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The Intentional System: tracing the conative feature of aboutness and directedness in human brain

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Abstract

Can we conceptualize an intentional system, as a higher order system, with a monitoring and regulatory role in brain and behavior? Is there a common conceptual ground for both intentionality and conatus? Are aboutness and directedness, two distinct intentional/conative elements? Moreover, do these two complementary elements represent interacting and complementary functions into the brain? This paper provides an overview of possible pathways of that intentional system in the brain, following the conceptual and neurobiological traces of aboutness and directedness. Also, it proposed a common conceptual and neurophysiological ground for both intentionality and conatus, through the study of the complementary and interacting functions of aboutness and directedness. Clarifying the associations between them will help us to better understand the brain-mind interactions, as well as our extension and interaction with the world.

Keywords

intentionality, intentional system**,** conatus, naturalizing intentionality, aboutness, directedness, neurophenomenology

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Introduction

Intentionality and consciousness are importantly related. *Intentionality*, from the Latin verb *intentio,* meaning 'directed at', and also "aim," "hold out," or "stretch", refers to the way that consciousness can be *about* things. For Brentano**,** intentionality is seen as *directedness* of mental phenomena towards an object [1]. Husserl's understanding was that all consciousness is intentional, in the sense that it is always intended *toward* something, and is always *about* something [2]. Heidegger argues that intentionality is a feature of *Dasein's* entire way of *being-in-the-world* [3].

On the other hand, *instinct* is a pattern-based behavior, containing *craving, impulse* or *appetite,* for realizing what is targeted by the *conative* element. Spinoza asserts that every individual thing strives to persevere in its existence, calling such striving *conatus,* a Latin term meaning *will* or *appetite* (from the Latin *appetitus,* meaning a *seeking* for something)**.** *Orexis,* the Aristotelian term for *appetite*, sometimes signify appetite in general and at other times the power of the *will* [4]. Conation is the mental process that activates and/or directs behavior and action. It is the intentional, goal-oriented, or striving component of motivation, the proactive aspect of behavior.

Theories based on functional learning, explanatory ascriptions of intentionality, and social constructions of intentionality suffer from problems related to the elementary forms of intentionality. Intentionality is a complex phenomenon that requires a complex theory. The huge research on these topics, in philosophy of science and neuroscience [review 5-9], released a lot of discussion and queries:

Can we conceptualize an intentional system, as a higher order system, having a monitoring or regulatory role on brain or behaviour? Are the main intentionality concepts of aboutness and directedness, two distinct but complementary intentional elements?

Also, can the concept of conatus contribute to our understanding of intentionality? Is there a common philosophical, or even physiological and neuroanatomical, ground for both intentionality and conatus? Moreover, can we conceptualize aboutness and directedness as conative elements?

Also, are aboutness and directedness two complementary conative/intentional elements that represent interacting functions and neuroanatomical networks in the brain? And if this is true, which is the aim of this design?

Tracing the aboutness system

Any new event activates many, if not all, brain networks: perceptual identification, spatial attention, lexical labeling, connection to past experience, linkage to emotional and visceral patterns, assessment of present context, planning of options, and prediction of consequences. For *spatial orientation*, the cortex around the intraparietal sulcus, the frontal eye fields and the cingulate gyrus constitute the three interconnected epicenters. The parietal component is related to the perceptual representation of behaviorally similar objects or faces. The frontal component displays a relative specialization for choosing and sequencing exploratory and orienting movements. The cingulate gyrus displays a relative specialization for the distribution of effort and motivation, while additional critical components are located in the striatum and thalamus. Finally, the thalamus is considered the gate of the cerebral cortex, and therefore the consciousness. It is the center of both top-down and bottom-up regulation of the course of information, while the cortico- thalamo-cortical circuits are involved in the synergic action of a wide range of neurocognitive networks [10-14].

In the field of philosophy of mind, *aboutness* has been often considered synonymous with intentionality, and it refers to the concept that a text, image, or action is *on* or *of* something. However, is there any specific "place" for *aboutness* into the brain? Developing a reference to *gravity* is critical in orienting our bodies in space, navigating through the environment, maintaining an upright and vertical orientation and sensing the passage of time as a function of terrestrial motion. The vestibular system informs of three-dimensional head acceleration as a functionof the linear pull of gravity. Vestibular stimulation occurs when crystals and fluid are displaced in the otoliths and semicircular canals, respectively, sending signals to the vestibular nuclei via the pontomedullary junction or the flocculonodular lobes of the cerebellum via the inferior cerebellar peduncle. The vestibular and somatosensory systems are known to be the phylogenetically and ontogenetically oldest systems initially concerned with survival-related processes. Moreover, vestibular input, integrating with proprioceptive input from the head and trunk at the vestibular nuclei, thalamus, and cerebellum, contextualizing the motion as self- or other-initiated [15-17].

Also, which would be a critical "network" for *aboutness* in the brain? Permanent predictive activity is indispensable and vital for survival. Predictive coding appears as a universal evolutionary pathway and is continuously modulated by external environmental or internal mental information. The *insula* plays a role in not only error evaluation but also updating the probabilities of an outcome. It has been described as a "hub" for autonomic, affective, and cognitive integration, and it is associated with a wide array of stimuli, including cognitive, socio-emotional, olfactory-gustatory, interoceptive sensation, and pain processing. Moreover, the *salience network* is an intrinsic brain circuit that plays a key role in stimulus processing, attention, and transition / switch between mental states. It's responsible for switching the brain's *default network* from default mode to task-related activity mode. The structures involved are the *anterior insula* and the *anterior cingulate cortex*, while the malfunction of this network is likely to be involved in the development of mental symptoms [18-21].

Tracing the directedness system

Two brain networks are involved in motivation: (a) The *dorsolateral prefrontal cortex* projection to the dorsolateral head of

the caudate nucleus has been linked to cognitive processes, response inhibition, working memory, organizational skills, reasoning, problem solving, and abstract thinking. (b) The *ventromedial prefrontal cortex* is involved in representing the current relative value of stimuli. This structure, together with the insula, is crucially involved in identifying the best choice at the moment of decision.

But, is there any specific "place" for *directedness* in the brain? *Desirative* or, rather, *orectic* phenomena are 'about' values or "directed toward" values, establishing the opening-up of the temporal horizon of intentionality. According to Pankseep [22], the brain contains an exploration, curiosity and interest *seeking system* that is responsible for the capacity of having an urge towards something. He suggested that this system makes possible the opening-up of the primordial temporal horizon. In parallel with its homeostatic function, eating can also be a pleasurable experience. This pleasurable response to food is related with the brain's core dopaminergic *reward circuits*, which are also implicated in drug use and sexuality [22, 23].

The main location of dopaminergic neurons is represented in the *ventral tegmental area*. The mesolimbic system stems from that region and projects to several components of the limbic system, such as the amygdala, the orbitofrontal cortex, the anterior cingulate cortex and the nucleus accumbens. This pathway is supposed to be involved in the activation of motivated behaviors with the function of producing subjective feelings of pleasure. Opioids modulate mesolimbic dopamine pathways in the ventral tegmental area by activating μ-opioid receptors present on the postsynaptic interneurons. Moreover, they cause hyperpolarization and the inhibition of GABA release of the presynaptic dopaminergic neurons, resulting in increased dopamine release [8]. *Reward circuits* include the amygdala, which is associated with emotional learning; the ventral tegmental area, which contains dopaminergic neurons and signals motivation and reward seeking; the nucleus accumbens, centrally involved in reward learning; and the lateral hypothalamus, which integrates these motivation signals, linking the homeostatic system with the hedonic system [21].

In Panksepp's suggestions the brain mediates *anticipatory* states, through the ability of lateral hypothalamus circuits to generate theta rhythms that sensitize both the associative abilities of the hippocampus and dopamine-mediated *timing functions* of the striatum [22, 23]. In scholastic philosophy, appetite is defined as the inclination and order of a thing toward the good. In psychology, this concept is closely connected with a number of other concepts, like orexis, conation, urge, drive, feeling, emotion, affectivity and passion. Conation, urge and drive are terms that are used almost interchangeably to indicate the forceful or impulsive aspect of appetites, while feeling and affectivity are generally used to indicate the felt quality connected with appetitive activity [24].

Appetite and feeding are controlled by two interacting systems: a *homeostatic system*, which ensures that a person gets enough calories to survive, and a *hedonic system*, which regulates the pleasure and reward aspects of eating [25]. Orexigenic and anorexigenic neurons (from Latin orexis [appetite] and Greek *órexis* [desire]), which stimulate and suppress food-seeking behaviors, respectively, are housed in the *arcuate nucleus* of the hypothalamus. These neurons project to the paraventricular nucleus, which promote catabolism, the ventromedial hypothalamus, which suppresses feeding behavior, and the lateral hypothalamus, which promote calorically dense food and locomotor activity, through melanin-concentrating hormone and orexin. The *lateral hypothalamic* area plays a role in arousal, feeding, motivation, and reward [25], while the hypothalamic *agouti-related peptide* and *neuropeptide Y* increase appetite and decrease metabolism and energy expenditure. These neurons also seem to control the neuronal pathways that regulate higher-order brain functions during development and in adulthood [26].

Discussion

The Spinozistic conception of a *conatus* is a historical precursor to modern theories of *autopoiesis* [27]. The archaic concept of *conatus* is today being reconciled with modern biology and neuroscience and is explained in terms of chemistry and neurology [28]. *Conation* refers to the connection of knowledge and affect to behavior, and is associated with the issue of "why." It is the personal, intentional, planful, goal-oriented, or striving component of *motivation*, the proactive aspect of behavior [29]. Desire is the fundamental conative state. Kolbe [30] suggested that human beings have a *conative style* or a preferred method of putting thought into action or interacting with the environment. He identifies four action or conative modes: (a) instincts to probe, refine and simplify (b) instincts to organize, reform and adapt, (c) instincts to improvise, revise and stabilize, and (d) instincts to construct, renovate and envision. For Kolbe, it is the combination of the striving instinct, reason, and targeted goals that results in different levels of commitment and action.

On the other hand, the principle of intentionality not only guides all voluntary thought and behavior, but is also implicated in all meaning, value, and purpose [31]. The most fundamental thesis of Daniel Dennett's [32] *intentional systems theory* is that the ontology of mental states cannot be considered in abstraction from the epistemology of mental state ascription. *Intentionality* had been proposed as the "aboutness" or "directedness" of mental states. Merleau-Ponty extended to *motor intentionality*" or form of bodily understanding, that allows us to remain spontaneously open and responsive to the people and things around us. *Derived intentionality* is intentionality that derives from other actual or merely possible instances of intentionality [33], but most of intentionality is probably derived from the *underived* or *original intentionality* of nonconceptual sensory-perceptual representations and perhaps some core concepts [34].

Millikan [35-36] suggested that Brentano was surely mistaken in thinking that bearing a relation to something nonexistent marks only the mental. She explains *intentionality* using the explanatory resources of natural selection: what thoughts and sentences and desires are 'about' is ultimately elucidated by reference to *what* has been selected and what it has been

selected *for*, i.e., what advantage it conferred on ancestors who possessed it. Intentionality includes, and is sometimes seen as equivalent to, what is called "mental representation". Millikan suggests that intentional systems can be conceptually divided into two parts: one aspect produces representations, while the other uses these representations. The representation and the represented must be paired, so it is a *normal condition* for *proper* functioning of the "user" aspect as it reacts to the representation. Also, the same sort of representational state may represent different things in different systems [35-36].

For biologists, intentionality of all sorts is ultimately the result of evolution via natural selection. *Intrinsic intentionality* and *nano-intentionality*, have been proposed as microscopic forms of *aboutness*, inherent in individual eukaryotic cells, that includes a goal-directed capacity to respond adaptively to novel circumstances [37]. The recently suggested *estimator theory* [38] is based on a conjectured internal process within each organism that estimates the organism's own evolutionary fitness. According to this suggestion, a *naturalistic theory of intentionality* should generate all of the following properties of intentionality: Directedness can be *many-to-one* which means a single entity may be the target of many different intentional components at once; Directedness can be *one-to-many* which means a single intentional component may target many different entities at once; Capability to make *contingent errors*, as well as *systematic errors*, which means an intentional component may have the ability to misrepresent [38].

"Naturalizing" intentionality is of the most important goals in philosophy of mind [33]. Here I suggest that the basic intentionality concepts of aboutness and directedness, are two distinct intentional elements, with an opposite direction of information flow, but with a complementary functioning. Table 1 provides an overview of the *aboutness' and directedness' intentional sub-systems*. The *aboutness sub-system* is designed to perceive the aboutness of things, having the ability to predict and being in the world. It uses the conative elements of desire and existence, and the conative style of adapt and stabilize. Presence is it's phenomenal intentionality and homoeostasis it's physiological intentionality. In micro-intentionality level, from the field of biology, we can have the example of autopoiesis, and in macro-intentionality level, from the field of super-organisms, the example of norm-compliance and morality.

On the other hand, the *directedness' intentional sub-system* is designed to direct the being towards the world, having a strong link with the conative element of appetitus and the conative style to construct and renovate. It is characterized from the phenomenal intentionality of motility, and the physiological intentionality of reward. In the micro-intentionality level, it is characterized by the tropism, and in the macro-intentionality level, by the shared intentionality and the collective intentionality.

The *aboutness' intentional sub-system* seems to use an egocentric-like function, as opposed to the directedness' intentional system, which use an allo-centric-like function. Also, the aboutness' intentional system seems to has a bottom-up flow of information, as opposed to the directedness' intentional system, which has a top-down flow of information. In brain level, the aboutness' intentional system is based mainly in vestibular and interoceptive system, using mainly the hubs of thalamus, insula, and hypothalamus, while the directedness' intentional system is based mainly in the dopaminergic mesolimbic pathway and the orexigenic and anorexigenic neurons, using as main hubs the nucleus accubens and the hypothalamus.

We may consider whether mental disorders might be specified by a class of radical failures of intentionality. It seems that in psychotic patients there is a failure of intentionality, due to inappropriateness of an intentional object or connection, or absence of an intentional object altogether [5, 39]. Human intentionality is closely associated with consciousness and agency. It has been suggested that in psychosis, a failure of corollary discharges to suppress self-generated inputs results in the absence of a "feeling of agency" in the *ego-centric* system, and in a compensatory enhancement of *allo-centric* priors, which might underlie delusions, and the enhancement of "judgments of agency" [40].

Table 1 shows also that *betweenness* is the common end or purpose of both aboutness and directedness sub-systems. Indeed, intentionality for Watsuji [41, 42], is a robustly embodied and situated affair, an ongoing activity of disclosing a meaningful world within various forms of reciprocity and *betweenness*. For him, the character and content of our intentional acts are deeply regulated by betweenness. For example, in the betweenness of seeing another person, one's activity of seeing, is a seeing determined by its being seen by the other. In *Rinrigaku ethics*, he proclaims the study of *ningen,* the English term for *human being,* which implies sociality or relationship. The Sino-Japanese character *nin* signifies two men supporting each other, while *gen* implies 'between' or 'among'. This *anticipatory horizon* is often regulated not just by our sensorimotor capacities but also by our sociocultural milieu. Watsuji suggests a *communal consciousness* in which the desire is socially qualified or modified. More simply, we learn from others both *what* to desire and *how* to desire it. We learn how to constitute *intentional objects* as *desirable* from others, since the world is constituted as a rich landscape of potential desire-worthy objects [41-43].

This is almost identical with the concept of *collective intentionality,* a biologically primitive phenomenon that humans share with other social animals. For Searle [44, 45], without collective intentionality there could not have been social reality and without a *pre-intentional sense of community* there could not have been collective intentionality. The individual intentionality that each person has is derived from the collective intentionality that they share. *Shared intentionality*, as a synonymous of collective intentionality, described as the power of the mind to share mental states like emotions, intentions, and beliefs with others. Two forms of shared intentionality have been suggested: *joint intentionality* and *we-intentionality*, where the later relies on the agents' capacity to understand themselves as group members and to adopt the group's perspective [46].

Finalizing, it is known that physical sciences deal with precise results that are usually difficult to explain, while phi-

losophy of science has imprecise results that can be easily explained by many different ways. Intentionality is a complex phenomenon that requires a complex theory. We can think on an *intentional system*, as a higher order system, which has a regulatory and monitoring role in brain and behavior. This paper provides an overview of possible pathways of that intentional system in brain, following the conceptual and neurobiological traces of aboutness and directedness. Also, it proposed a common conceptual and neurophysiological ground for both intentionality and conatus, studying of the complementary and interacting functions of aboutness and directedness. Clarifying the associations between them could help us tobetter understand the brain-mind interactions, as well as our extension and interaction with the world.

Table 1. The main Conceptual and Neurobiological characteristics of the Aboutness and Directedness Intentional sub-systems

Conceptual and Neurobiological Characteristics	The Aboutness' Sub-System	The Directedness' Sub-System
Design	About something	Toward something
Goal	Prediction	Conation
Function	Being in the world	Towards the world
Conation	Desire	Striving
Conative style	Adapt, Stabilize	Construct, Renovate
Phenomenal Intentionality	Presence	Motility
Physiological Intentionality	Homoeostasis	Reward
Micro-intentionality	Autopoiesis	Tropism
Macro-intentionality	Norm compliance, Morality	Shared intentionality, Collective intentionality
Ego- / allo-centric	Ego-centric function	Allo-centric function
Information Flow	Bottom-up	Top-down
Brain Networks	Vestibular, Interoceptive system	Dopaminergic mesolimbic pathway, Orexigenic & anorexigenic neurons
Brain Hubs	Thalamus, Insula, Hypothalamus	Nucleus accubens, Hypothalamus
Large-scale Networks	Default Mode Network	Executive system
Representations	Production of representations	Use of representations
Conscious level	mostly non-conscious	mostly conscious
Shared intentionality	We-intentionality	Joint-intentionality
Collective intentionality	Betweenness	Betweenness

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