations, social impact, and decay of conceptual beliefs: A cultural perspective. Brain and Behavior. 2024; 14: e3470. https://doi.org/10.1002/brb3.3470
[120] Sharot T, Rollwage M, Sunstein CR, Fleming SM. Why and When Beliefs Change. Perspectives on Psychological Science. 2023; 18: 142–151. https://doi.org/10.1177/17456916221082967
[121] Popper K. Scientific method. In Miller D (ed.) Popper Selections (pp. 133–142). Princeton University Press: Princeton, USA. 1985 [1934].
[122] Diller A. Constructing a comprehensively anti-justificationist position. In Jarvie I, Milford K, Miller D (eds.) Karl Popper: a centenary assessment. Volume II, Metaphysics and Epistemology (pp. 118–129). Ashgate: London. 2006.
[123] Fleck L. Genesis and development of a scientific fact. The Chicago University Press: London. 1935/1981.
[124] Kuhn TS. The Structure of Scientific Revolutions. In Neurath O, Carnap R, Morris C (eds.) International Encyclopedia of unified science. University of Chicago Press: Chicago. 1962.