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The DMN between Imagination, Creativity and Musement: a new path for neurosemiotics

Original Study

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Abstract: The Default Mode Network (DMN) is reshaping cognitive neuroscience, offering fresh insights into high-level cognitive processes and the relationship between the humanities and the natural sciences. This article explores how neuroscientific research on the DMN can inform a neurosemiotic approach. It builds on Duarte's recent proposal (2020; 2022) to associate the activities of this neural network with Peirce's notion of *musement*, while arguing that such an identification faces significant challenges and calls for critical reconsideration. Through an analysis of Peirce's *Collected Papers* and the neuroscientific literature on the DMN's role in creativity, the article demonstrates that: (1) musement and the DMN can only be linked indirectly; and (2) the DMN exhibits a non-specific role in creative production. Expanding on this framework, it further suggests that the DMN is tied to a more fundamental semiotic process essential to everyday semiosis: imagination.

Keywords: Default Mode Network, Imagination, Creativity, Musement, Neurosemiotics.

1. INTRODUCTION: THE IMPORTANCE OF THE DMN FOR NEUROSEMIOTICS

Recent advances in neuroscience are increasingly reshaping how key phenomena are conceptualised within philosophy and the human sciences. Neuroscientific findings are often called upon to support or challenge hypotheses about cognitive processes that shape our capacity to make sense of the world. Among the most significant discoveries in recent years – and one that has had a major impact on philosophical discourse – is the identification of the Default Mode Network (DMN; Raichle et al. 2001).

Initially discovered by chance during studies on resting brain states, the DMN is a neural network comprising the medial prefrontal cortex, the posterior cingulate cortex, the precuneus, and the angular gyrus. These regions exhibit high functional connectivity and tend to activate when individuals are not engaged in externally oriented tasks. Subsequent research showed that the DMN is also engaged during internally directed activities, such as autobiographical memory retrieval and future-oriented imagination (Raichle 2015).

Since these discoveries, the DMN has emerged as a privileged object of inquiry into various high-level cognitive functions, including free associative thought, recollection of past experiences, inner speech, mind-wandering, moral evaluation, future planning, and self-representation (Andrews-Hanna et al. 2014; Callard, Margulis 2011). In short, it has become a focal point for the neuroscientific study of some of the most distinctive faculties of human cognition. For this reason, recent studies have begun to investigate (with different approaches and aims) the potential role of the DMN in supporting different semiotic capacities (Pennisi 2022; Lobaccaro 2022a; Duarte 2020; Andrews 2020).

Drawing on this body of research, the present article seeks to explore how recent neuroscientific findings on the DMN may contribute to a neurosemiotic framework

(García, Ibáñez 2022a), and how they may further the broader project of cognitive semiotics (Paolucci 2021a; Lobaccaro 2022b).

In particular, some recent studies have attempted to interpret the cognitive functions associated with the DMN through semiotic categories, proposing a link between the network's activity and Peirce's concept of musement (Duarte 2020; 2022). According to this view, the DMN would sustain creative and abductive modes of thought that are fundamental to sense-making (§2). However, this identification is not without difficulties and calls for a critical reassessment, which should be conducted by examining both the theoretical definition of musement and the available neuroscientific evidence. Following a theoretical positioning within neurosemiotics (§3), the article will clarify, on the one hand, the relationship between musement and creativity (§4), and, on the other, critically examine the hypothesised link with the DMN through a re-reading of the available experimental data (§5–6). Finally, it will propose an alternative account of the DMN's role within a semiotic theory of cognition, showing how it may be associated with a plurality of imaginative and cognitive processes (§7).

2. DMN AND MUSEMENT: A POSSIBLE CONNECTION?

It is now widely recognised that the DMN activates when the brain is not engaged in any specific task, playing a largely passive role associated with mind-wandering and free, associative thinking, where memories of the past intermingle with future projections in mixed sign forms (images, thoughts, and sounds). Moreover, the DMN is structurally connected to other brain regions involved in semantic memory and perceptual systems (Andrews-Hanna et al. 2014; Buckner et al. 2008; Mullally, Maguire 2013; Schacter et al. 2012; Spreng et al. 2009). One area where the DMN has recently attracted considerable attention is in the neuroscience of creativity (Abraham 2018a).

On these grounds, Antonio Duarte (2020; 2022) has proposed that the activity of the DMN provides the neuronal basis for understanding the neurobiological origins of a particular mode of thought highly valued by Peirce (cf. §4): *musement*, defined as "the power to establish connections between different objects, especially between objects in different Universes" (CP 6.455).

> The main purpose of this article is to identify the inner human activity Peirce calls musement with the mental processes that arise through the workings of the brain's default mode network. In doing so, musement […] will finally be situated within what today we understand as its neurobiological origin. (Duarte 2020, 145)

Duarte argues for a direct and causal overlap between the activation of the DMN and the capacity for musement. This cerebral localisation of a semiotic faculty, he contends, is properly justified by a crucial factor: creativity. Numerous studies underscore the key role played by DMN activations during tasks typically labelled as creative (Andreasen 2011; Beaty et al. 2014; Ellamil et al. 2012; Limb, Braun 2008; Takeuchi et al. 2011). For Duarte, then, just as Peirce conceived of musement as the imaginative play that generates creative abductions, the DMN would constitute the brain mechanism underpinning creativity (Duarte 2022, 31), because it "brings new ideas to the fore" (Duarte 2020, 157).

> The activity of the brain's DMN has been identified with the pure play of the mind described by Peirce […] Here, pure play is transformed into musement. […] A hundred years ago Peirce noted the importance of this kind of mental activity and its connection to creativity. Now, the recent discovery of the DMN legitimates Peirce's ideas about musement in a scientific way. (Duarte 2020, 157).

However, such a direct identification and neurobiological reduction of Peirce's thought raise significant problems, prompting a twofold reflection: first, whether a semiotic capacity can genuinely be situated and reduced to neural network activation; and second, whether neuroscientific studies genuinely support such an anchoring, in light of Peirce's philosophical reflections.

3. THE IRREDUCIBILITY OF SEMIOTICS

Before investigating further Duarte's proposal and future directions for a neurosemiotics of the DMN, a preliminary reflection is necessary on the very notion of studying the brain as the seat of semiotic processes, and of viewing the neurosciences as a legitimising framework for semiotic thought. Neurosemiotics, in fact, does not constitute a unified field with clearly defined aims and methods. Rather, it represents a constellation of diverse research efforts, undertaken at different times and from different theoretical backgrounds, that have sought to apply semiotic concepts to the neurosciences (Kull, Favareau 2022). Nevertheless, two divergent tendencies can be identified within neurosemiotics. The first conceives neurosemiotics as closely tied to cognitive neuroscience, with the primary aim of identifying the neural mechanisms underlying semiotic functions:

> In this sense, neurosemiotics can be defined as the branch of the neurosciences that investigates the neurophysiological basis of semiotic behavior […]. Neurosemiotics attempts to correlate neurophysiological processes with well-defined aspects of semiotic behavior in order to better understand the information-processing systems that sustain them and to devise appropriate remedial strategies when these capacities become impaired because of disease or injury. (Bouissac 1998, v. *Neurosemiotics*)

This view is strongly grounded in a form of naturalism and mechanicism, assuming that brain mechanisms can be investigated and, through them, semiotic functions

explained. Understood in this way, neurosemiotics would be little more than a branch of neuroscience dedicated to the study of capacities we classify as semiotic (Jorna 2009). However noble and respectable, this epistemological project fails to engage with the distinctive demands of semiotic inquiry: neurology, far from providing an explanatory basis for semiosis, is itself a derivative – an organised system of relations that studies the network of signs it produces, treating them as though they were the very fabric of reality.

Framing the issue in this way would mean abandoning the core project of semiotics, in favour of a naturalisation based on a not-semiotic epistemology that ultimately weakens semiotic theoretical power. If thought and semiosis are understood along Peircean lines, it becomes impossible to *explain* or *legitimize* them through neurobiological structures. Peirce explicitly rejects any identification of thought with its material substrate and criticises attempts at such reduction:

> […] mind on the contrary is essentially an external phenomenon. The error is very much like that which was so long prevalent that an electrical current moved through the metallic wire; while it is now known that that is just the only place from which it is cut off, being wholly external to the wire. Again, the psychologists undertake to locate various mental powers in the brain; and above all consider it as quite certain that the faculty of language resides in a certain lobe; but I believe it comes decidedly nearer the truth (though not really true) that language resides in the tongue. In my opinion it is much more true that the thoughts of a living writer are in any printed copy of his book than that they are in his brain. (CP 7.364)

From this perspective, semiotics must be conceived as a logical and epistemological framework capable of shedding new light on the phenomena of life, cognition, and science (Lacková 2025). In short, it is semiotics that must provide the framework through which we, as semioticians, can approach and make use of the neurosciences—not the other way around. Following this line of thought, a second tendency within neurosemiotics can be identified, one developed by recent research programmes. Here, various neuroscientific tools are seen as valuable for understanding aspects of semiosis, without entailing any commitment to reductionist assumptions. Within this framework, neurosemiotics emerges as a field capable of:

> [effacing] methodological and theoretical boundaries, foregrounds epistemological continuities among traditions, and leads to applicable innovations in theory building, basic research, clinical science, data analytics, and diverse applied arenas. In other words, a new theoretical and empirical space must emerge that captures semiosis as codetermined by brain, body, and culture. We will refer to this field as neurosemiotics – embracing the convenient synecdoche of the prefix "neuro" while rejecting any reductionism or popular hype that may be attached to it. (García, Ibáñez 2022b, 1)

Conceiving neurosemiotics in non-reductionist terms allows it to take a central place within broader cognitive semiotic projects, which seek to trace a continuity between Peirce's philosophy and externalist and enactive theories of cognition (Caravà 2015; Fabbrichesi 2016; Gallagher 2022; Iliopoulos 2019; Paolucci 2011; 2021a). These approaches firmly reject any identification of cognitive processes with brain activity alone, instead understanding cognition as an extended process involving brain, body, and environment. The brain, therefore, can and must be studied, but it should be understood as an interface and *medium*, a node within the internal and external processes (Fuchs 2018) that give rise to the organism's sense-making capacities and its role as an interpreter of its *Umwelt* (Kull, Favareau 2022; Lobaccaro, 2025).

Accordingly, Duarte's proposal cannot be accepted as a naturalising explanation of musement. Rather, it should be interpreted as an attempt to map how part of the semiotic process may be investigated on a neuronal level. We propose to read Duarte's suggestion as an effort to provide a possible neurobiological framework for musement, one that could serve as the basis for developing an experimental method suitable to its investigation without reductionist commitments (see Paolucci 2012a). This is the way cognitive semiotics can engage with neuroscience: not in search of naturalising explanations, but in pursuit of "strategies of access to meaning in order to transpose it, [...] to constitute new and usable path for meaning" (Basso Fossali 2009, 65 [my translation]). From this perspective, neuroscientific research offers new interpretants that may open up fresh pathways of meaning, and new forms of knowledge that can extend the reach of semiotic inquiry into new domains (see, for instance, Martinelli 2025). On the basis of this orientation, we shall now return to musement, to investigate whether and how the DMN might prove useful to this endeavour.

4. ABDUCTION, CREATIVITY, AND MUSEMENT

Duarte's proposal builds on a comparison between neuroscientific data regarding the relationship between the DMN and creativity, and a parallel identification of creativity with Peirce's notion of musement. We shall first outline the relationship between creativity and musement in order to better assess whether the functions of the DMN can be meaningfully aligned with Peirce's conception.

In semiotics, creativity is not understood in its common usage—as a sudden, *ex nihilo* creation of original and novel ideas or products (Leone 2015; Bartezzaghi 2021). Rather, it is conceived as the mind's ability to draw upon pre-existing knowledge circulating within a given cultural system and recombine it in novel, effective ways (Eco 2004).

Creativity arises in response to a novel problem that generates an "irritation of doubt" (CP 5.374), demanding resolution. This resolution is sought through the careful selection and recombination of knowledge stored within the semiotic space known as the *Encyclopedia*, the archive of already-signified meanings and the "already-said" (Eco 1984; Paolucci 2021b).

The nature of the problem may vary (Anderson 1987): a) it may pertain to observable reality, giving rise to a form of practical creativity, intertwined with invention and discovery; b) or it may concern the domain of the imaginary, manifesting as an inner drive to give form to conceptual or affective meanings through various expressive means (narration, argumentation, painting, music, etc.), resulting in artistic or philosophical creativity.

The process that enables, in the face of a given problem (result), the tracing of an effective solution (rule) within the universe of knowledge – such that the problem can be explained as an instance (case) of a more general law – is called abduction (CP 2.96). To abduct – from the Latin *abducere*, meaning "to carry away" – involves taking a pre-existing sign from its relational system and reconfiguring it within a new system of relations, thus generating a new meaning. Identified by Peirce as a fundamental operation of semiosis, abduction denotes the ability to bring one or more elements into connection with a general law that organises and explains them. However, abduction can occur in different modes. Most of the time, abduction is anything but creative: it is typically used to reaffirm well-established, habitual knowledge, functioning in an almost automatic manner (Bonfantini, Proni 1983; Eco 1990; Sørensen et al. 2017). Nonetheless, abduction is also the only logical operation through which, when confronted with problems that cannot be explained by the knowledge already available to a community, it becomes possible to rework such knowledge and generate a genuinely new sign (CP 7.218).

In this second case, abduction is the only mode of reasoning that, according to Peirce, can introduce a genuinely new idea (CP 5.171). It proceeds through a *sensuous hypothesis* (CP 2.643), where the described case seeks a potential explanation, which must later be tested through a process of deduction and induction (CP 7.164–255). This form of abduction – which Peirce describes as "a bolder and more perilous step" of logical thought (CP 2.632) – does not constitute a fully regulated inference: rather, it is the consideration of a fact under a new light, opening the way to a possible explanation. Here, abduction is not simply the search for a rule to explain a case, but an attempt to rework ideas and perceptions, mapping their relations. In this sense, abduction functions as an *original inference* (CP 2.96), initially manifesting at the perceptual level:

> The abductive suggestion comes to us like a flash. It is an act of insight, although of extremely fallible insight. It is true that the different elements of the hypothesis were in our minds before; but it is the idea of putting together what we had never before dreamed of putting together which flashes the new suggestion before our contemplation. (CP 5.181)

According to several interpreters (Anderson 1987; 1995; Cooke 2018; Paolucci 2012b), this abductive and conjectural mode of thought, characterised by creativity and freedom in exploring possibilities, is closely connected to the activity that Peirce names musement. Peirce speaks of "a certain agreeable occupation of mind" (CP 6.458), for which no precise name had been found, though he describes it as refreshing (if it occupies about six percent of one's time). He considered naming it *reverie*, but rejected this term, since it suggests *vacancy and dreaminess*, which did not capture its distinctive features. He therefore called it *Pure Play* – a form of wandering governed only by the free movement of thought, with recreation as its sole aim. This activity involves playfully combining the brute facts of reality with the world of ideas, weaving new connections between them. Pure Play can assume various forms: aesthetic contemplation; imaginative constructions (castle-building) in which moral intuitions are trained; or the exploration and contemplation of one or more elements, questioning their causes. It is this last form of play that Peirce specifically identifies as the *play of musement*.

In musement, questions and ideas are followed wherever they may lead, nurturing a mode of thought open to wonder and anomalies. This activity acts as a *ludic interface* (Coppock 2014), a playful and dreamlike preparatory stage in which the mind yields passively to impressions. Once certain impressions capture attention, a focused observation develops, leading eventually to meditation on their causes. However, if one exerts too much conscious effort and rigorous reasoning begins, the play of musement ceases, giving way to scientific inquiry.

Musement thus serves as a precursor to scientific discovery, through a passive engagement with one's own ideas (in the form of words, diagrams, experiments; CP 6.461), allowing them to combine freely and gradually come under rational control. Peirce essentially identifies musement with the inspiration that initiates scientific inquiry: through musement, an original abductive insight (CP 2.96) can emerge, contemplative in character, and subsequently be developed into a formal hypothesis. Musement thus appears as one of those mysterious processes of sign-combination that Eco associated with creativity – a phenomenon he believed could "certainly fall within the competence of neuroscience" (Eco 2004, 14, [my translation]).

5. THE DMN AND ITS NON-SPECIFICITY IN CREATIVITY

At first glance, it may seem that Peirce's musement coincides, in some respects, with the cognitive functions typically associated with the DMN. Both: (a) are initiated when the individual is not engaged in any specific activity; (b) are linked to a quasi-passive mode of mind-wandering and free associative thought, where memories of the past and projections of the future intermingle; and

(c) involve the integration of pre-existing knowledge: musement integrates diverse universes of experience, just as the DMN is structurally connected to brain areas involved in semantic memory and perceptual systems (Andrews-Hanna et al. 2014; Buckner et al. 2008; Mullally, Maguire 2013; Schacter et al. 2012; Spreng et al. 2009).

Despite these general similarities, it is clear that musement, within Peirce's philosophy, is a highly specific operation, whereas the DMN is described in the literature as a broadly active network supporting everyday cognitive functions (Raichle 2015). Indeed, many of these functions – such as reverie, daydreaming, moral imagination, and aesthetic contemplation – are precisely those from which Peirce sought to distinguish musement. In short, while the DMN's functions may partly overlap with those of musement, they also greatly exceed them. Nevertheless, this does not prevent us from considering, following Duarte, that musement could arise from a specific pattern of DMN activation during creative tasks.

As we have seen, Duarte's hypothesis is mainly grounded in neuroscientific studies that report strong DMN activation during creative activities and tasks (particularly Beaty et al. 2014; Ellamil et al. 2012). However, it is important to recognise that this hypothesis falls into a broader neuroscientific mythology of creativity, a tradition which links creativity to divergent thinking and to its supposed localisation within specific brain structures (see Abraham 2024). Indeed, studies exploring the relationship between the DMN and creativity (including those cited by Duarte) present numerous interpretive difficulties. Among the early contributions on this topic (Andreasen 2011; Ellamil et al. 2012; Limb, Braun 2008; Takeuchi et al. 2011), only Andreasen reports full DMN activation during creative tasks. Other studies, such as that by Takeuchi et al. (2011), show activation limited to specific DMN regions, such as the precuneus. Conversely, Ellamil et al. (2012) argue that DMN activation is not involved in idea generation – an activity instead linked to the medial temporal lobe (which governs memory-related functions) – but rather in the creative evaluation phase, during which only certain DMN areas activate alongside the Central Executive Network (CET), with which the DMN is normally anti-correlated.

Another important study (Limb, Braun 2008) points in a different direction: during artistic improvisation tasks, they observed activation in only part of the DMN (the anterior medial prefrontal cortex), accompanied by deactivation of the CET and of another DMN area (the dorsomedial prefrontal cortex). These results are interpreted in opposition to those of Ellamil and colleagues: while Ellamil et al. (2012) suggest that DMN and CET jointly contribute to creative evaluation, Limb and Braun (2008) propose that the deactivation of the CET frees a portion of the DMN to generate new ideas autonomously. In this study especially, the role of the DMN appears highly controversial, given that activation and deactivation occur in two functionally distinct but adjacent regions.

In the neuroscientific literature, the evidence linking the DMN to creativity has therefore been constructed by combining hypotheses drawn from studies of a global type (network-based) with those from a localist approach (focused on specific brain areas). However, these latter studies actually leave considerable interpretive freedom regarding the results, since individual brain areas generally belong to multiple neural networks. As a consequence, the activation of a given area can be attributed to different networks depending on the initial hypothesis adopted by the research group conducting the study (Abraham 2018b).

Further complicating the picture is the way these neuroscientific findings have been interpreted and translated into neurocognitive theories, which suggest that creativity results from the interplay of two distinct cognitive processes: a spontaneous, divergent, and creative mode of thinking, and a convergent, evaluative one. This dual-process model of creativity is said to be reflected in the simultaneous activation of the DMN and the CET (Jung et al. 2013; Mok 2014). These theories form the basis of the research conducted by Beaty et al. (2014; 2015; 2018), a research group whose hypotheses are among the main references in Duarte's paper. One of their studies (Beaty et al. 2015) highlights the concurrent activation of the DMN and CET – typically anti-correlated networks – during creative tasks. However, the same study offers two different interpretations: one suggesting that each network predominates in a distinct phase of the creative process (the DMN in idea generation, the CET in evaluation), and another proposing that both networks contribute simultaneously to creativity.

Even if we were to accept these findings as definitive (which, as we shall see, is not the case), they would already pose a challenge to Duarte's position: namely, that if musement were to be localised neurobiologically, it would implicate not only the DMN but also the CET. For the sake of discussion, let us assume that musement pertains solely to the generative function associated with the DMN, excluding the evaluative function attributed to the CET. Even then, it becomes crucial to question the methodology underpinning the dual-process hypothesis.

Anna Abraham (2024, 129-150), in her study of the neuroscientific mythologies of creativity, clearly demonstrates that the research used to further support the model presented in Beaty et al. 2015, such as Beaty et al. 2018, is methodologically fragile. These studies rely on small sample sizes (often only a few hundred participants) despite employing complex methods such as the *Brain-Wide Association Studies* (BWAS), which require a minimum of 2000 participants to achieve statistical robustness. Moreover, Abraham points out that the fMRI technologies used in these studies are not yet capable of resolving the temporal sequencing of network activations, making it impossible to determine whether creativity involves two distinct phases or a single, simultaneous process.

This methodological fragility must also be considered alongside findings from studies that focus on the

activation of specific brain areas rather than entire networks. Such research shows that the CET is predominantly involved in creative tasks requiring controlled semantic processing, problem solving, reasoning, analogical thinking, and metaphor production (Abraham 2018b; 2019) – all operations that, in principle, would fall within the domain of musement. Furthermore, studies focusing on localised brain activations, rather than BWAS, do not identify a predominant involvement of DMN areas during creative tasks. Rather, they consistently point to the primary role of areas associated with the Semantic Memory Network (Abraham 2014).

Adding yet another layer of complexity, research has shown that typical DMN functions – such as episodic memory and mind-wandering – are not strongly correlated with originality or creative output (Madore et al. 2015; Zeitlen et al. 2022). From this review, two key conclusions emerge:

– The functions of the DMN extend well beyond the activities attributable to musement, encompassing many cognitive operations that are simpler and less creative;
– Even if musement were to be localised neurobiologically, it would involve not only the DMN but also other brain areas and networks, such as the CET and the Semantic Memory Network.

In conclusion, rather than confirming a strong link between the DMN and musement, this analysis points to only a partial overlap between the two. On the one hand, the DMN participates in many cognitive operations from which Peirce sought to distinguish musement; on the other, creative thought processes do appear, at least in part, to involve the DMN.

It is on this partial overlap that reflection must focus, in order to determine what role the DMN might play within a broader semiotic inquiry.

6. THE DMN AND IMAGINATIVE INTEGRATION

In analysing the role of the DMN, Abraham (2019) points out that studies on creativity have often sought to show that the network is implicated in higher levels of creative ideation, while overlooking the fact that the DMN, rather than suggesting a specific link with creativity, seems instead to reveal a substantial continuity between creative and non-creative cognition. The DMN is indeed involved in various types of imaginative but non-creative thinking, such as autobiographical memory, prospection, theory of mind, self-referential thought, and moral reasoning. These operations can be triggered either spontaneously or directly during periods of rest or low cognitive engagement. Moreover, the network is also implicated in non-creative aspects of imaginative thought, such as future semantic thinking and counterfactual reasoning (Abraham 2016; Andrews-Hanna et al. 2014; Buckner et al. 2008; Mullally, Maguire 2013; Schacter et al. 2012; Spreng et al. 2009).

Contrary to what is commonly assumed, this network is not activated only during task-negative conditions (that is, when the mind is not engaged in a specific task) but also during task-positive conditions. Indeed, it appears that the DMN is connected to the salience system, which directs cognition toward relevant perceptual stimuli, facilitating the DMN's context-dependent function of providing perception with schematic frameworks through imaginative simulations based on stored knowledge. Thus, it is involved in all tasks requiring the intervention of intentional imagination (*intentionally based imagination*) to interpret or disambiguate situations and contexts by drawing inferences from prior knowledge (Abraham 2016; 2018b; 2019; 2024; Gerrans 2014). In short, the DMN seems to play a role in supporting various aspects of imagination, from contemplative and daydreaming modes to more structured tasks involving context interpretation, situation understanding, and predicting others' intentions.

A recent article by Yeshurun, Nguyen, and Hasson (2021) further clarifies this perspective. The authors propose conceptualising the DMN as a dynamic network capable of integrating information across wide temporal scales. They show that the function of the DMN and its subareas during extrinsic (task-positive) activities has been increasingly studied over the past years. From their perspective, the DMN should not be seen as a purely intrinsic system active only during stimulus-independent tasks, but as a network actively involved in regulating responses to external stimuli. The DMN's subareas alternate between extrinsic and intrinsic activities, acting as a condensation space capable of integrating sensory inputs across extended temporal frameworks with previously stored intrinsic information. For example, the DMN is crucial for narrative comprehension (whether the narrative is written, seen, heard, or read) and it appears to be activated independently of the *expression plan*. Its role seems tied to interpretative activities that, particularly in cases of narrative ambiguity, involve the recruitment of other brain networks to regulate and facilitate the processing of extrinsic signals.

This role of the DMN in extrinsic activities has also led researchers to reconsider how the DMN operates during intrinsic activities. According to their perspective, the DMN should not be seen as a mechanism for producing representations, but rather as an *integrator of information through schematisation*. It supports the construction of situational schemas, which are subsequently mobilised across various cognitive functions. For instance, the DMN is activated when reading a story at moments of plot twists, or when new information prompts a change in the interpretation of an event. One of the most surprising findings from the experiments reviewed by Yeshurun and colleagues (2021) is that DMN activation patterns are shared among participants who arrive at similar interpretations of a given situation and differ among those with divergent interpretations. The study shows that DMN activity changes not only in response to internal stimuli (such as prior beliefs, memories, behavioural and conceptual schemas, personal narratives, emotions, motivations, and

bodily states) and external stimuli (such as contextual cues, actions, and all types of narrative texts or salient environmental stimuli), but also during social situations (including group decision-making, dialogue, embodied interactions, and storytelling/listening).

Another key finding expressed in this study is that participants' brains tend to synchronise their DMN activity during social interactions, even modulating each other's brain responses. In other words, interaction with others and with the external world plays a decisive role in DMN activation. According to this perspective, the DMN should be conceived as the brain area where stimuli from the self, the body, the external world, and others are dynamically integrated – the space where individual imagination encounters the social world.

Thus, the DMN functions as a fundamental "sense-making network" (Yeshurun et al. 2021, 187): a neural space activated whenever prior knowledge meets external stimuli, through either the confirmation or violation of expectations about the environment (expectations that the brain continuously generates and updates). This framework also helps to clarify what happens during creative tasks: the DMN is activated in both typical and atypical situations. In the latter case, where a novel solution must be found for an unprecedented problem, the DMN connects with other brain areas associated with creativity, such as the Semantic Memory Network and the CET (Abraham 2024, 148).

This radically different conception of the DMN invites a reinterpretation from a semiotic perspective that differs markedly from Duarte's, while nonetheless drawing significantly on his original intuition. Rather than constituting the neurobiological seat of a single cognitive operation, the DMN should be understood as the neurobiological substrate of a structure that is constantly operative within human cognition: the structure of imagination.

7. PEIRCE, ECO, AND THE CLUES FOR A NEUROSEMIOTICS OF IMAGINATION

The central role played by imagination in semiotic and abductive processes had already been emphasised by Peirce, who argued that original abduction necessarily requires an imaginative act – one capable of providing a schema or diagram (an interpretant) through which reality can be framed from a particular stance:

> When a man desires ardently to know the truth, his first effort will be to imagine what that truth can be; He cannot prosecute his pursuit long without finding that imagination unbridled is sure to carry him off the track. Yet nevertheless, it remains true that there is, after all, nothing but imagination that can ever supply him an inkling of the truth. He can stare stupidly at phenomena; but in the absence of imagination they will not connect themselves together in any rational way. Just as for Peter Bell a cowslip was nothing but a cowslip, so for thousands of men a falling apple was nothing but a falling apple; and to compare it to the moon would by them be deemed 'fanciful' (CP 1.46).

The distinction Peirce draws between imagination as idle fantasy – which leads thought astray – and imagination as a synthetic operation was later taken up by Eco in *Kant and the Platypus* (1997), where the semiotician distinguishes between *imagine*$_1$ and *imagine*$_2$:

> Let us grant therefore that the Imagination, whatever faculty or activity it may be, provides the intellect with a schema, so that it can apply it to the intuition. Imagination is the capacity to represent an object even without its being present in the intuition (it is "reproductive" in the sense that we have called to imagine$_1$), or it is synthesis speciosa, productive imagination of a species, figure [imagine$_2$]. (Eco 1997 [1999], 81)

For Eco, as for Peirce, imagination is the schematising capacity that operates both in task-unoriented activities – such as mind-wandering – and in task-oriented activities – such as interpreting a plot twist, where the subject must imagine or figure out new relations to make sense of a situation. In practice, imagination intervenes both as a mechanism of free mental wandering and as a means of producing abductions that schematise the perceptual field. Peirce clearly highlights the connection between abduction and perceptual judgment, showing in several passages that the aim of abduction is not to develop new concepts, but to establish habits (Paolucci 2021a): semi-automatic interpretative modes for unreflexively making sense of the world. In this sense, abduction ultimately "shades into perceptual judgment without any sharp line of demarcation between them" (CP 5.181). Thus, perception itself would be nothing more than the accumulation of *subconscious abductions* (CP 5.298–5.306) that we perform most of the time, i.e. abductions that tend to be correct or effective precisely because they rely on consolidated, non-creative knowledge. The role of imagining$_2$, therefore, is to schematise what happens within the field of experience and for the most part, this function does not require creative effort, but rather a process of reintegration based on pre-existing knowledge. Viewed in this light, the role attributed to the DMN in theories of *predictive processing* (Gerrans 2014; Abraham 2019) aligns perfectly with the role that imaginative abductions occupy in contemporary semiotic theories of perception (Paolucci 2021a, ch. 5): namely, elaborating mismatches between perceptual anticipations and environmental stimuli by mapping them onto consolidated semiotic *frames* and *scripts* stored in memory. It should therefore come as no surprise that the DMN – as understood by Yeshurun and colleagues (2021) and Abraham (2016; 2024) – appears to be the neural mechanism whose activations are correlated both with the function of imagining$_1$ and, more precisely, with the function of imagining$_2$: that is, integrating sudden changes into an ongoing script or sequence and reassigning them new significance.

Only when this operation fails does the DMN, connecting with other areas, supports the creation of a genuinely new hypothesis – a *creative abduction*, thus linking back to what Peirce calls *musement*.

8. CONCLUSION

The analysis developed throughout this article shows that the DMN cannot be simply equated with the activity of musement as conceived by Peirce. Rather, the DMN appears as a dynamic integration device that enables the constant schematisation of experience, combining internal and external stimuli through the activation of stored semiotic frameworks. This function corresponds to what Eco, following Kant, distinguishes as *imagining*$_1$ (reproductive imagination) and *imagining*$_2$ (productive imagination), both of which the DMN supports. Musement and creative abduction, therefore, do not arise directly from the DMN's basic activity, but only when its ordinary integrative processes prove insufficient, requiring the generation of genuinely new hypotheses. Neuroscientific research on the DMN and its relationship to creativity thus discourages the idea of directly linking the DMN's functions to the concept of musement. Similarly, it challenges the traditional hypothesis that associates DMN activations exclusively with imaginative activities occurring in the absence of external tasks (activities that would align with Peirce's notion of pure play). Instead, it paves the way for a new conception of a semiotics of creativity, one rooted within the same semiotic-cognitive operations that are active even during activities not conventionally regarded as creative. In this perspective, the DMN should be interpreted not as the neurobiological seat of a single cognitive function, but as the structural substrate of imagination as an ongoing, dynamic semiotic process – a conception that points towards the possibility of a non-reductionist neurosemiotics of imagination.

Naturally, this conclusion cannot help but leave a certain sense of incompleteness, as any such suggestion – if it is to be sustained – would need to be integrated into a broader theoretical framework that more clearly articulates and defines the operation of schematisation and its relationship to the DMN. Developing such a framework, however, extends well beyond the aims of the present article, even if some preliminary steps have already been taken by comparing the schematisation processes described in the DMN literature with semiotic concepts of narrativity and their role within perceptual semiosis (Lobaccaro 2022a). Nonetheless, such an intuition would also require empirical validation, through experimental studies capable of substantiating or refining the connections hypothesised between semiotic processes and neural dynamics. Future research should aim to develop interdisciplinary methodologies capable of capturing not only the biological correlates of imaginative activity, but also the multi-layered semiotic processes through which individuals schematise, interpret, and reorganise their experiential worlds. A closer integration between empirical neuroscience and semiotic theory could help build a richer and more nuanced understanding of how sense-making unfolds across biological, cognitive, and cultural domains. Further opportunities to pursue this line of inquiry, both theoretically and experimentally, are certainly to be hoped for.

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