Default Mode Network, Schizophrenia, and Narrativity. Comments on Psychopathology of Language

DEFAULT MODE NETWORK, SCHIZOPHRENIA, AND NARRATIVITY
COMMENTS ON PSYCHOPATHOLOGY OF LANGUAGE

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Abstract: This paper discusses some of the ideas expressed in the paper Psychopathology of Language, DMN and Embodied Neuroscience: A Unifying Perspective (Pennisi 2022). Pennisi presents an innovative and promising framework, but some issues need a critical discussion.

In particular, I argue against the idea that schizophrenia is mainly a linguistic disorder and the idea that the functions associated with the Default Mode Network (DMN) are essentially linguistic. By referring to phenomenological psychopathology (Parnas and Sass 2007) and evolutionary psychology (Corballis 2017), I show that: i) schizophrenia is better conceived as not a primarily linguistic disorder, but as a disorder that affects human experience as a whole (Stanghellini 2008); ii) the DMN functions could involve language, but it is not essentially linguistic. I examine an alternative view that individuates the main function of DMN in the narrative imagination (Carroll 2020), comparing it with the idea of narrativity developed by cognitive semiotics (Paolucci 2021).

Keywords: Default Mode Network, Schizophrenia, Psychopathology of Language, Narrativity, Cognitive Semiotics, Phenomenological Psychopathology.

1. INTRODUCTION

In the focus article of the last issue entitled Psychopathology of Language, DMN

and Embodied Neuroscience: A Unifying Perspective, Antonino Pennisi (2022) delineates a new, original framework that aims to integrate the psychopathology of language with the studies of evolutionary biology and embodied, affective and social neuroscience.

The work focuses on recent neuroscientific findings about the Default Mode Network (DMN) (Buckner et al. 2008; Raichle 2015), a large-scale brain system primarily composed of the dorsal medial prefrontal cortex, the posterior cingulate cortex/precuneus and the angular gyrus. The DMN was identified because of its high activity during passive control conditions. Today, it is studied to measure intrinsic brain activity (i.e., the neural states generated spontaneously by the brain rather than in response to stimulation or immediate responses to environmental stimuli). After its fortuitous discovery (Buckner 2012), the DMN has received a growing and widespread interest from several scholars in the social and biological sciences for its psychological and clinical relevance.

Referring to this literature, Pennisi conceives the DMN as a possible junction for an interdisciplinary theory that holds together an etho-bio-neurological view with an anthropo-socio-semiological one capable of integrating the psychopathological studies on Körper (the biological body) with those on Leib (the lived body, the body as the fulcrum of the experience) (see Pennisi 2021; Gallagher 2005; Fuchs 2018).

There are good reasons to think that the studies on the Default Mode Network and its alteration in psychopathologies are the right path to realise the integration proposed in the article. On the one hand, an abnormal function of the DMN can be conceived as one of the most significant insights in recent neuroscientific research (Buckner et al. 2008; Broyd et al. 2009; Whitfield-Gabrieli, Ford 2012): in particular, the DMN offers important data for those psychopathologies such as mood and anxiety disorders, bipolar disorder,

autistic spectrum, ADHD, and major psychoses (schizophrenia and paranoia). On the other hand, since its identification (Raichle et al. 2001; Greicius et al. 2003), the DMN has become a means through which investigating all those high-level cognitive functions that our culture conceives as specific human beings' faculties, such as the association of free thoughts, the recollection of past experiences, the inner speech, the mind wandering, the moral evaluation, the planning of future activities, the creativity, the self-image, etc. (Andrews Hanna et al. 2014; Callard, Margulis 2011; 2014; Pennisi 2022). In short, the DMN is an area that enables the neuroscientific study of the most representative faculties of human cognition and how these faculties are altered in psychiatric disorders. For these reasons, the field of DMN studies is a perfect candidate for promoting the integration of the two approaches of which the author is one of the prominent representatives: the Spinozian Cognitive Science (Pennisi 2021) and the Psychopathology of Language (Pennisi 1998).

In the context of this innovative approach with which we cannot but sympathise, we believe that in Pennisi's argumentation, a few interpretive issues worthy of discussion are to be found. The author promotes a language-centred approach arguing that studies on DMN corroborate a theory that sees schizophrenia as a specific linguistic disorder and that the intrinsic activities associated with DMN can be interpreted as primarily linguistic.

This paper will illustrate the reasons for a more modest version of these claims showing that:

1) Although studies on DMN may help us understand some of the linguistic manifestations of schizophrenia, they do not allow us to opt for a theory that identifies schizophrenia as a predominantly linguistic disorder.

2) The DMN and its associated cognitive functions may involve language without, however, being identified with it.

Later I will put forward an interpretation of the DMN from a semiotic-

cognitive perspective (Paolucci 2021), framing its primary function in active sense-making for the narrativization of experience (Yeshurun et al. 2021; Ferretti 2022; Corballis 2014; Carroll 2020). The DMN functions can be seen in the light of one of the fundamental theses of semiotics, namely the idea that the specific way in which human beings make sense of the world is a narrative Gestalt (Greimas 1970; Paolucci 2012a; Brandt 2020) which is present as much in perception (Paolucci 2021) as in understanding the actions and intentions of others (Paolucci 2019), as in understanding any form of narrative (Eco 1979; Greimas 1970). In conclusion, I will delineate future challenges and opportunities for an integrative approach that holds together cognitive semiotics, psychopathology of language, and scientific research on DMN.

2. PSYCHOPATHOLOGY OF LANGUAGE AND DMN: PROGRESS AND CONCERNS

Pennisi's project to integrate the psychopathology of language with embodied cognition's perspectives is brought forth through a massive and wide-ranging argument, which can be summarised in four main steps:

i. First, the article examines the major neuropsychiatric findings, with particular reference to schizophrenia, highlighting how neuroscientific data are so far incapable of conveying the «biological complexity» that characterises pathological and non-pathological human cognition and behaviour. In order to navigate such complexity, it is required a philosophical integration capable of identifying not only neuronal networks but also «the network of meanings that transforms cognitive systems into ontological systems» (Pennisi 2022: 23). The approach for investigating this network of

meanings is the psychopathology of language, a discipline academically instituted by the author in 1987 (Pennisi 1994; 1998). One of the crucial theoretical proposals advanced by the psychopathology of language is «the thesis that schizophrenia should be considered primarily a language disease» (Pennisi 2022: 24; see also Pennisi 1998; 2001; 2003; Falzone 2004; Pennisi, Perconti 2006; Cardella 2017). However, as the author acknowledges, the proposals made «at the time, failed to turn into theoretically and clinically plausible hypotheses» (Pennisi 2022: 28). For this reason, it becomes necessary to test these hypotheses in the light of current neuroscientific studies, which the author identifies in DMN studies.

ii. In his analysis of the literature on DMN, Pennisi argues that the intrinsic cognitive functions linked to DMN activation have a «fundamentally linguistic nature» (Pennisi 2022: 32). To support this hypothesis, he underlines that Brodmann's area 39 (Angular Gyrus, AG, which is only present in the human brain) is a crucial part of the DMN. Moreover, comparing the projection of all the results of the meta-analysis on the activation of the brain's areas during semantic processing (Binder et al. 2009), it is evident that the areas associated with internal semantic processing are also areas that are activated in the DMN during intrinsic activities.

iii. The studies considered by the author show that during resting states, schizophrenic patients manifest hypoactivation in the frontal areas of the DMN and hyperactivation in the posterior areas of the DMN, particularly in Brodmann's area 39. Indeed, Area 39 (Angular Gyrus) is typically associated with the semantic processing of heard words, inner dialogue, semantic association, and semantic memory. Recently, one of the functions attributed to the AG is the semantic processing on multiple levels of abstractions from the

sensory, motor, and affective inputs (Binder, Desai 2011). In short, this area allows a form of anchoring to semantic representations depending on context and familiarity. The AG is usually activated in semantic processing tasks only when recovery of semantic disambiguation is required, which naturally varies according to the linguistic encyclopedia of the individual (Pennisi 2022: 44). In sum, AG has the role of a repository for multimodal representations that are used during non-automatic processing tasks. According to Pennisi, the hyperactivation measured in the posterior part of the DMN and involving Brodmann's area 39 (Mannell et al. 2010; Pomarol et al. 2008) may unveil the nature of some of the specific disturbances that characterise the schizophrenic disorder, such as semantic hyper-association, derailments, rumination, and rumours.

iv. The idea that AG is associated with embodied abstractions appears even more interesting considering the semantic theory of the cortico-subcortical distribution of language. Following this theory, semantic processing takes a dorsal route, which transforms acoustic signals into articulatory representations, and a ventral route, involving the Angular Gyrus, that allows a polymodal semantic integration, i.e., the conjunction of semantic elements from different sensory systems. Therefore, a kind of cognitive subsystem with a dual function shall be hypothesised. It should work like an interface between the motor and sensory processes (dorsal route) and between the articulatory representations and the personalised and «embodied» semantic processing. Several theories have suggested that this interfacing role may be played by subcortical areas such as the basal ganglia (Poeppel, Hickok 2004). Recent studies on DMN in schizophrenia show evidence of a hyper-association «between the posterior and subcortical areas during periods of prolonged rest DMN» (Pennisi 2022: 42). According to the author, these neuroscientific insights seem to suggest the very

confirmation of the theory that considers the fundamental problem of schizophrenia as an alteration of the connection between semantic production and embodied abstractions, a kind of conceptual-semantic hyper-productivity that fails to anchor itself to an ontological level (Pennisi 1998).

Moving from these arguments, it is possible to deduce some fundamental statements that the article intends to prove:

a) Studies on the DMN are essential to better understanding psychopathologies and to integrating the perspective of semiotics and philosophy of language with that of neuroscience.

b) Studies on the DMN bring neuroscientific evidence to identify the pre-eminently linguistic nature of schizophrenia.

c) The intrinsic activities that trigger the DMN can be interpreted as primarily linguistic.

While the article strongly demonstrates point (a), points (b) and (c) appear to be particularly problematic. The proposal in fact, although well-argued and robust, does not present sufficient justification for accepting such strong interpretations of the neuroscientific data.

My hypothesis is that it is possible to preserve the proposals and reflections of the target paper almost in their entirety by incorporating them into an alternative framework able to mitigate the claims b) and c). This will be possible by showing that:

- The DMN studies bring a wealth of evidence indicating that schizophrenia is also, but not primarily, a language disorder.

- Language is not the only but one of the central elements in the

cognitive functions associated with DMN.

In the next section we will deal with the latter point, while in the fourth section, we will address the first.

3. SCHIZOPHRENIA IS NOT ONLY A LANGUAGE DISORDER: A PHENOMENOLOGICAL PERSPECTIVE

As Pennisi rightly remarked, schizophrenia is a typically human disorder not found in other animal life forms (Pennisi 2022: 24)[1]. On this basis, it is possible to identify the specific nature of schizophrenia in the same evolutionary specificity that characterizes human cognition: language. Indeed, the schizophrenic linguistic manifestations are so characteristic that they have always been regarded as one of the most distinctive elements of the disorder (Kraepelin 1899; Tanzi 1899-1900; Piro 1967; Pennisi 1998; Dema 2022).

Specific studies on the hyperactivation of the posterior part of the DMN during resting states, carefully examined by Pennisi, may indicate cognitive activities generally associated with AG, such as the semantic processing of heard words, inner dialogue, and the elaboration of metaphors (Davis-Gaskell 2009; Kouider et al. 2009; Sharp et al. 2010; Price 2010). Moreover, these areas seem to constitute the neural basis for the linguistic manifestations identified by the psychopathology of language such as the flight of ideas, the avalanche effect, semantic derangement, mannerism, and verbigeration (Pennisi 1998). The hypothesis seems plausible and deserves further investigation, but it is unclear why such hyperactivation should be reported as solely related to a linguistic dimension of schizophrenia. The data shown by Pennisi, in fact, suggest that the study of DMN can help in understanding some of the language disorders in schizophrenia, but does not eliminate other concurrent explanations in the

definition of the disorder itself. Thus, the target paper may well support that alterations in the DMN could help explain schizophrenic language disorders. Still, it is not decisive in order to favour the primarily linguistic interpretation of schizophrenia provided by the psychopathology of language.

In addition, the final part of Pennisi's argument, which builds a bridge between the psychopathology of language, contemporary studies on the anatomy of language and studies showing a hyper-connection between the DMN and the basal ganglia, seems more problematic (Salvador et al. 2010; Sheffield, Barch 2016). Pennisi reads this hyperconnection as the fundamental semantic imbalance of schizophrenia: «because it alters the relationship between the ordinary processes of schizophrenic semantics and the "embodied elaboration"» (Pennisi 2022: 48). Nevertheless, it is not clear why the author interprets the studies in this way: Salvador et al. and Sheffeld's and Barch's studies do indeed show hyperconnectivity between the DMN and the basal ganglia, but not as Pennisi argues with the posterior areas of the DMN and the angular gyrus. The hyperconnectivity that constitutes «the main disorder of the disease» (Salvador et al. 2010) is between the basal ganglia and the frontal area of the DMN, which is not involved in the neuroanatomical model of meaning processing (Hickok, Hoersh 2004) considered by Pennisi. The author of the paper should therefore clarify this point before stating that it is the «element that better proves the profoundly linguistic nature of schizophrenia» (Pennisi 2022: 46). Thus, the interpretation of a primary linguisticity of schizophrenia is particularly hard on the basis of the neuroscientific data alone. Moreover, some theoretical reasons lead to be even more cautious about this idea:

– The proposed thesis of a primary language disorder in schizophrenia must first come to terms with the fact that schizophrenic language disorders, albeit specific, are not manifested by all sufferers (Kupenberg 2010: 3). In

addition, in patients, schizophrenic language does not always maintain the same register, it blurs at moments, then returns to linear, and presents extremely dissimilar manifestations, as noted by Pennisi himself (2022: 27). Rather, this fluctuation of language disorders needs to be compared with the relative stability of negative symptoms related to affectivity and coenesthesia (Rossi Monti, Stanghellini 1999).

– On the other hand, coenesthetic and perceptual-experiential disorders are conceived as primary by classical phenomenological psychopathology (Jaspers 1913; Minkowski 1927). The phenomenological research on this topic has led to the development of diagnostic models such as the EASE (Parnas et al. 2005), an operationalized diagnostic model that has proven to be reliable and predictive (Nordgaard et al. 2021; Parnas, Henriksen 2014). These studies indicate that the disorder's original nature is related to the sensorimotor rather than linguistic dimension (Gallagher 2004; Fuchs 2009; Stanghellini 2009; Pennisi 2018). This strand of thinking has converged in an account that frames schizophrenia as a disorder of ipseity (Sass, Parnas 2003), that is, the minimal non-reflective and non-linguistic form of subjectivity connected to proprioception and sensomotricity (Gallagher 2000; Zahavi 2008). In the very last few years, these theories have also found plenty of evidence thanks to neuroscientific research that attempts to test the hypotheses of phenomenological psychopathology (cf. Gallese, Ferri 2014; Ebish et al. 2013; Ferri et al. 2012; Parnas et al. 1996; Borda, Sass 2015). These findings indicate a schizophrenic disorder of body movement discrimination, agency, multimodal integration of perceptual stimuli, affectivity and recognition of environmental stimuli. None of them is connected or can lead to the hypothesis of a primarily linguistic disorder. Interpretations on the role of the DMN in schizophrenia have also been put forward within this picture (Gerrans 2014; Sass, Byrom 2015). These interpretations do not emphasise the hyperactivation of the

posterior part of the DMN in resting states of the brain (as Pennisi does) but the hyperactivation of the anterior regions of the DMN during task-related activities (Whitfield-Gabrieli, Ford 2012). In this framework, hyperactivation is seen as an excess of the imaginative component of perception that confines the subject a delusional state. Essentially, the role of the DMN is not seen as related to linguistic functions but to the function of producing simulations of experiential scenarios that induce the subject to directly experience multiple realities (Gerrans 2014; Gallagher 2009; Sass 2014).

However, on the basis of a phenomenological approach, it is still possible to provide an alternative view to the fact that schizophrenia is a specifically human disorder that also involves language. As Pennisi observes, language constitutes a specificity of both human cognition and brain (Pennisi, Falzone 2016). Yet, in the current state of research, we know that it is not the only uniquely human faculty. Indeed, there is an influential strand of studies in psychology and social neuroscience that explains the specificity of human language moving from another form of specificity that is equally constitutive of the Sapiens species: intersubjectivity and social cognition (Tomasello 1999). The capacities of mimesis, attention and joint intention are shared with large mammals, but in the human animal they take the form of cooperative intentionality capable of creating a shared space between

individuals (Tomasello 2019). Human social cognition is characterized by a kind of we-intentionality (Zahavi 2021) that, according to these theories, constitutes a prerequisite for the development of social, cultural and linguistic cognition (Corballis 2002, 2017; Tomasello 2003; Ferretti 2010). Semiotic cognition is also characterized by a social and intersubjective specificity (Violi 2008; Paolucci 2020; Zlatev 2008).

– Over the past two decades, phenomenological psychopathology has increasingly moved closer to these positions in what has been called an intersubjective turn (Van Duppen 2017). In the last years, it has been emphasized that alongside the loss of the subjective dimension, which psychopathology has always identified as the core of the schizophrenic experience, there is a simultaneous loss of the intersubjective dimension of experience. Hence, schizophrenia is a disorder of both the self and the self-with-the-other (Stanghellini 2008; Fuchs 2015; Gallagher 2013; Hutto 2013; Ebish, Gallese 2015). The schizophrenic disorder, as an alteration in the relationship between lived corporeality and the world, also involves the immediate form of intercorporeality that constitutes the basis for the emergence of higher forms of social cognition (Gallese 2003; Gallagher, Hutto 2008; Gallagher 2020; Paolucci 2019).

– Within the intersubjective turn of psychopathology, an increasing emphasis is being accorded to language (Pienkos, Sass 2018) and the ways in which it is intrinsically linked to the intersubjective dimension of schizophrenia (Pienkos, Sass 2016). The thesis of psychopathology is that schizophrenic disorder originates as a disturbance of ipseity and intersubjectivity but comes to encompass the subject's entire field of experience, including the linguistic field (Sass 1992). By breaking the inter-subjective bonds that allow subjects to participate in everyday social life, schizophrenia produces a form of language use that becomes autonomous by separating itself from the communicative

dimension of social exchange. Schizophrenic language is one of the products of the crisis of common sense (Stanghellini 2008) originated from the basic disorders of consciousness. Without a world shared with others, language becomes a private world in which the schizophrenic subject navigates by assembling and disassembling its pieces without any need for anchorage to a shared situation.

Essentially, these arguments can affect the language model proposed by Pennisi, showing that: (a) language disorders, albeit widespread, are not always present in schizophrenia; (b) the phenomenological psychopathology from which the psychopathology of language originates holds that the disorders prevalent in the emergence of schizophrenia are related to a disorder unconnected to the higher processes of thought and do not, at least in the early stages, involve the linguistic faculties; (c) this theory is compatible with neurological evidence including those from of the DMN studies; (d) the fact that schizophrenia is a specifically human disorder can be explained by two antagonistic theories that do not yet have any conclusive evidence. The Darwinian theory that identifies language as the species specificity of humans is plausible (Pennisi, Falzone 2016) but not definitive, to the extent that other eminent and widespread theories identify the true specificity of human cognition in the forms of social cognition from which the acquisition of linguistic faculties would derive; (e) the idea that the human specificity of schizophrenia can be related to the distinctive social cognition of the human animal has recently been highlighted by contemporary phenomenological psychopathology. In this framework, schizophrenia is thought to be a disturbance of the body and inter-corporeality that erodes the dimension of common sense inhabited by the subject by producing a detachment between linguistic competence and the world shared with others.

DMN studies certainly allow to study how the brain is or is not activated during task-related goals or not-related task activities, but the evidence that can be derived does not allow for the pre-determination of the interpretive strategy, if not by placing constraints on it (Paolucci 2012b). At this stage of knowledge, it is not possible to know whether the disorders identified by Pennisi in the DMN are the result of a specific dysfunction of language areas in the brain or whether they are the result of a large-scale reorganisation of neuronal networks intrinsically linked to a change in the subject's experience. The relationship between *Leibe* and *Korper*, so valuable to Pennisi's Spinozian proposal (2021), is still far from being resolved. This is not because we lack information on *Korper's* neurobiological alterations, but because we lack theories of *Leibe* that enable us to bring the available data into a unified framework. Therefore, it seems that to shed light on the biological complexity of schizophrenia, we need to put forward not only a theoretical integration drawn from phenomenological analyses of patients' accounts but also a resettlement of the available neuroscientific data used to validate the theories at stake.

However, I would like to suggest a possible path of integration between the ideas of the psychopathology of language and those of phenomenological psychopathology. On the one hand, in fact, the researchers from the psychopathology of language state that «the predominantly semantic and pragmatic value of the schizophrenic disorder requires, in fact, the reconstruction of phases of collective and social processing of language» (Pennisi 2022: 25), also thinking that schizophrenic language disorders can be conceived as an inability to participate consistently in the linguistic games of a community (Cardella 2017). On the other, phenomenological psychopathology also identifies language disorders starting from a dysfunction of the processes related to social cognition and intercorporeality. The intersubjective dimension of the schizophrenic disorder can thus become the basis for theoretical

comparison and implementation (for a proposal, see Lobaccaro 2022; Lobaccaro *forthcoming*).

One can dispense with the problematic thesis of the exclusively linguistic nature of schizophrenia and place theories of the psychopathology of language within the broader research framework that conceives schizophrenia as a disorder of the basic experience of a shared world. This would allow interpreting schizophrenia also as a constitutively, but not primarily, linguistic disorder.

4. FROM THE LINGUISTIC TO THE NARRATIVE INTERPRETATION OF DMN FUNCTIONS

The integration between the psychopathology of ipseity disturbance models (IDM, Sass, Parnas 2007) and those of psychopathology of language could also benefit neuroscientific study and research. Indeed, the relationship between the areas that seem to bear evidence in favour of an IDM model and the areas involved in the DMN could be investigated. The first steps of this integration attempt have already been taken by outlining a bio-pheno-social model of schizophrenia that promises to hold together studies on perceptual and sensorimotor disintegration with those on abnormal DMN functioning (Sass et al. 2018; Nelson et al. 2009, 2013, 2014). In this respect, more and more neuroscientific studies show the extreme connectivity of the DMN with other neuronal networks with which it works in correlation or anticorrelation (Andrews-Hanna et al. 2014; Margulies et al. 2016) such as, for example, the social brain network (Mars et al. 2012; Corbetta et al. 2008), the mirror neuron system (Monlar-Szakacs, Uddin 2013; Sandrone 2013; Li et al. 2014) and the salience network (Seeley 2019; Gerrans 2014). In this sense, the research on DMN could provide indispensable assistance in better understanding how the entire neuronal activity of schizophrenic patients is organized. The DMN is a

perfect candidate for this task precisely because, as Pennisi points out, it is the largest network in the human brain and is involved in an extreme variability of cognitive functions (Pennisi 2022; Andrews-Hanna 2012). Indeed, recent studies have shown that the DMN is not only active during the intrinsic activities of resting states, but also in goal-directed tasks where it is believed to assume the fundamental role of action planning (Yeshurun et al. 2021). The DMN is currently thought to play a role in mental wanderings, planning future actions, remembering past experiences, dreaming, reflecting on oneself and one's body image, the ability to switch from one thought to another, imagination, understanding stories, some social cognition tasks, and analysing one's own and others' emotions. Considering this great versatility, it is not clear why, according to the target paper, the extreme variability of activations and functions involved in DMN should be traced back to a «fundamentally linguistic nature» (Pennisi 2022: 32). Pennisi advances two fundamental reasons for this interpretation:

– The essential role that the angular gyrus plays in functions involving the DMN and in semantic processing leads to plausibly consider it an area that enables a kind of inner dialogue that brings to light emotional states, creative processes, stored information material, autobiographical memories, etc. (Pennisi 2022: 34).

– The almost complete overlap between the neuronal areas of the DMN and those involved in the task of processing linguistic concepts in the absence of external stimuli. Pennisi refers to Binder's (2009) meta-analysis, showing that «the semantic system identified here is also strikingly similar to the human brain thought to be active during the conscious resting state» (2781-2782). The author develops his interpretation by saying that all brain areas that contribute in a species-specific way to the semantics of word recognition seem to be involved in the DMN, deducing that «in the absence of stimuli, the

human brain becomes a linguistic brain» (Pennisi 2022: 37).

This argument aims to show, through data that does not actually falsify its validity, only one of the many possible interpretations of the relationship between language and the DMN. Although the neuroscientific data do not disconfirm the position advocated in the article, at the same time, they do not seem to prove its cogency at this stage.

For example, the use of the angular gyrus as possible evidence for the linguisticity of DMN functions does not consider the multimodality of this area (Seighert 2013). That is, Pennisi selects as the pre-eminent function only one of the many with which the angular gyrus is associated, and extends it to the entire neuronal network, of which, however, the AG is only a part[2]. The theory that interprets the role of the angular gyrus in the DMN as an area for linguistic task-free semantic and conceptual processes (Binder et al. 1999) is one among many others. Alternative perspectives suggest that the bilateral AG acts as dynamic self-referential regions during rest that are associated with interoception and somesthesis (Laird et al. 2009). Alternatively, the AG might be engaged in constructing mental scenes based on memory during rest or when subjects envision themselves in the future (Andrews-Hanna et al. 2010).

The fact that intrinsic linguistic processing of meaning activates neural areas that completely overlap with the DMN, and activates different areas when meaning is processed from external stimuli (Binder et al. 2009), does not imply that the cognitive functions associated with the DMN are linguistic. In other words, this finding can be used to show that intrinsic semantic processing is one of many functions associated with DMN activity, without necessarily asserting that all functions associated with the DMN have to do with linguistic meaning processing.

The predominant interpretation of the DMN is that it is a powerful system for producing mental simulation aimed at organizing past experiences and

anticipating future ones in the absence of immediate environmental stimuli (Raichle, Gusnard 2005; Buckner et al. 2008). These simulations are forms of self-projection in meaningful models of the self and its relations with the world (Buckner, Carroll 2007; Raichle 2015; Stan, Christoff 2018). This interpretation can rely on the fact that the Default Mode Network is not only the largest neuronal network in the human brain, but is also present in many other animal species, such as the monkey (Buckner et al. 2008), the cat (Popa et al. 2009), the rat (Lu et al. 2012) and in mice (Stafford et al. 2014). Thus, it can be assumed that the interspecific function of the DMN is to integrate sensory and affective information in order to produce simulations of behaviour and plan actions to cope with future changes in the environment. The DMN can be understood as a powerful simulator that uses information from the past to predict the future (Gerrans 2014: 70)[3].

Such forms of simulation are not necessarily linguistic; rather they have also been thought of as simulative forms of reenactment of perceptions and actions (Gerrans 2014). Interestingly, even when not characterized as propositional forms, the simulations attributed to DMN activation are conceived as forms of imagination with a narrative structure (Carroll 2020; Gerrans 2013; Corballis 2014). Approaches that frame the DMN in this way emphasize how this is a core network for Mental Time Travel and Mental Space Travel (Suddendorf et al. 2009; Carroll 2020; Ferretti 2022). Those capacities indeed are common to many mammals, but particularly developed in humans that are able to project themselves into the future with the imagination in order to design and plan decisions on a contextual basis and on past individual experiences (Suddendorf et al. 2007). But not only that. The network is strongly involved in social cognition during mindreading tasks, when we try to understand the actions of others, during the reflection on others' emotional states, and is involved in the perception of social isolation (Spreng et al. 2020). No surprise then that recent

studies also highlight the association with mirror neuron system circuits in processing face-to-face interactions (Monlar-Szakacs, Uddin 2013; Sandrone 2013; Li et al. 2014). These findings have allowed some theorists to associate the DMN, in addition to the ability to Mental Time Travel and produce imaginative simulations, with another fundamental imaginative function: perspective-taking, that is, the ability to put oneself in the other's shoes (Carroll 2020; Ferretti 2022).

The preponderant role of the DMN thus seems to be related to a cognitive form of narrative organization and integration of other elements from the various other cognitive functions such as perception, memory, motivation, emotion, and social cognition (Sambuco et al. 2022).

These ideas on DMN and its function have led to the elaboration of new theories on the evolution of language that go in the opposite direction of the idea of a mainly linguistic function of DMN. Indeed, these theories conceive language as the result of the inherent narrativity of the brain and human communication (Corballis 2017; Ferretti, Adornetti 2020; Ferretti 2022). In other words, according to these theories, humans have not learned to tell stories that make sense of the world because they have a language, but they have developed a language because it enhances their ability to construct narratives that make sense of the world.

If we take these theories seriously, the idea of entirely linguistic functioning associated with the DMN may give way to a notion of a DMN that also, but not only, accomplishes linguistic functioning (Carroll 2020). Although what has been called the narrative brain (Ferretti 2022) attains its most significant enhancement in the encounter with symbolic representations, it is by means of the narrative capacities of spatial and temporal navigation, of projecting oneself into possible worlds, and of taking on the other's point of view, that humans are able to develop language skills.

Nevertheless, such an interpretation raises a series of problems that need to be addressed within a broader philosophical framework. Indeed, if we consider, as Pennisi does, the DMN with a linguistic approach, the discussion lies in its functions within a classical framework of the philosophy of mind and cognitive science based on the idea that mental representations have a propositional and symbolic conceptual structure. In contrast, framing the DMN within the functions of Mental Time Travel, perspective-taking, and narrative simulations makes the waters murkier. In fact, what is meant by a nonlinguistic narrative simulation (Gerrans 2014; Hutto 2016)? What is meant by an imaginative representation endowed with semantic content but preceding linguistic forms (Corballis 2015; 2017; Ferretti 2022)? For the way in which they have been formulated, theories of the narrative brain all seem to overly emphasize how narrative mechanisms are located in particular areas of the brain that by their activation allow the construction of representations in narrative-format. The consequent result is a picture of a neural network engaged in collecting pieces of representations stored in other areas of the brain and creating scenarios within which it can subsequently place the individual through forms of self-projection (Ferretti 2022). But is this the right path? In the next section, we will try to show how, through a cognitive semiotic approach (Paolucci 2021), it is possible to maintain the idea that the DMN plays a role in the narrativization of experience, yet without reducing narrativity to the imaginative production of stories.

5. A SEMIOTIC PROPOSAL FOR THE DEFAULT MODE NETWORK

In a recent review article, Yeshurun, Nguyen and Hasson (2021) propose a very interesting view of the DMN, identifying it as an active and dynamic sense-making network capable of integrating information from vast time scales. The paper shows how the function of the DMN and its subareas during extrinsic activities has been increasingly studied over the years. Thus, according to their perspectives, the DMN would not be an intrinsic system active only during stimulus-independent tasks but an area that actively intervenes in the regulation of stimuli. DMN's subareas activate and deactivate alternating extrinsic and intrinsic activity. In this way, DMN acts as a condensation site capable of holding together and reprocessing inputs from sensory areas and integrating them into a larger time scale with a series of prior intrinsic information. For example, the DMN is crucial for understanding a narrative, whether written, seen, heard, or read, and seems to be activated completely independently of the story's expressive format. DMN's role seems to be related, indeed, to the interpretative activities that allow – in cases of ambiguity in a story – to call upon the activity of other networks to regulate and facilitate the processing of the extrinsic signal.

This role of the DMN in extrinsic activities also leads the authors to rethink the way the DMN operates in intrinsic activities: according to them, it does not function as a mechanism that produces stories, but as an integrator of information through schematization. It is connected to the processing of situational patterns that can then be involved in various functions. For example, it is activated when there is a plot twist or when some information pushes towards a change in the interpretation of a story. Furthermore, one of the most

surprising results from the experiments cited in the review concerns the fact that DMN activations are shared by subjects with similar interpretations of the same situation and are different from those with different interpretations. The study shows that the DMN does not only change its activity when exposed to internal stimuli (previous beliefs, memories, behavioral and conceptual schemas, individual stories, emotions, motivations, body states) and external stimuli (context, actions and narrative texts of any kind, salient stimuli) but also when we are exposed to social situations (group decision-making, dialogue, embodied interactions, telling/listening to a story). Another finding is that participants' brains in social interaction situations tend to synchronize in these areas, even co-modifying. In other words, interactions with others and the outside world play a decisive role in activating the DMN. According to this review, the DMN is to be conceived as the area of the brain where the stimuli belonging to the self, the body, the world, and others are integrated. It is the area where the individual imagination meets the social world.

If interpreted in this way, the DMN appears to be the neuronal area where we can map the activities related to those semiotic functions that, in ffant and the Platypus (1997), Eco called imagine1 and imagine2:

> 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 imagine1), or it is synthesis speciosa, productive imagination of a species, figure [imagine2] (Eco 1997-1999: 82).

For Eco, imagination is the ability of schematization that intervenes both in the case of not task-oriented activities, such as mind wandering, and in task-oriented ones, such as interpreting a plot twist, in which the subject has to imagine or figure a series of new relations to interpret a situation. The imaginative acts

of the DMN could also be compared to the difference Charles Sanders Peirce posits between pure reverie and musement (6.458). Whereas the former is characterized by vacancy and dreaminess, the latter is «the power to establish connections between different objects, especially between objects in different Universes» (CP 6.455). Peircean musement has also been interpreted as the capacity to integrate different universes of experience, not resorting to rules but, instead, through the integration of regularities, and has rightly been compared to that capacity that Eco calls imagine2, the specious synthesis that enables the generation of figurative schemes (Paolucci 2010). It is, therefore, no coincidence that musement has recently been proposed as a pivotal concept for understanding the activities of the DMN (Duarte 2020).

But how should we conceive of this schematizing activity of the imagination that is so important for semiotics, and how can we compare it to the one related to DMN functions by Yeshurun *et al.* ?

Paolucci (2021) has recently proposed to frame the schematizing activity, which has such a prominent place in Peirce and Eco's semiotics, through the concept of narrativity, as elaborated in the semiotic tradition (Greimas 1975; Brandt 2007; Lorusso et al. 2012).

According to the semiotics' perspective, narrativity is a gestalt, a deep structure through which we can schematize an experience in order to endow it with meaning. Narrativity is not understood as the form of the story, although it can be traced through narrative analyses, instead, it is the only way the subject can give sense to the experience. We find narrativity in all kinds of texts, practices, and interactions to which we can attribute meaning. This can happen properly because it is the form through which mutations of meaning are organized (Paolucci 2012a). For this reason, one cannot think of semiotic narrativity either as a property expressed by linguistic stories, or as a form of imaginative creation of a story. On the contrary, narrativity it is the cognitive function enabling both

linguistic stories and story-like imaginations, through the setting up of a form that can be endowed with meaning.

Briefly, narrativity is a processual form of interrelated positions organised in a suitable and stable way beyond the superficial variations characterising any single story. According to semiotics, narrativity is not the story, but the structure of positions that gives shape to the story and embodies in it. [...] For semiotics, narrativity is a morphology with a regular pattern that structures meaning and experience (Paolucci 2021: 112-113).

In this view, narrativity is a kind of interface, the form that allows shaping experience through meaning. This capacity is the one that allows for the mediation between the phenomena and the meaning, the only way through which we can identify patterns in phenomenological experience, interpreting them as a token of a certain type. It is precisely the form of every sense-making. This schematic characterization brings the concept of narrativity closer to the function of the DMN proposed by Yeshurun et al. (2021). The fact that the DMN shows the same degree of activation during identical situations, presented under different expressive formats, is perfectly compatible with the semiotic idea that narrativity, being the form of meaning, is totally independent of the occurring formats in which it is expressed. The fact that the activations of the DMN change when a situation change is compatible with the idea that we narrativize experience in order to interpret it. The idea of the DMN as an integrating mechanism that collects intrinsic and extrinsic data by organizing them in a single time scale is similar, then, to the semiotic idea of narrativity as a purely topological gestalt, the positions of which are to be filled through meanings belonging to different domains of experience and knowledge. Finally, intersubjectivity, by influencing DMN activations and producing co-modifications during interactional exchanges, is plausibly akin to the semiotic perspective. In fact, according to semiotics, narrative competence

is already present in very young children, and it is precisely this feature that allows them to shape the occurring interactions, occupying an actorial role within a positional field that is defined as actantial (Violi 2012; Paolucci 2019). It is due to the fact that actantial positions can be occupied by different actors that humans develop the ability to put themselves in the others' shoes and capacities such as perspective taking, role and pretend play, and the ability to deceive the other by constructing possible worlds (Paolucci 2021). If we were to attribute this cognitive skill to the activations of the DMN, we could then say – like Yeshurun et al. (2021) – that it is the sense-making network par excellence.

Furthermore, the concept of semiotic narrativity comes close to the ideas expressed on DMN narrativity by evolutionary approaches (Corballis 2015; Carroll 2020; Ferretti 2022), yet it departs from them due to its purely formal character and unrelatedness to forms of mental representations endowed with content. In fact, semiotic narrativity is not characterized by semantic content, but by what in semiotics is called a form of content (Eco 1971): it is a gestalt through which the human organism traces a pattern in the experience eligible for semantic interpretation.

This view prevents us from thinking of narrativity as an intracranial function only located in the brain; instead, it is an emergent phenomenon that characterizes human cognition, being distributed in the interactions between the organism and its environment. Rather than a form of representation, it is a mode of action (Paolucci 2021). Connecting the DMN to such a modality would not reduce the narrativity to a brain function, but helps to detect one of the elements contributing to such an activity. A semiotic approach to cognition can only think of the brain as one of the biological conditions for the emergence of cognition, and not as its only cause which is instead to be found in the dynamic interaction between body, brain and environment (Paolucci 2012b), or if one prefers between Leibe, Korper and Umwelt (Pennisi 2021). The brain must be

conceived as an organ that poses constraints and possibilities (Ceruti 1986), that bears trace of our interactions with the world, and enters a dynamic relationship with the internal states of our body and the environment we inhabit (Fuchs 2018). It is a place in which meaning is condensed and retransformed. Therefore, the DMN should not be conceived as the area producing narrativity but as one of the elements involved in the imaginative operation that we, as embodied organisms situated in a culture, perform. In sum, according to cognitive semiotics, studying the DMN is to study the way in which our brains contribute to the human form of sense-making.

The relationship between DMN and semiotic narrativity, as sketched here, dramatically changes even the interpretation of DMN's alterations in psychopathology. In this view, abnormal brain activity must be understood not as a dysfunction of internal mechanisms, but as a sign of the alterations of the meaningful relationship with the world.

For example, the semiotic theory proposed by Paolucci that frames autism spectrum disorders as a problem in the intersubjective narrative organization (Paolucci 2019, 2022) could find a solid experimental basis in DMN studies that demonstrate a hypoactivation of DMN areas related to social cognition (Harikumar et al. 2021; Balthelt, Geurts 2021; Padmanabhan et al. 2017). In the same way, schizophrenic delusions could be framed by relating DMN disturbances in the prefrontal cortex during task-related activities (Whitfield-Gabrieli, Ford 2012) to the idea of an aberrant and crystalized form of narrativization of experience, blocking any project of the individual, and condemning him/her to a single mode of sense-making (a first attempt in Lobaccaro 2022).

An interesting challenge could be related to studies on auditory verbal hallucinations. Following the patients' first-personal accounts, in fact, hallucinations are related not only to the perception of voices, but to voices that

are spatialized outside the individual and maintain a quasi-perceptual character (Stanghellini 2008; Ratcliffe 2017). Again, there is a large amount of studies on DMN and hallucinations (Weber et al. 2020; Geng et al. 2020; Zhao 2018), but they need an integrative interpretation. Perhaps an alliance between neuroscience, psychopathology of language and cognitive semiotics could rightly serve the cause. Hopefully, these topics could be discussed in the future.

ENDNOTES

1 See also Pennisi 2001; Lo Piparo 2001; Falzone 2004; Cardella, Falzone 2021.

2 The angular gyrus is indeed an area involved in linguistic functions, but it is also involved in numerous other forms of cognition and neuronal networks. In his review of fMRI studies on the angular gyrus, Seighert (2013) clearly shows how it is also involved in tasks of social cognition, action planning, attention, visual-spatial navigation, and body spatial cognition, multimodal integration of external stimuli, narrative comprehension, and episodic memory, all dimensions that appear to be severely impaired in schizophrenia (Frith 1992; 2004; Heinrichs, Zakzanis 2006; Lysaker, Lysaker 2008; Maiese 2016; Bowie, Harvey 2005; Daniel et al. 2006).

3 It is on the basis of this interpretation that some hypotheses have been advanced about the role of the DMN in the functional architectures that characterize predictive processing models (Gerrans 2014). According to these theories, the DMN could play a key role in the disambiguation of predictive errors generated by a mismatch between an incoming perceptual stimulus and its predictive anticipation produced by the higher-order neuronal hierarchy (Gerrans 2014; Dohmatob et al. 2020; Bar et al. 2007).

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