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Dissociative identity as a continuum from healthy mind to psychiatric disorders: Epistemological and neurophenomenological implications approached through hypnosis

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ABSTRACT

The topic of multiple personality, redefined as Dissociative Identity Disorders (DIDs) in the DSM-5, is an intriguing and still debated disorder with a long history and deep cultural and epistemological implications, extending up to the idea of possession.

Hypnosis is an appealing and valuable model to manipulate subjective experience and get an insight on both the physiology and the pathophysiology of the mind-brain functioning; it and has been closely connected with DIDs and possession since its origin in 18th century and as recently proved the capacity to yield a loss of sense of agency, mimicking delusions of alien control and spirit possession.

In this study we report on five very uncommon "hypnotic virtuosos" (HVs) free from any psychiatric disorder, spontaneously undergoing the emergence of multiple identities during neutral hypnosis; this allowed us to check the relationship between their experience and fMRI data.

During hypnosis the subjects underwent spontaneous non-intrusive experiences of other selves which were not recalled after the end of the session, due to post-hypnotic amnesia. The fMRI showed a significant decrease of connectivity in the Default Mode Network (DMN) especially between the posterior cingulate cortex and the medial prefrontal cortex.

Our results and their contrast with the available data on fMRI in DIDs allows to draw the hypothesis of a continuum between healthy mind – where multiple identities may coexist at unconscious level and may sometimes emerge to the consciousness – and DIDs, where multiple personalities emerge as dissociated, ostensibly autonomous components yielding impaired functioning, subject's loss of control and suffering. If this is the case, it seems more reasonable to refrain from seeking for a clear-cut limit between normality (anyway a conventional, statistical concept) and pathology, and accept a grey area in between, where ostensibly odd but non-pathological experiences may occur (including so-called non-ordinary mental expressions) without calling for treatment but, rather, for being properly understood.

Multiple personality is an intriguing and still debated disorder with a long history and deep epistemological implications. Since the tripartite definition of the soul by Aristotle, man has been mainly conceived as a monolithic creature endowed with a rational soul – a view also held by Scholastics and the rational theology by Thomas Aquinas – and persisted until the 19th century, when the unconscious was discovered and the first cases of multiple personality were described. The seminal works by the so-called *médecin philosophes*, i.e., Ribot, Janet and Binet, the report of multiple personalities and the ostensibly absurd phenomenology of hypnosis (as Maynert defined it in 1889 [1]) including amnesia and somnambulism, led to the century-old idea of the rational soul as the foundation of man entering a progressive decline. It became clearer and clearer that consciousness was but a thin, superficial layer of a much deeper, unknown unconscious mind with a complex structure, an apartment or even a flat complex including dark cellars, rather than a single bright room.

Pierre Janet recognized the *désaggregation mentale* as a deficit of integration of components of mental experience and assigned to

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consciousness a role of order and synthesis of the disaggregated subconscious elements. He also reported on the "*doublement de la vie*" and introduced an apparent way of curing hysteric patients by creating a second healthy personality [2,3]; this raised in turn the idea of a possible existence of a second self, anyway saving the concept of the unity of personality in terms of "mental synthesis" [4]. Later on, William James concluded that consciousness may be split into parts which coexist but mutually ignore each other [5].

In the DSM-5, the multiple personality disorder has been redefined as a dissociative identity disorder (DID), which shows a relationship and comorbidity with post-traumatic stress disorder (PTSD) [6,7].

The adopted definition of DIDs closely depends on cultural and ethnic factors and is endowed with inescapable epistemological implications [8]; accordingly, the DMS-5 has wisely included the pathological possession in DID, when other identities are attributed to an external entity (demon, deity, spirit, or human being), in order to meet the values of different cultural worlds. However, in the attempt to tell those which are "*normal part of a broadly accepted cultural or religious practice*" from pathological ones (meeting the criteria for DIDs), the DSM looks to implicitly consider the latter as non-cultural. If this is the case, it implies the need for a differential diagnosis: a hard job if possible, given the suffering yielded by possession and the related need for care also in other cultures [9]. Therefore, some authors have criticized the DSM positivistic inclination to consider the definition of psychiatric disorders as universally valid, stripping them of their cultural context and consider them as individual, biological-psychological diseases, while skipping the psychosocial experience, the meaning of perceived illness and related therapeutical implications from an emic perspective [9,10].

Neuropsychology has provided a wealth of invaluable data on the neurocorrelates of many mental functions, allowing for two main outcomes: a) a huge improvement of the diagnosis and management of neurological disorders; b) an insight into the physiological aspects of mind, which have shed much light on how we are, perceive, process data, think and behave, improving a metacognitive awareness of our mental processes with their value and limits. The data from functional neuroimaging have also shown the scientific "reality" of higher-order functions, once considered as void of any physical counterpart and, as such, immaterial, scientifically irrelevant and matter of philosophy and religion at best.

Hypnosis is an appealing and valuable model to manipulate subjective experience and get an insight on both the physiology and the pathophysiology of the mind-brain functioning for two main reasons [11,12]: a) the capacity to create clinically informed analogues of functional and structural neuropsychological disorders; b) the possibility to check the power of mind to intentionally manipulate the activity of unconscious brain areas. Hypnosis is closely connected with DIDs and possession since its origin in 18th century. In fact, Justinus Kerner in 1836 reported on 11 cases of possession, 5 of which recovered following mesmerism [13]; Kerner described as well a case of possession explicitly mentioning the concept of multiple personality [14]. Hypnosis has recently shown the capacity to yield a loss of sense of agency mimicking delusions of alien control and spirit possession and, thus, allowing an experimental insight into physiological brain mechanisms possibly implied in psychopathology [15].

Multiple identities, or "other selves" and their relationship with hypnosis have been well described by Richeport [16]. The aim of this study is to report on five "hypnotic virtuosos" (HVs), i.e., subjects with the highest hypnotic ability, who spontaneously underwent the experience of other identities; this allowed us to observe them with a neurophenomenological approach, i.e., comparing their experience to fMRI data recorded during hypnosis. Our results enable us to draw the hypothesis of a continuum between normality – where multiple selves (or different parts of the self) may coexist, remaining unconscious or seldom emerging to the consciousness – and psychiatric disorders, where multiple personalities emerge as dissociated, ostensibly autonomous components with the related subject's loss of control and suffering.

Materials and methods

Participants and hypnotic procedures

Five healthy hypnotic virtuosos (group HV, 2 males and 3 females, age 40.8 ± 6.9 ys) were included in the study, due to the spontaneous emergence of other identities during neutral hypnosis. Hypnosis had been previously induced using a shortened version of the procedure described by Kirsch et al. [17,18] as well as the techniques suggested by Tart and Cardeña [19,20], in order to minimize the effects of external suggestions. In the week preceding the experiment all subjects were submitted to formal psychiatric interviews to exclude psychiatric disorders. Their profiles were further checked using the Italian version of the Temperament and Character Inventory-Revised scale (TCI-R) [21] and the Symptom Checklist-90 (SCL-90) [22]. Hypnotizability was checked using the Stanford Hypnotic Susceptibility Scale-Form C (SHSS-C) [23]. The subjectes did not have any trauma history or mental disorders in childhood or adolescence according to the DSM-5 [6], other physical or psychological disorders and were drug-free; the formal psychiatric interview was conducted by a senior psychiatrist (AM) with extensive clinical experience excluding the presence of DIDs according to the DSM-5, that is "a disruption in the usually integrated functions of consciousness, memory, identity, and perception of the environment" [24].

The fMRI data of the HVs were compared to those of obtained from 16 healthy, low hypnotizable subjects (group HC, age = 41.13 ± 19.38 years, 6 males and 10 females) drawn from the sample of 96 subjects previously recruited to validate the Italian version of the Pekala Consciousness Inventory PCI; HC subjects had a SHSS-C score of 4 or less and an average Hypnoidal State Score (HSS) of PCI-HAP score of 4.5 [25].

The study design is shown in Fig. 1. The induction procedure consisted of slowly counting from 1 to 30, while suggesting a progressive relaxation of the individual parts of the body through suggestions of well-being, peace, calmness and serenity, going deeper and deeper into a hypnotic state (it lasted about 20 min as an average); all suggestion were always permissive – e.g., "if you wish you can… the choice is always yours…".

Resting state (RS) fMRI data acquisition and analysis

Functional and anatomical images were acquired using a 1.5 T Siemens Magnetom Avanto MRI scanner with an 8-channel head coil

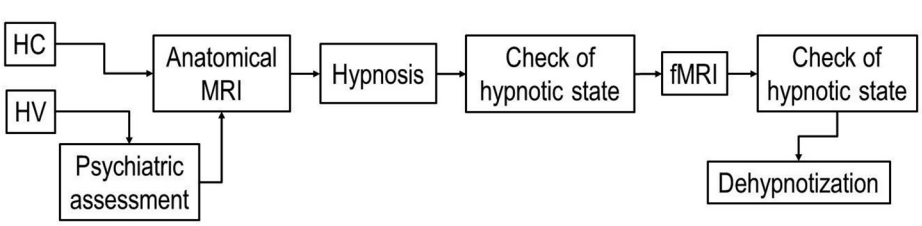

Fig. 1. Study design (HV = hypnotic virtuosos; HC = control group).

(Erlangen, Germany). Blood oxygenation level dependent (BOLD) EPI images were collected at rest for 6.6 min (TR/TE = 2500/30 ms; resolution = 3.1 × 3.1 × 2.5 mm^3; matrix size = 64 × 64; number of axial slices = 39; and number of volumes = 160). High resolution T1-weighted 3D scans were also collected (TR/TE = 1900/3.37 ms; resolution = 1 × 1 × 1 mm^3; matrix size = 192 × 256; and number of axial slices = 176) to be used as anatomical references for the RS-fMRI data analysis.

Preprocessing of the RS-fMRI data was carried out using FSL [26,27]. Standard preprocessing involved the following steps: motion correction with MCFLIRT [28], non-brain tissues removal using BET [29], spatial smoothing with a 5 mm FWHM Gaussian kernel, and high-pass temporal filtering with a cut-off frequency of 0.01 Hz. Single-subject spatial independent component analysis (ICA) with automatic dimensionality estimation was performed using MELODIC 3.0 [30]. Subsequently, each dataset was cleaned from artefacts using FIX [31,32]. Each single-subject 4D dataset was then aligned to the subject's high-resolution T1-weighted image using FLIRT [28,33] enhanced with brain-boundary registration [34], registered to the MNI152 standard space using FNIRT [35], and subsequently resampled to 2 × 2 × 2 mm^3 resolution. After preprocessing, a second-level analysis was performed to investigate brain connectivity changes at single-subject level, comparing the two conditions, and at the group level, comparing each virtuoso participant with the group HC.

Individual contrast hypnosis vs baseline

The fMRI images under hypnosis (HY) and baseline resting state (RS) were processed by means of voxel-based functional connectivity (FC) analysis [36]. For each individual and condition, a region of interest (ROI) with a of 6-mm radius was positioned in the posterior cingulate cortex area (PCC-ROI; MNI coordinates: 0, −53, 26) [37,38]. The averaged time series within the PCC-ROI was extracted by means of the Resting-State fMRI Data Analysis Toolkit (REST, V1.8). Voxel-based FC maps were obtained by computing a linear correlation between the averaged PCC-ROI time series and the time courses of all the remaining brain voxels. FC maps were then transformed into z-FC maps using the Fisher transformation. The individual thresholding method [36] was then used to compute individual measures of each participant and obtain a quantitative comparison between the two conditions (HY and RS). Thirty-nine surrogate time series of the PCC-ROI were constructed with the iteratively refined amplitude adjusted Fourier transform (iAAFT) and were used to obtain 39 surrogate FC and z-FC maps. These 39 surrogate z-FC maps were then used to estimate the subject-specific random errors and to obtain the subject-specific thresholds to be applied to all the voxels of the original z-FC maps. Only voxels with a correlation outside the range defined by the upper and lower thresholds were considered as significantly connected with the PCC-ROI.

Individual comparisons of HV and group C (HC)

We used the DMN obtained from a functional template [39] to perform a correlational analysis between the PCC and the medial prefrontal cortex (mPFC). The DMN template was split into four distinct anatomical areas [40], including the PCC, mPFC, and the left and right parietal lobes. These areas were then used to generate subject-specific spatial maps and time series for HC and HV (both conditions) by means of the Dual Regression approach [41,42]. For each individual, the PCC and mPFC time courses were used to evaluate the temporal correlation between them. Finally a single case statistical analysis was conducted for each participant belonging to the HV group and for both conditions using a modified *t*-test via the SINGLIMS.EXE tool, [43] to assess whether an individual's score was significantly different from group HC.

Ethics statement

The study protocol was approved by the ethics committee of the Fondazione Don Carlo Gnocchi, ONLUS, Milan (Italy). All participants gave written informed consent to take part in the study according to the recommendations of the Declaration of Helsinki for investigations in human subjects.

Results

Among HV subjects, one had been successfully submitted to hypnosis for headache prior to the study (subject n. 3), while the remaining four asked to experience hypnosis for research. Their history neither disclosed relevant previous traumatic or distressing experiences nor psychiatric disorders. At the psychiatric evaluation, all HVs had a satisfactory socio-occupational status and affective functioning. Their SCL 90 scores were within the normal range and the personality profiles assessed with the TCI-R showed a good-to-high adaptability to environmental demands (character dimension). The temperamental dimensions were in the average range as well, with three participants showing low levels of Harm Avoidance – an index of extraversion, flexibility, openness and good adaptation to situations; the SHSS-C score was 12 in all cases.

Phenomenological data

During hypnosis the subjects underwent spontaneous non-intrusive experiences of other selves which were not recalled after the end of the session, due to post-hypnotic amnesia; therefore, an insight in their experience was obtained from their report during hypnosis. The reported experiences of other identities in each participant were the following:

1. A 36 years old female. She evoked Runa, an ill-defined entity (neither age nor place of origin were reported) flying in an unidentified aircraft, perhaps a space one, who reported to be beyond the space-time. Runa felt a deep compassion for humanity and was moved following her warn against the risk of a future disaster yielded by the beclouded human consciousness.
2. A 45 years old female. She had previously experienced several different identities, including a spiritual guide named Ognanios (undefined as regards space and time location) and Jacques the Molay, the last grand master of the Knights Templar (1243–1314). During the fMRI session she relived the latter identity and allegedly reported that the hypnotist in his previous life was Simon Mathieu de Font Blanc, another Knight Templar, fighting with him at the siege of Acre in 1291. She took about ten minutes to come out of hypnosis at the end of the session.
3. A 55 years old man. He experienced the identity of Senenmut, an 18th dynasty ancient Egyptian architect.
4. A 35 years old man, who had previously reported on several different identities. During the session he experienced the identity of an unidentified Buddhist monk.
5. A 38 years old female. She experienced the identity of a Caucasian child belonging to nomad tribes, including the reminiscence of a merciful master called Eagle.

fMRI data

The voxel-based FC analysis in within-group comparison showed a generally reduced FC spatial extension for each HV participant in HY compared to RS condition. Fig. 2A shows the z-FC map of a representative case obtained in both conditions, showing that the PCC-ROI was functionally connected with the mPFC during RS, while connectivity was significantly reduced during HY.

The temporal analysis of the connectivity strength between the PCC

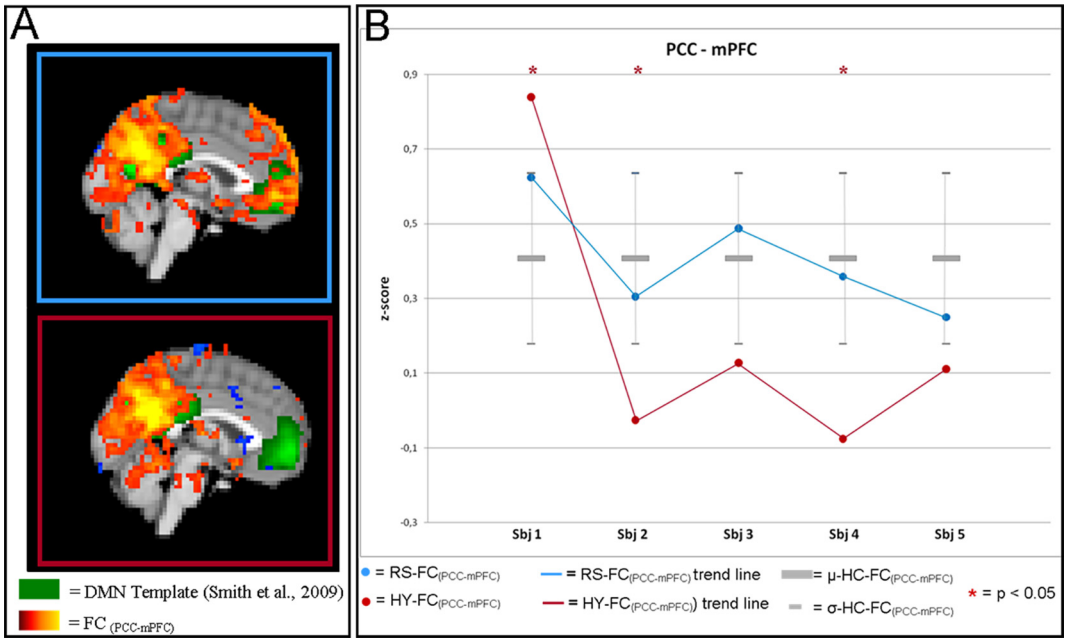

Fig. 2. Panel A: shows a typical pattern of voxel-based functional connectivity (FC map) for an HV subject in resting state (RS, blue box) and hypnosis (HY, red box). FC values, in red-yellow, are superimposed on the DMN template, in green. Compared to RS, the HY condition shows a decreased FC spatial extension in the medial prefrontal cortex (mPFC). Panel B: the results of the comparison of each HV subject with the control C (HC) group are shown. At RS the connectivity strength is within the range ($\mu \pm \sigma$) defined by the group C (HC). Instead, during hypnosis (HY) four out of five HV subjects show a reduced FC between PCC and mPFC compared to the HC group (* = significant difference in the individual HV subject to HC group comparisons between RS and HY; RS-FC$_{(PCC\text{-}mPFC)}$ = functional connectivity between PCC and mPFC at basal rest; HY-FC$_{(PCC\text{-}mPFC)}$ = functional connectivity between PCC and mPFC during hypnosis; μ-HC-FC$_{(PCC\text{-}mPFC)}$ = mean FC value between PCC and mPFC in HC; σ-HC-FC$_{(PCC\text{-}mPFC)}$ = standard deviation of FC value between PCC and mPFC in HC).

and the mPFC led to different results in the two groups (Fig. 2B). In RS the values of the temporal correlation between the PCC and the mPFC were within the range obtained from the group HC. Accordingly, no significant differences were found when comparing each HV subject with the group HC during RS; instead, four out of five HVs showed a reduced FC trend between the PCC and the mPFC compared to HC in HY condition, and in three of them the change was significant.

Discussion

It has been debated whether hypnosis can be considered as an altered state of consciousness, at least in its deeper stages [44,45]. Later on, the Division 30 of the American Psychological Association has defined hypnosis as "*A state of consciousness involving focused attention and reduced peripheral awareness characterized by an enhanced capacity for response to suggestion*" [46]. Unlike the previous definition [47], it emphasizes hypnosis as a state of consciousness, highlighting the relevance of subjective experience for both its definition and assessment, rather than taking into account behavior only.

Several neuroimaging studies were conducted in the last decade to seek for possible markers of high hypnotizability and/or changes in the functional architecture of the brain during different phases of hypnosis [48–50]. An increased functional connectivity between the left dorsolateral prefrontal cortex (DLPFC) and the salience network (SN) has been recently shown in highly hypnotizable subjects, but future studies are required to check how these functional networks change and interact during hypnosis and to which mental processes and subjective experience they are related to [49].

Hypnosis has proved the capacity to yield relevant changes of neurovegetative regulation and pain threshold, up to the level of surgical analgesia [51–56], allowing for meaningful alterations of cardiovascular parameters, as well as surgery with hypnosis as an adjunct to pharmacological anesthesia or even as a sole anesthesia in selected cases [57–61]. Deep hypnosis, as well as meditation, is associated to relevant changes of arousal, self-awareness, subjective experience, time perception and meaning, positive affect, rationality, memory and enhancement of attention, serenity, imagery and its vividness [62–67]. These changes are also shared by other non-ordinary mental expressions (NOMEs) – such as mystic, near-death and near-death-like experiences, and out-of-body experiences (OBEs) – suggesting possible links between them. In fact, they may include feelings of pure consciousness and unitive mystical state (as defined by Forman [68]), such as *"having no thoughts", "being one with everything," "increased meaningfulness.", and "merging with pure light or energy*" [62,64,69–71]. The same feelings are spontaneously elicited also in hypnotically induced OBEs [64].

HVs are quite uncommon and are able to experience the full range of the above-mentioned changes, as well as reach the feeling of loss of personal identity and experience other identities, even reporting alleged memories of past lives [72]. Multiple identities have been previously reported in hypnosis. According to Milton H. Erickson (quoted by Zeig [73], Ch. 28), the phenomenon, despite its peculiarity and history – traditionally linking it to the idea of possession and putting it at the boundaries between psychiatry, religion and parapsychology – is not necessarily dysfunctional; rather, it provides the unique opportunity to explore and improve the understanding of the physiology of mind and its unconscious processes, where psychiatric cases – likewise neuropsychological disorders, such as aphasia, anosognosia, etc. – reflect pathological changes of physiological functions.

Our HVs allowed us to check whether hypnotic emergence of other identities may share some common features with neuropsychological patterns of DIDs. Before discussing our results, it is worth shortly analyzing the relationship between brain areas involved in DID and hypnosis.

DIDs, hypnosis and related brain network

Reinders et al. [74] have suggested opposite emotion-regulation patterns in DIDs, where the posterior association areas and parahippocampal gyri are activated in neutral identity state (also named

"*apparently normal part of the personality*"), while dorsal striatum and caudated nucleus are activate in the hyper-aroused trauma-related identity state (also named "*emotional part of personality*"). The former shows an autonomic hypo-arousal associated to activation of right mid/anterior cingulate cortex, bilateral superior frontal gyrus, right middle frontal gyrus and left medial frontal gyrus, leading to decreased activation of the sympathetic nervous system, while the dorsal striatum seems to be involved in dissociation, especially in switching between identity states. The activation of dorsomedial prefrontal cortex (dmPFC) is impaired in emotional numbing and enhanced in mindfulness. Alexithymia yields, a hypoactivation of the ventromedial prefrontal cortex (vmPFC, which is associated to embodied emotional/self-awareness) and the anterior insula (which is associated to interoceptive network and probably involved in the evaluation of how one feels) as well as activation of right inferior frontal gyrus (IFG, involved in the emotion regulation) [75].

The close connection between PTSD and sympathetic tone is a specific aspect of the universal, inseparable mind-body relationship at the base of both the physiology and the pathophysiology of stress and psychosomatic disorders. The insula and the anterior cingulate cortex (ACC) play a pivotal role in the psychosomatic connection; in fact, both somatic and interoceptive vegetative ascending inputs from the body traveling through the thalamus are integrated in the fronto-insular cortices, thus reaching the salience network (SN). Salient signals can in turn affect the DMN and the central executive network (CEN) to guide behavior [76]. An intriguing connection also exists between the vmPFC and the autonomic nervous system [77], suggesting that the altered connectivity between the PCC and the mPFC (hub of the DMN) may be related to changes of the vagal tone in absence of external stimuli; it may also help explaining the mechanisms of enhanced vagal tone during hypnosis [53,56] – a fact correlated to subject's hypnotic ability [78] – as well as the capacity of hypnosis to strongly affect cardiovascular activity according to specific suggestions [53,79–81].

As far as the DMN is concerned, several studies on hypnosis report on its deactivation [82–84]; furthermore, deeper levels of hypnosis have been related to lower connectivity and larger gray matter volumes within the anterior areas of the DMN, a fact that might explain the HVs' higher ability to modulate its activity, viz, to reduce spontaneous thought [83]. On the other hand, the ACC is activated in hypnotically induced pain, especially when its affective component is enhanced by suggestion of feeling an unpleasant sensation [85,86]. The rostral ACC (rACC) is negatively correlated to hypnotic relaxation and positively to absorption, while the pgACC is not significantly changed [87]. This is a relevant aspect, since the pregenual cingulate cortex (pgACC) and rACC are part of the DMN and the SN, respectively, and the ACC is involved in many functions, such as attention, motivation, emotion, pain, solution of conflicts between incongruent stimuli and motor control.

The DMN, given its relevance to self-referential processing, may play a central role in DIDs and PTSD [88]. The DMN gathers several structures, including PCC, precuneus (PC), vmPFC, pgACC, temporo-parietal region and medial temporal lobes; it is involved in episodic retrieval, self-reflection, mental imagery and stream-of-consciousness processing [37,89,90]. The DMN is divided into three major subdivisions, i.e., the vmPFC, dmPFC and PCC, the main role of which is the following:

a) The vmPFC receives sensory information from the external world and the body via the orbital frontal cortex and conveys that information to structures such as the hypothalamus, the amygdala, and the periacqueductal grey matter of the midbrain. Its activity reflects a dynamic balance between focused attention and a subject's emotional state [91,92] and its damage may engender personality changes [93].
b) The dmPFC can be distinguished from vmPFC by its association with self-referential judgements [89].
c) The PCC, the medial precuneus and the lateral parietal cortex are also involved in recollection, suggesting a link between the hippocampal formation and the posterior elements of the DMN, i.e., the possibility that recollection of personally relevant memories be a component of the cognitive content of DMN [94]. Bilateral medial temporal regions are also correlated to frontal and parietal brain regions in memory retrieval, suggesting their involvement in the cumulative experiences of wakefulness and daily memory consolidation [95].

To summarize, according to Raichle [96] "*Data from humans suggest that the DMN instantiates processes that support emotional processing (vmPFC), self-referential mental activity (dmPFC), and the recollection of prior experiences (posterior elements of the default mode network)*".

A decreased perfusion of orbitofrontal cortex has been reported in DIDs [24,97], associated to increased perfusion in the medial and superior frontal and occipital regions [24]. According to the authors, these changes might reflect the role of orbitofrontal cortex in emotion regulation, attachment, development of the self and temporal organization of behavior, where the increased perfusion of the medial and superior frontal and occipital regions might help overcoming the impulsivity through an inhibitory response to orbitofrontal cortex alterations. Furthermore, patients with DIDs may seldom show outstanding and intriguing creativity and artistic abilities [98], a condition in line with Erickson's view, although appearing in the context of a severe psychiatric disorder. Greater suppression of the DMN during a state of mind-wandering trance may be associated with better performance on an otherwise attention-demanding task [99], as it is a mechanism also involved with automatic processing [100].

Menon [101] has proposed that a broad range of neurological and psychiatric disorders as well as deficits in self-referential processing (e.g., symptoms of depersonalization) can be understood in terms of dysfunction of DMN, CEN and SN (Fig. 3). In fact, the SN is implicated in detection and integration of emotional and sensory stimuli, as well as in modulating the switch between the internally directed DMN and the externally directed CEN cognition; it allows for a competitive, context-specific stimulus selection, in order to focus attention and concentrate resources towards goal directed activities [102]. The CEN consists of highly interconneceted areas, including several subsystem with related functions and the capacity for a wide range communication with other systems through flexible hubs, able to update according to task demand [103].

Recent findings suggest that dysfunctional interactions between CEN and DMN contribute to psychosis [104,105], where DMN alterations might lead to the disruption of the balance between processing systems which manage external/internal channels of information [90,106,107]. As far as PTSD and dissociative disorders are concerned, Garfinkel and Liberzon have emphasized the role of mPFC – which can be considered as the hub of the DMN – in contexualization and self-referential processing, and its dysfunction as possible cause of dissociative symptoms [108]. Recent models have also highlighted that symptoms of PTSD related to deficits in self-referential processing (e.g. depersonalitazion) may be linked to aberrant connectivity between regions of the DMN [75]; more specifically, interactions between an overactive SN and hypoactive DMN could form a basis for intrusive trauma recollections and impaired autobiographical recall. Furthermore, some models of PTSD have implicated exaggerated activity in the anterior insula as the neural locus of heightened interoceptive and emotional awareness. Complex changes were found in patients with PTSD plus dissociative symptoms, including a decreased connectivity between the anterior cerebellum and vermis and the areas involved in somatosensory processing, multisensory integration, and bodily self-consciousness, as well as increased connectivity between the posterior cerebellum and cortical areas related to emotion regulation [75,109,110], a fact well fitting with the notion of an overactive SN. Some authors also support the notion that the trauma exposure may lead to a general increase in amygdala hyperresponsivity [111–114],

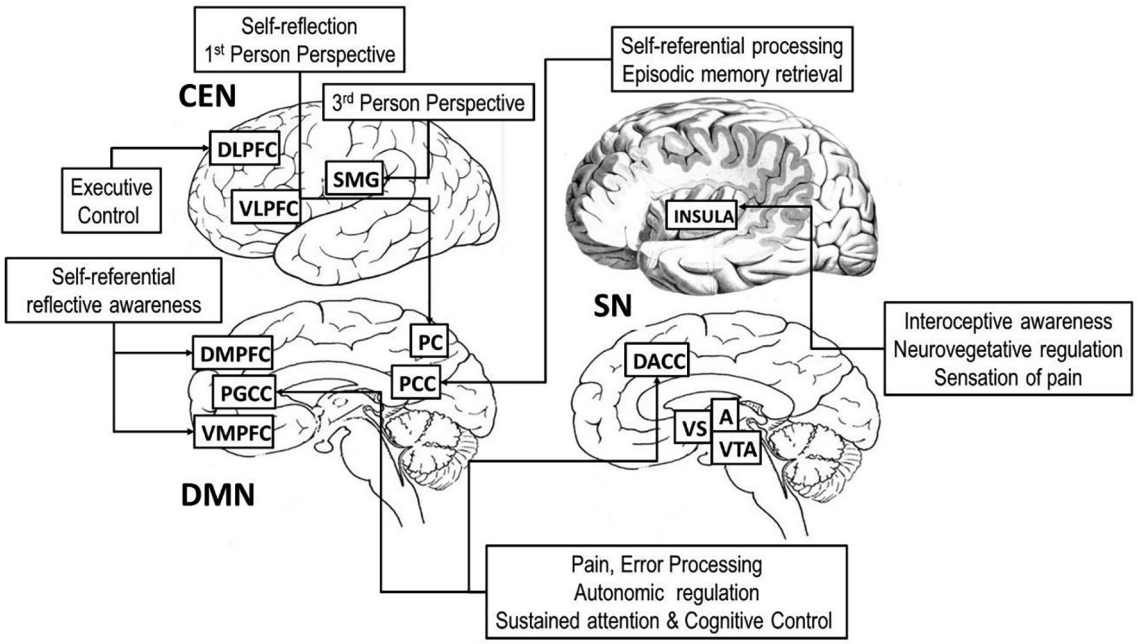

Fig. 3. A schematic representation of main components of the fronto-parietal central executive network (CEN), the Default Mode Network (DMN) and Salience Network (SN) and main related mental processes.

and the failure of ACC to inhibit this response [115].

Sridharan and collegues [116] reported that the right anterior insula (node of the SN) plays a critical role in switching between CEN and DMN, in a competitive interaction during cognitive information processing. The right anterior insula plays a critical and causal role in activating the CEN and deactivating the DMN and, thus, a hyperactivation of this area can affect the self referential processing. Traumatic experiences can alter the development of the self, yielding dissociation, altering the sense of identity and fragmenting it, where feelings of trauma-related shame support the feeling of being, inferior, bad, dirty, annihilated or identified with the aggressor. Accordingly, a decreased connectivity between PCC and mPFC, right superior frontal gyrus and left thalamus was found in PTSD patients with childhood abuse [75].

From the data discussed above, it seems reasonable to conclude that some psychiatric disorders, as well as deficits in self-referential processing, may be related to dysfunctions of DMN, SN and CEN and/or their relative strength and relationship. Among these, the DMN is an interesting target for clinical exploration, given its role in emotional processing, self-referential activity and recollection; if this is the case, studies on both dissociative disorders and hypnotically induced experience of other identities may offer an intriguing perspective in the understanding the physiology and pathophysiology DMN. In recent years, functional neuroimaging studies have provided an increasing evidence of the modulation of brain connectivity within the DMN during both hypnosis and meditation [82–84,87,117–119]. However, hypnosis is far from being a simple monomorphic state and, thus, DMN changes may vary according to hypnotic ability, hypnotic depth and hypnotic tasks.

As far as PCC-mPFC connectivity is concerned, there is an increasing evidence that the mPFC is involved in the integration of information gathered from both external and internal environment and relays it to the PCC [96,99,120,121]. A functional study on psilocybin found that this hallucinogen decreases functional coupling between PCC and mPFC, while increasing the coupling between the mPFC and DLPFC, a fact which may be a neurocorrelate of the phenomenal “egoless” state yielded by this drug [122]. Perhaps, the subjective experience of a lessened egoic state, when associated to an uncontrolled access to hippocampal memory archives, might justify false recollections or disperception of past memories, given that: a) PCC and medial precuneus as well as the lateral parietal components of the DMN show a connection with the hippocampal formation and, thus, with memory [94]; b) the DMN supports emotional processing and self-referential activity (in the ventral and dorsal mPFC) and the recollection of prior experiences (in the posterior cingulate cortex and the medial precuneus). However, the egoless state looks to be a ill-defined concept, including two opposite meanings. The first reflects a dysfunctional condition – e.g., depersonalization and alienation in dissociative disorders [123] – while the second indicates a normal (or even better-than-normal) condition yielded by deep introspective activities, such as meditation. In fact, the aim of meditation is to overcome the narrow limits of ego and ordinary consciousness on the way of wisdom, enlightenment and Self enlargement, a well-defined target in eastern philosophies as well as by Russell in the western one [122,123 Ch.Xv].

Deeley et al. [15] have studied hypnotical simulated loss of self-control of movements following suggestions of alien, internal spirit, possession and contrasted them with suggestions of control by external machine; the aim of this protocol was to mimic psychotic patients with delusions of being controlled by external forces or internal entities other than self. The authors reported different changes of connectivity depending on the internal or external attribution of non-self control by alien entities or impersonal machines. The former was associated to an increased connectivity between motor cortex and brain areas involved in the representation of the self in relation to others (including the medial, and orbito-medial PFC and PC), while the latter was associated to brain areas and circuits involved in error detection and imagery (including left middle temporal gyrus and ACC). This study shows that: a) the different conditions are underpinned by different brain activities; b) hypnosis is an excellent tool to simulate specific experiences yielded by psychiatric disorders, thus allowing for an insight in their physiological circuits.

Spontaneous experience of other identities in HVs

Our cases show prominent changes in connectivity between mPFC and PCC, which seem to be in line with the DMN suppression observed in dissociative components of PTSD. Interestingly, in our subjects a similar decrease in connectivity might have yielded a parallel decrease in

the egocentric perspective and, thus, facilitated the emergence of seeming other identities. The changes of connectivity between the mPFC and the PCC during hypnosis may occur in opposite directions; in fact, a disconnection was found in four case, while an increased connectivity was observed in the remaining one. This data are not contradictory because a hyperconnectivity might lead to an exaggerated focus on one's own thoughts and feelings as well as to an ambiguous integration between them and outer world events, as it has been reported in shcizophrenic patients and their first degree relatives [107]. Perhaps, the increased DMN connectivity in subject n. 1 of our series may reflect her experience, the only one in this series reporting a feeling of deep compassion for humanity which is also a feature of both mystical experiences and eastern meditation, like the *Tongleng* meditation (kindness-love-compassion) in Mahāyāna Buddhism [126–128]. *Tonglen* meditation is associated to the activation of the ACC and right insula (hub of SN), amigdala and right parieto-temporal junction, PCC and precuneus, also correlated to the heart rate [129], while in *vipaśyanā* meditation an activation of the ACC and dmPFC has been reported without involvement of the PCC [130]. These data show the close interrelationship between the DMN and SN and may help explain their changes in meditation, deep hypnosis, as well as PSTD. In fact, an activated SN together with deactivated DMN may exist in all of them and their differences probably depend on the content and meaning of the related experiences: in PTSD the overactive SN reflects the negative affect stemming from the previous traumatic experience, while in hypnosis and meditation it may reflect the positive one, closely related to empathy and kindness-love-compassion.

Given the importance of mPFC in dissociative pathology [108] – justifying an abnormal contextualization and self-referential processing [96,99,120,121] – we can speculate that it may also play a physiological role in the hypnotic dissociative phenomena. In this regard, it is worth clarifying that what is called dissociation in hypnosis is a product of an intentional focused attention and absorption, enabling one to disregard what is at the periphery of the attentive field. In fact, a close correlation has been found between the Dissociation Experience Scale and the Tellegen Absorption Scale [131], making hypnotic dissociation a physiologic, purposeful and useful endpoint of hypnosis, where focal attention and concentration imply the withdrawal of distracting and irrelevant stimuli.

The above-mentioned alterations of DMN and SN in PTSD, the changes of DMN activity in hypnosis, as well as the increased DLPFC-SN functional connectivity in highly hypnotizable subjects [49] and in psilocybin administration [132], reflect the complex interrelationship between DMN, SN and CEN, with their flexible hubs; it allows for a wide range communication with other systems, a high mind-brain flexibility in processing information and, thus, for a wide range of outcomes, i.e., the great variety of experiences (including NOMEs), adapting behaviors, positive self-transformation as well as dysfunctional changes as the other side of the coin.

In hypnosis the emergence of other identities is not pathological in itself, as clearly shown by our cases; therefore, the emergence of other identities in hypnosis may provide the unique opportunity to explore the physiology of brain network, the dysfunction of which is at the base of DIDs. Other identities have been traditionally considered as matter of hallucination or delusion, terms endowed with huge cultural and epistemological implications. Since Aristotle, the Western thought has introduced a logical strategy of thinking to tell reality from illusion, where first-person perspective reports are judged as real or false, according to the correspondence with the third-person "objective" perspective and logic reasoning. On the other hand, they are far from being unerring, since collective illusions or beliefs (including the *Zeitgeist*, the *spirit of the times*) may lead to take for true what is false and for fool individuals not sharing it. This is a recurrent phenomenon in scientific revolutions too, the last of which is the huge change of paradigm introduced by quantum physics. As a result, the positivist inclination of Western psychiatry has considered hallucinations as a marker, sometimes pathognomonic, of schizophrenia until late 20th century, while there is now evidence that non-intrusive hallucinations associated to a proper insight in their nature are non-pathological and may occur in up to 15% of non-clinical population [133,134].

The hypothesis of other identities as a continuum from healthy mind to psychiatric disorders

The emergence of other identities, in its broadest sense, is an intriguing and heterogeneous experience; its phenomenology has imbued many human activities and involved different disciplines, challenging the human kind of all times. When this occurs, the subject may transiently get a different personality, or have a dialogue with inner – intrusive or non-intrusive, good or evil – entities providing good suggestions, hints for enlightenment or forcing him/her to unwanted behaviors. The understanding of these phenomena and the competence in managing bad ones has been shared by different disciplines (sometimes being a matter of contention), viz, medicine, psychology, religion, parapsychology and Spiritism with their specific therapeutic tools (e.g., drugs, psychotherapy, spells and exorcism). On the other hand, the non-pathological ones encompass NOMEs – such as visions, prophecy, mystic experiences, inspiration in art and music, as well as memories of previous lives.

It is worth recalling that in the antiquity the worlds of humans and gods were not dualistically split; rather, they were accepted, contiguous and in a reciprocal communication, making oracles, dreams and auditory perception-hallucinations of gods and deceased providing orders or advises was a normal, welcome and fully accepted "real" event. As far as medicine is concerned, in ancient Egypt and Greece ἐγκοίμησις (*enkoimesis*, *incubation*, allowing for an encounter with the god) was routinely used for some three millennia to get oracles or as healing practice in Imhotep, Serapis, Apollo and Asclepius temples, also called "sleep temples" [71,135–138]. With the advent of monotheism, the Western culture abandoned all ancient practices, but a remnant of incubation survived through the Middle Ages in the miraculous healing in sanctuaries [139]. Then, the birth of Galilean sciences as a political compromise with the Church and the Cartesian ontological split of *res cogitans* and *res extensa* led to the former being assigned to the exclusive competence of the Church and the latter to the science [70]: a compromise survived until now with the doctrine of the *Non-Overlapping Magisteria*, also endorsed by the National Academy of Sciences of the USA [140,141]. As a result, an increasingly materialist-objectivist perspective was held with positivism and then with physicalism leading to monist materialism as the ruling perspective in modern science; nevertheless, both positivism and materialist monism are metaphysical in nature, since they rely on an ontological *a priori* foundation, which is endowed with specific limits and possible flaws (the analysis of this crucial problem is far beyond the aims of this article; for further analysis see [70,142,143]). When applied to mental disorders, the positivist inclination of medicine is focused on the definition of normality and disease, both being conventional, culturally and statistically based concepts, [70,71]; the belief in the universal value of such definitions and related management criteria may also yield bad results, when applied *tout court* to other cultures [10], while too strict definitions and diagnostic criteria might lead to normal subjects being wrongly taken for pathological [144].

The experience of other identities may range from a dialogue with inner non-intrusive or even good voices or entities to alien, hostile ones and fully dissociated personalities. Given the wide range of non-pathological and pathological pictures, it seems more reasonable to phenomenologically conceive them as a *continuum* ranging from the physiology of mind to its disorders, rather than trying to establish a clear-cut limit between normality and the whole of other pictures, to be taken a priori for dysfunctional.

In psychotherapy and hypnotherapy different but compatible views of the problem have been previously conceptualized as "hidden

observer", "co-consciousness", "internal self-helpers" and "ego-states" [145–151]. Milton Erickson thought that so-called multiple personalities might also disclose potential resources and treated several cases by managing them as subject's collaborators. Another approach aims to the fusion and integration of alien entities in a whole, in order to overcome dissociation [16]. In this regard, an interesting step of some shamanic rituals is asking the patient to build up one or more dolls representing his/her problem(s), an action helping to objectify, i.e., project them outside, in order to limit, control or withdraw them.

Our results show that absolutely healthy subjects with high hypnotic ability may spontaneously undergo experience of other identities, of which they are unaware after dehypnotization; these data support the hypothesis of other identities as a non-pathological condition, suggesting the need for further study to better understand their physiological meaning as well as identify when and how they need to be treated. The experience of other identities has a link with hallucinations, the role of inner speech and the development of Self. The huge complexity of these topics and the analysis of their relationship is far beyond the limit of this article; however, a few key points are useful to better shape the hypothesis of a continuum between the physiology and pathology of the above-mentioned varieties of other identity experiences.

As mentioned above, hallucinations have been considered in the past as markers of psychosis, while it is now clear that both hallucination and NOMEs may occur non-clinical population [64,69,133,152]. As a whole, this means that all of us are embedded in a continuum ranging from so-called but ill-defined normal consciousness (which, anyway, includes a wealth of misperceptions, illusions, false beliefs and accepted dogmas at any given time) to hallucinations and NOMEs, showing the naivety of common sense, also imbuing the positivist objectivism. As Remo Bodei provocatively stated, "*The images flash do not arise from some sort of 'immaculate perception' engendered by the plain presence of external agents… Thus, one must not define the hallucination as a false external perception, rather the external perception as a 'true hallucination*" [153,p. 59].

Auditory verbal hallucinations, once considered as pathognomonic of schizophrenia, may be regarded as the result of a misattributed inner speech [154]. If this is the case, the disorder stems from misattribution (dissociation) rather than the speech in itself, while its occurrence in non-clinical population without distressing consequences holds the hypothesis of a continuum [155]. Therefore, it seems reasonable to define them as an extension of the normal inner speech, misattributed to other identities, while a better dialogic inner speech, a compassionate attitude, meditation and hypnosis might help coping with them favoring a process of integration [154]. In fact, inner speech is an essential activity for cognition and metacognition, planning, making decisions, as well as evaluating, knowing and motivating oneself. The problem was well defined by Descartes himself in *Meditationes de Prima Philosophia* (1641, II Meditation) as follows: "*Yet in the meantime I am greatly astonished when I consider [the great feebleness of mind] and its proneness to fall [insensibly] into error; for although without giving expression to my thought I consider all this in my own mind, words often impede me and I am almost deceived by the terms of ordinary language*" [156]. In short: no words no thought, be it truthful or deceitful, while a total loss of language (as in global aphasia) may surprisingly yield a silent but happy mind in a feeling of fusion with the universe, as witnessed by the neuroscientist Jill Bolte Taylor following her left stroke [157,158].

The fact that inner speech is related to decreased connectivity in the DMN and fronto-parietal system, and the activation of the left IFG [159,160] suggests a link between inner speech, DIDs and the other identities experienced in our cases, where a DMN decreased connectivity has been found. Furthermore, a deactivation of DMN and activation of right IFG have been reported in hypnosis [82], while changes of activity of both insula and IFG were found in meditation, depending on the type of technique (i.e., *śamatha* or *vipaśyanā* meditation), [125,161,162].

In conclusion, the whole of data discussed above shows the role of DMN in non-pathological experience of other identities as well as the huge complexity of the interrelationship between DMN, SN and CEN at the base of inner life and its relationship with the outer world. Both hypnosis and meditation have shown to intentionally change DMN activity, while an altered balance between DMN, SN and CEN has been related to DIDs and psychosis. Thus, DMN, SN and CEN may be regarded as a highly integrated set of functional, dynamic attractors, the relative strength and connectivity of which may change over a lifetime, according to both experience and introspective activity. The above data also hold the hypothesis of a continuum, ranging from normal consciousness and NOMEs to psychiatric disorders. Defining them as a continuum has relevant implications in clinical practice, since it may help overcoming the positivist inclination to fix a clear-cut limit between normality and pathology (a hard job, if possible) and accept the existence of a grey area of non-pathological, despite ostensibly odd phenomena (and oddity is conventional in nature, closely depending on the *Zeitgeist* and adopted metaphysics) to be approached with more flexibility. This may allow for a better, non judgemental insight into patient's world and help him/her from inside to understand, tame and integrate the dissociated components of their personality, when present, with behavioral approaches – including Eye Movement Desensitization and Reprocessing (EMDR), Ego State Therapy, hypnosis, and meditation [127,163,164] – while helpfully using drugs when necessary to relieve symptoms. In fact, from an existential point of view, both non-pathological and pathological phenomena may be considered as the result of life experience, rather than the only expression of an isolated, neurobiological, physical disorder to be relegated to pharmacological manipulation: they are the result of a poor solution to trauma and adversities of life, a fact linking them to the concept of positive health, as well as of development of Self and resilience [124,165–169].

The main limits of our study are the limited sample of subjects, a fact depending on their rarity, and the fMRI data analysis limited to the DMN. However, despite the small sample, our cases clearly show the possibility of unconscious experience of other identities in healthy subjects, while further studies are required to check the relationship between DMN, SN and CEN in these intriguing non-pathological experiences and the possibility of manage their alterations with hypnosis and other behavioral techniques.

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Declaration of Competing Interest

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