Consciousness and Cognition 97 (2022) 103244

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

The self and its internal thought: In search for a psychological baseline

Andrea Scalabrini [a,*], Adriano Schimmenti [b], Michelangelo De Amicis [a], Piero Porcelli [a], Francesco Benedetti [c,d], Clara Mucci [e], Georg Northoff [f,g,h,i,j,1]

[a] Department of Psychological, Health and Territorial Sciences (DiSPuTer), G. d'Annunzio University of Chieti-Pescara, Via dei Vestini 33, 66100 Chieti, CH, Italy
[b] Faculty of Human and Social Sciences, UKE - Kore University of Enna, Cittadella Universitaria 94100, Enna, EN, Italy
[c] Psychiatry &Clinical Psychobiology Unit, Division of Neuroscience, IRCCS San Raffaele Scientific Institute, Milan, Italy
[d] University Vita-Salute San Raffaele, Milan, Italy
[e] Department of Human and Social Sciences, University of Bergamo, Piazzale Sant'Agostino, 2, 24129 Bergamo, BG, Italy
[f] The Royal's Institute of Mental Health Research & University of Ottawa. Brain and Mind Research Institute, Centre for Neural Dynamics, Faculty of Medicine, University of Ottawa, Ottawa, 145 Carling Avenue, Rm. 6435, Ottawa, Ontario K1Z 7K4, Canada
[g] Mental Health Centre, Zhejiang University School of Medicine, Tianmu Road 305, Hangzhou, Zhejiang Province 310013, China
[h] Centre for Cognition and Brain Disorders, Hangzhou Normal University, Tianmu Road 305, Hangzhou, Zhejiang Province 310013, China
[i] TMU Research Centre for Brain and Consciousness, Shuang Hospital, Taipei Medical University, No. 250 Wu-Xing Street, 11031 Taipei, Taiwan
[j] Graduate Institute of Humanities in Medicine, Taipei Medical University, No. 250 Wu-Xing Street, 11031 Taipei, Taiwan

ARTICLE INFO

Keywords:
Self-consciousness
Spontaneous thought
Rumination
Depression
Psychological baseline

ABSTRACT

Self-consciousness is neuronally associated with the brain's default mode network as its "neuronal baseline" while, psychologically the self is characterized by different thought modes and dynamics. We here raise the question whether they reflect the "psychological baseline" of the self. We investigate the psychological relationship of the self with thought modes (rumination, reflection) and mind-wandering dynamics (spontaneous, deliberate), as well as with depressive symptomatology. Our findings show a relationship between self-consciousness and i) mind-wandering dynamics, and ii) thought functional modes, in their respective forms. At the same time, self-consciousness is more related to spontaneous mind-wandering than deliberate and to rumination than reflection. Furthermore, iii) rumination acts as a mediator between self-consciousness and spontaneous mind-wandering dynamics; and iv) the relationship between high levels of self-consciousness and depressive symptoms is mediated by ruminative modes and spontaneous mind-wandering dynamics. Together, these findings support the view of the self as "psychological baseline".

* Corresponding author at: Department of Psychological, Health and Territorial Sciences (DiSPuTer), G. d'Annunzio University, Via dei Vestini 33, 66100 Chieti, CH, Italy.
E-mail addresses: andrea.scalabrini@unich.it (A. Scalabrini), georg.northoff@theroyal.ca (G. Northoff).
URL: http://www.georgnorthoff.com (G. Northoff).
[1] Co-corresponding author at: Georg Northoff, Mental Health Centre/7th Hospital, Zhejiang University School of Medicine, Hangzhou, Tianmu Road 305, Hangzhou, Zhejiang Province, 310013, China. Mind, Brain Imaging and Neuroethics, Canada Research Chair, EJLB Michael Smith Chair for Neuroscience and Mental Health, Royal Ottawa Healthcare Group, University of Ottawa Institute of Mental Health Research, 1145 Carling Avenue, Room 6467, Ottawa, ON K1Z 7K4, Canada.

https://doi.org/10.1016/j.concog.2021.103244
Received 30 June 2021; Received in revised form 29 October 2021; Accepted 17 November 2021
Available online 27 November 2021

1. Introduction

1.1. The self and its thoughts – What is their relation?

William James was one of the first authors who consistently conceptualized the self as a key feature of human nature about which everything else revolves, the fundamental core of our mental life (James, 1890). James proposed that thinking and focusing on the self requires that the I, i.e., the subject, becomes the Me, i.e., the object of its own attention and thoughts. This process entails that, in addition to the subjective self itself, i.e., the I, one may also want to investigate its more objective manifestations in, for instance, consciousness and thought, i.e., the Me. Today, the state of the scientific knowledge is that while self-consciousness has been investigated in both its psychological (Ingram, 1990; McKenzie & Hoyle, 2008; Simsek, 2013; DaSilveira et al., 2015) and neural (Wolff et al., 2019; Huang et al., 2016) levels, the relation of self to its own internal thought modes and their dynamics (see below) remains yet unclear.

The self has been linked to different structures here conceptualized as different thought functional modes, i.e., reflection and rumination (Trapnell & Campbell, 1999), and also to the dynamics of self-generated thoughts and mind-wandering (Andrews-Hanna et al., 2010; Christoff et al., 2016). Intriguingly, William James already in 1890 described how the "*contents*" and the "*movement*" featuring of mental states are characterized by a spontaneous and dynamic nature of thoughts. However, the relationship between self-consciousness and its spectrum of thought, here defined as thought functional modes (rumination, reflection) and dynamics of spontaneous thought (as in spontaneous mind-wandering as distinguished from deliberate mental activities) is yet to be investigated. A more careful investigation may have important implications not only in the mental health of subjects but, mostly relevant, at a subclinical and/or clinical levels of mental states like in depression in which the self-consciousness and its thought are altered (Northoff 2016a; Northoff et al., 2011). Such understanding makes the investigation of the relationship of the self to its own thought modes and dynamic even more urgent.

1.2. From the "default mode functionality" of the brain to the "psychological baseline" of the self and its internal thought

The task evoked activity as well as the brain's spontaneous activity (or resting state) have been investigated more and more over the years (Logothetis et al., 2009; Raichle et al., 2001). Especially the default mode network (DMN) that comprises the cortical midline structures and shows strong power in the low-frequency fluctuations (Buckner et al., 2008; Raichle, 2009) has been associated with self-relatedness during both task-evoked activity and spontaneous thought activity (Gusnard & Raichle, 2001; Zhu, 2004; D'Argembeau et al., 2005; Moran et al., 2006; Schneider et al., 2008; Enzi et al., 2009; Northoff et al., 2010; Whitfield-Gabrieli et al., 2011; Hu et al., 2016). Research findings suggest that the spontaneous activity of the brain may contain some self-specific information, serving to process and assign self-specificity of the contents related to the subsequent internal or external stimuli (e.g., rest-self overlap/containment, Bai et al., 2016; Davey et al., 2016; Northoff, 2016a; Qin & Northoff, 2011; Huang et al., 2016; Wolff et al., 2019; Scalabrini et al., 2018; Kolvoort et al., 2020).

The here suggested relation between the functional role of DMN and its association with self-related task-evoked activity and spontaneous activity of the brain has also been extended to what has been defined as "default mode functionality" (Raichle, 2015) or "psychological baseline" (Northoff & Bermpohl 2004; see also Scalabrini et al., 2020a; Scalabrini, Xu, & Northoff, 2021). Such default mode functionality is related to how the brain is topographically and functionally organized in its spontaneous activity; that, in turn, provides the "psychological baseline" for the processing of different functions including cognitions and its spectrum of thoughts in mind-wandering.

Based on these neural data, one would expect a close psychological relationship between self and its spectrum of thought. Specifically, one would expect that the self serves as the default, reference, or psychological baseline for its own spectrum of thought.

1.3. Spectrum of thought and their relation with the DMN: mind-wandering dynamics and thought functional modes

Mind-Wandering (MW) refers to a form of mentation disconnected from the environment and immediate sensory perception, shifting the attentional focus from the external task towards a constant flow of internal task-unrelated thoughts (Stawarczyk et al., 2011; Mason et al., 2007; Seli et al., 2017). MW is usually characterized by two domains: content and dynamics. On a content base, MW is characterized by mainly internally self-generated thoughts (different from externally perceptual-guided thought) and plays an important role in relation to the self (see Andrews-Hanna et al., 2010; Christoff et al., 2009; Qin & Northoff, 2011; Northoff, 2017, 2018). Indeed, intriguingly MW too, exactly like the self, has been associated with the spontaneous activity of the brain (or "resting state activity") and especially the DMN (Gusnard & Raichle, 2001; D'Argembeau et al., 2005; Moran et al., 2006; Northoff et al., 2010).

On a dynamic base, MW can be distinguished in two types: a "*spontaneous*" type (MW-S), where the attentional focus tends to move unintentionally from the ongoing task to other unrelated thoughts, and a "*deliberate*" type (MW-D), where attention is diverted from the task and intentionally directed towards other thoughts (Carriere et al., 2013; Seli et al., 2015). Defined in this way, MW-D and MW-S reflect different degrees of subjectively perceived control - consistent with the dynamic and process-based nature of these experiences (Andrews-Hanna et al., 2013; Andrews-Hanna et al., 2014; Christoff et al., 2016) - and are mediated by distinct neural correlates (Golchert et al., 2017).

Similarly, Trapnell and Campbell (1999) distinguished between rumination (RUM) and reflection (REF) as two different subtypes of attitudes towards the self. RUM is a kind of maladaptive, persistent, inflexible self-focused process of circular thought, motivated by internal or external conflicts. REF is an adaptive kind of inspection of one's own thoughts and feelings, motivated by curiosity or

epistemic interest in the self. It remains to be investigated how these two kinds of thought modes are related with the self and MW dynamics.

1.4. The self and ruminative thought in depression

The increased focus on self together with the increased internal oriented cognition, e.g. rumination, characterize depressive symptomatology (Northoff, 2007) and is featured by studies in neuroscience supporting the key role of the default mode network including its relation to the self (Hamilton, Chen, & Gotlib, 2013; Kaiser, Andrews-Hanna, Wager, & Pizzagalli, 2015; Northoff, Wiebking, Feinberg, & Panksepp, 2011; Scalabrini et al., 2020a; Scalabrini, Xu, & Northoff, 2021). Indeed, becoming increasingly self-involved and self-conscious might lead to rumination as form of spontaneous MW (Christoff et al., 2016). Rumination is defined as a kind of persistent and inflexible self-focus that leads to and exacerbates depressive symptoms (Trapnell and Campbell, 1999; Nolen-Hoeksema et al., 2008; Marchetti et al., 2016).

In more detail, a recent investigation by Scalabrini et al., (2020a) shows that at a neuronal level the DMN and its self-related functions subjugate individuals suffering from depression. This suggests that during a period of resting state/mind wandering, depressed people's self might be subjugated by the ruminative structure of its thought – this remains to be shown on the psychological level, though.

1.5. Aims of the study

We here depart from the background that the self and its thought spectrum have both been associated neuronally with the spontaneous activity of the brain's default-mode network suggesting a "default mode functionality" on the neuronal level (see Fig. 1). The goal of our study is to investigate whether the self provides the psychological baseline for its own thought modes and their dynamics. While on the neuronal side we have certain evidence for the DMN serving as neuronal baseline of the self, the respective psychological counterpart is not clear yet and it leaves open the question: does the self provide the psychological baseline for its own inner thought and cognition?

We are theoretically moving closer to the epistemic level of Radical Embodiment (RE) as recently introduced by Barsalou (Barsalou, 2008; Barsalou et al., 2003) and by Borghi and Caruana (Caruana & Borghi, 2013; Borghi & Caruana, 2015). This level considers cognition as a dynamical system characterized by continuously and interdependently changing variables, which can be better described by the dynamical system theory (e.g., Spivey, 2008), then by representational explanations. In accordance with RE our theoretical approach is a-modal and domain-independent: it aims to search for the "common currency" between brain and psyche (Northoff et al., 2020a, 2020b; Northoff & Scalabrini, 2021) investigating how the spatio-temporal features of neuronal and psychological components can be considered as the "baseline" or default for the subsequent development of mental features like thought modes and dynamics.

Our psychological investigation comprises four different steps:

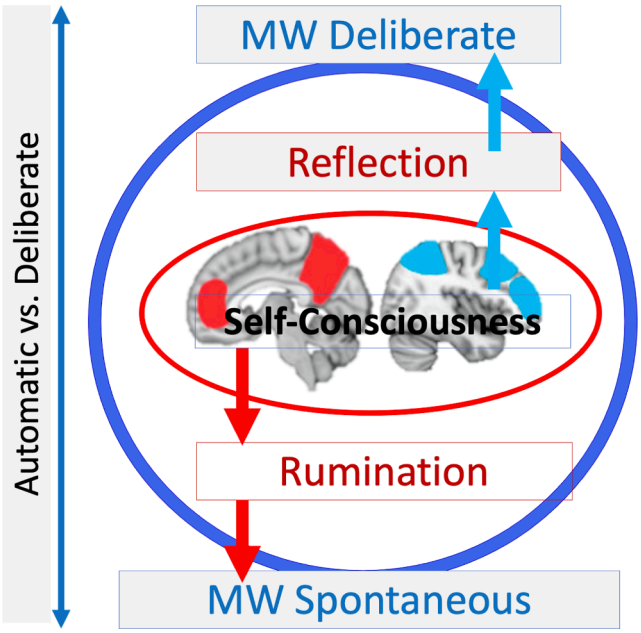

Fig. 1. Theoretical framework of the relationship between self-consciousness, thought functional modes and mind-wandering dynamics.

(i) we aim to test the relationship between self-consciousness and the different forms of mind-wandering dynamics, e.g., spontaneous vs deliberate,
(ii) similarly, we aim to test the relationship between self-consciousness and different thought functional modes, e.g., rumination vs reflection,
(iii) we aim to investigate the psychological mechanism underlying the triangular relationship between the degree of self-focus, i.e., self-consciousness, the modes of thoughts, i.e., rumination and reflection, and mind-wandering dynamic in its spontaneous and deliberate forms,
(iv) finally, we aim to test the relevance of this relationship for depression probing a model which might explain the underlying mechanism on the well-known relation between increased self-focus and depressive symptomatology (Watkins & Teasdale, 2001; Northoff 2007, 2016b; Takano & Tanno, 2009) in a non-clinical population.

Overall, we expect a close association of the levels of self-consciousness with both spontaneous and deliberate mind-wandering dynamics as well as with both rumination and reflection. This would provide support to the hypothesis that the self provides the reference or baseline, i.e., psychological baseline for its own mind-wandering and thought modes. One may then want to raise question whether the distinct forms of mind-wandering and the thought modes can be distinguished from each other in their relationship to the self; both are related to the self as psychological baseline, but they may be related to the self in distinct ways, e.g. at different degrees. Finally, we use the case of depressive symptoms in a general population to support the role of the self: if the self serves as psychological baseline, changes in the self, including the degree of its relationship to mind-wandering and thought modes, should also modulate the degree of its depressive symptoms. The case of depressive symptoms can thus serve as first tentative litmus test of our hypothesis of the self serving as psychological baseline.

2. Methods

2.1. Participants

The study involved 410 adults (140 males, 34.1%; 270 females, 65.9%). Participants ranged in age from 18 to 65 years old (M = 31.41, Me = 27; SD = 12.24) and most of them showed high level of education (3.9% middle school; 42.2% high school, 22.2% BA university degree; 27.1% MA or Msc university degree and 4.6% PhD or equivalent). Males were slightly older than females in this sample [$t_{(408)} = 2.678$, $p = 0.008$; 95 %CI [1.68, 5.89]; males: $M = 33.64$, $SD = 13.58$; females: $M = 30.25$, $SD = 11.32$] whereas there was not gender difference in relation to the years of education [$t_{(408)} = 0.59$, $p = 0.55$; 95 %CI [-0.405, 0.760]; males: $M = 20.15$, SD = 2.99 ; females: $M = 19.98$, $SD = 2.73$].

2.2. Materials

Self-Consciousness Scale - Revised Version for Use with General Populations (SCS-R). The SCS-R (Scheier & Carver, 1985; Italian adaptation in Comunian, 1994) is a 22-item self-report questionnaire that investigates the concept of self-consciousness or self-focus. The theory behind it was proposed by Mead (1934) and operationalized as the theory of objective self-awareness (Duval & Wicklund, 1972). Self-consciousness is mainly considered as the activity of becoming the object of one's own thoughts, for example: "*I always try to figure myself out*; *I'm concerned about what other people think of me; It's hard for me to work when someone is watching me*". The subjects were asked to evaluate the items using 5-point rating scale (e.g., 0 extremely uncharacteristic, 4 = extremely characteristic). For the purpose of this study, we considered the total score of SCSR representing a general tendency of the individual to focus and being concerned on individual's thoughts about the self (self-focus). Previous work has shown good reliability and consistency over time properties (Scheier & Carver, 1985). In the present study Cronbach's alpha for SCSR was 0.81.

Mind Wandering Spontaneous Scale (MW-S) and Mind Wandering Deliberate Scale (MW-D). The MW-S and the MW-D (Carriere et al., 2013; *Italian version* in Chiorri & Vannucci, 2019) are two 4-item scales that assess individual differences in trait levels of spontaneous and deliberate MW, respectively. Items are scored using 7-point Likert scale. Higher scores reflect a greater tendency to mind wander spontaneously or deliberately. Previous studies reported adequate reliability and discriminant validity of the two scales (Chiorri & Vannucci, 2019). In the present study Cronbach's alpha for MW-S was 0.86, for MW-D was 0.82.

Rumination-Reflection Questionnaire (RRQ: Trapnell & Campbell, 1999; *Italian version* in Vannucci & Chiorri, 2018). It is a 24-item measure that investigates rumination (RUM) and reflection (REF). Reflection and rumination are considered divergent functional modes or structures of thoughts related to the self: for instance, reflection is related to the item *"My attitudes and feelings about things fascinate me"* while rumination is featured by items like *"My attention is often focused on aspects of myself I wish I'd stop thinking about"*. The items are divided equally between the two subscales, evaluated on a five-point Likert scale, from 1 ("completely disagree") to 5 ("completely agree"). Previous work has shown good reliability and convergent validity (Trapnell & Campbell, 1999). Cronbach's alpha for RUM was 0.89, Cronbach's alpha for REF was 0.90.

The DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure (American Psychiatric Association [APA], 2013, *Italian version* Raffaello Cortina Editore, 2015) was used to assess psychopathological symptoms with a specific focus on depression domain and mania used as a control condition. This measure includes 23 items rated on a 4-point Likert-type scale ranging from "very false or often false" to "very true or often true". Each item investigates how often an individual has suffered from specific symptoms in the last 2 weeks. The following is the example of depression and mania domain used in the present study. A) depression: 1) "Little interest or pleasure in doing things?", 2) "Feeling down, depressed, or hopeless?"; Cronbach's alpha = 0.70). B) mania: 1) "Starting lots more projects than

usual or doing more risky things than usual?" 2) "Sleeping less than usual, but still have a lot of energy"; Cronbach's alpha = 0.61)

2.3. Procedures

All participants were recruited online from the general population using a snowball-like system procedure trough an online survey via social networks (e.g., Facebook and web-forums) and provided informed consent prior to participation in the study. People received an invitation that included a brief description of the study and an anonymous electronic link to the online survey. The web page provided a brief description of the research and methodology. Information on sociodemographic variables including sex, age and education were collected. Inclusion criteria were as follows: 1) age between 18 and 65 years; 2) native or fluent Italian language speaker; 3) not being in treatment with psychotropic medication that might influence the thought processing within the past 3 months. We followed Fritz and MacKinnon's (2007) rules to detect a required sample size for mediation analysis. Thus, we stopped our recruitment procedure when more than four-hundred participants resulted eligible. Specifically, five-hundred individuals participated to the study and signed the electronic informed consent. Eighty-one participants were excluded for incomplete data, thus other nine subjects did not respect the inclusion criteria. The final sample size was constituted by four-hundred and ten subjects. This study was consistent with the ethical principles of the American Psychological Association (APA). Privacy of participants was guaranteed in accordance with the European Union General Data Protection Regulation 2016/679. The study was approved by the Institutional Review Board of Psychology of the University d'Annunzio (UdA) of Chieti, Italy (no. 20023) and is part of the Search for Excellence - UdA for the project SYNC (The Self and its psYchological and Neuronal Correlates – Implications for the understanding and treatment of depression as a disorder of Self)

2.4. Statistical analysis

SPSS 25 (IBM, USA) was used to analyze data. Cronbach's *α* coefficient was used to assess the internal consistency of the measures. Descriptive statistic and differences between groups were tested by means of independent sample *t*-test and Chi-square test. Pearsons' r coefficient was used to evaluate the association between the variables. Significance with multiple comparisons were tested with Bonferroni correction. Hotelling-Williams test (Steiger, 1980) was performed to test the equality of two correlation coefficients obtained from the same sample, with the two correlations sharing one variable in common. Partial correlations were computed controlling for the effect of each variable respectively. Mediational models were examined using PROCESS version 3.0 tool for SPSS (Hayes, 2017). The prerequisite for mediation analysis were satisfied according to Baron and Kenny (1986). First, we tested a model where self-consciousness and mind-wandering-spontaneous were the independent and the dependent variables, respectively, and rumination was considered as mediator. In the second model self-consciousness and rumination were the independent and the dependent variables, respectively, while mindwadering-spontaneous was considered as mediator. Last it was proposed a serial multiple mediational model where self-consciousness and depressive symptoms were the independent and the dependent variables, respectively, while rumination and mind-wandering-spontaneous were considered as mediators (Fig. 5B describe the causal order of mediators).

Consistent standard errors were calculated, and sociodemographic variables (age, sex and years of education) were included as covariates in the analysis to minimize the risk of biased results. Bias-corrected bootstrap methodology using 5000 independent samples (95% CI) was applied to estimate the significance of the indirect effect. The bootstrap 95% CI was also computed to evaluate the significance of the direct, total effect, and regression parameters. A *p* value of 0.05 was set as the criterion for statistical significance.

3. Results

Table 1 shows descriptive statistics. No sex differences were observed in the sample for all the variables with the exception of a slight but statistically significant higher levels of self-consciousness in women, $t(408) = -2.393$, $p = 0.017$; 95 %CI [-1.44, −0.14], and

Table 1
Descriptive Statistics and Gender Differences.

	Full sample (N = 410)		Observed Range	Men (N = 140)		Women (N = 270)		Men vs Women *t* [408]	*df*	*p*	95% CI		Cohen's *d*
	M	*SD*		*M*	*SD*	*M*	*SD*				*LL*	*UL*	
SCSR	12.08	3.19	3.00–20.00	12.28	3.15	13.07	3.18	−2.39	408	0.02	−1.44	−0.14	−0.25
MW-S	15.30	6.05	4.00–28.00	14.66	5.97	14.92	6.73	−0.38	408	0.70	−1.58	1.07	−0.04
MW-D	15.67	5.70	4.00–28.00	15.92	5.96	14.83	5.71	1.81	408	0.07	−0.92	2.28	0.19
RRQ Rumination	12.49	2.12	12.00–60.00	39.24	9.00	41.07	9.42	−0.89	408	0.06	−3.73	0.06	−0.20
RRQ Reflection	12.31	1.49	14.00–60.00	42.89	8.78	42.81	9.73	0.08	408	0.94	−1.85	2.01	0.01
Depressive symptoms	2.06	1.11	0.00–4.00	1.97	1.13	2.10	1.11	−1.11	408	0.27	−0.35	0.09	−0.12
Manic symptoms	2.06	1.11	0.00–4.00	2.19	1.23	1.91	1.22	2.16	408	0.03	0.02	0.52	0.23

SCSR = Self-Consciousness Scale Revised; *MW-S* = Mind Wandering Spontaneous Scale; *MW-D* = Mind Wandering Deliberate Scale; *RRQ* = Rumination Reflection Questionnaire. *M* and *SD* are used to represent mean and standard deviation, respectively. *df* is used to represent degrees of freedom. *LL* and *UL* are used to represent lower limit and upper limit of *CI* (Confidence Interval), respectively.

a slight but significant higher levels of mania symptoms in men, $t(408) = 2.162$, $p = 0.31$; 95 %CI [0.25, 0.52].

3.1. The relationship between self and mind-wandering

The results showed that SCSR was associated with MW-S at a moderate level ($r = 0.346$, $p < 0.001$, 95 %CI [0.25, 0.42]), while only

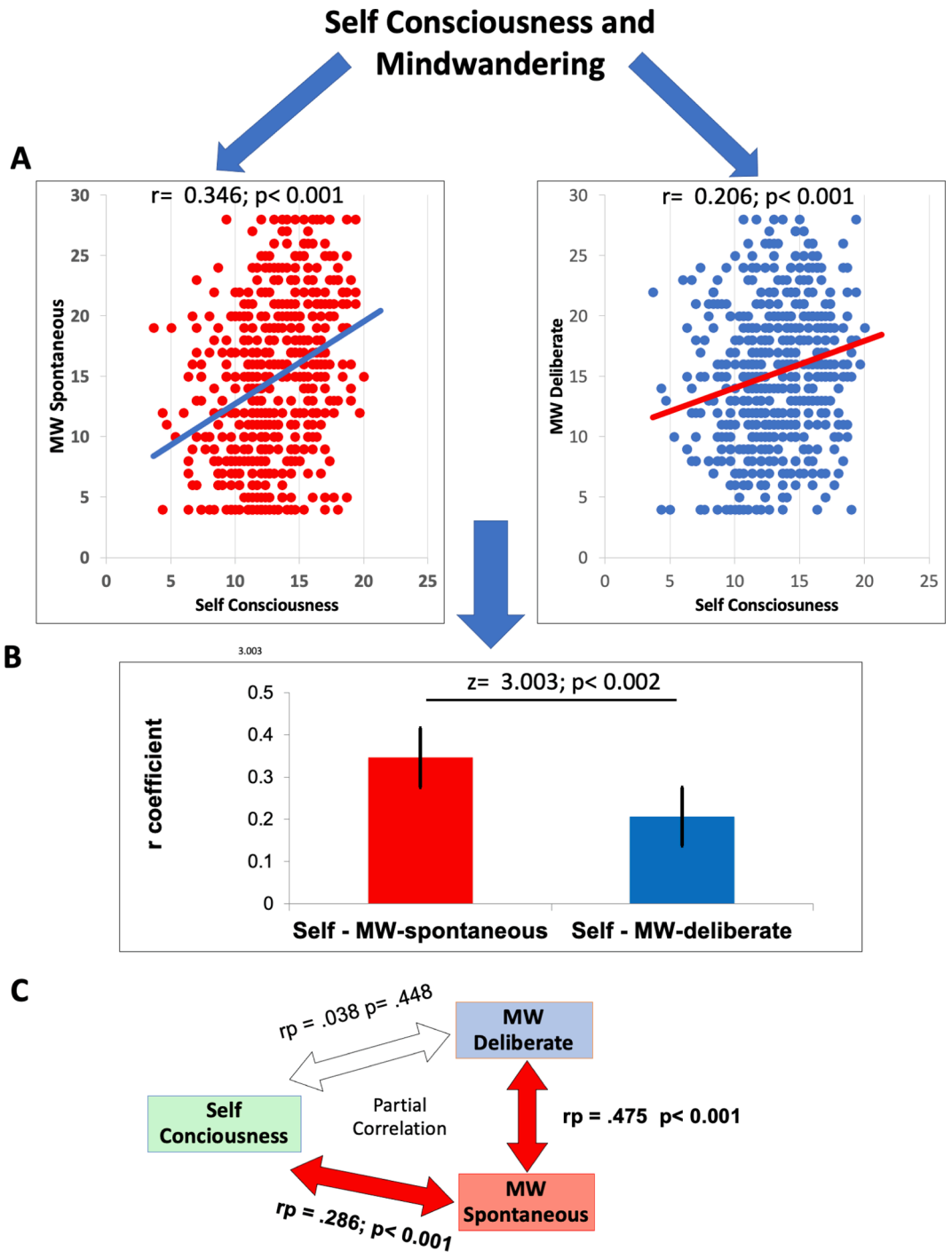

Fig. 2. The relationship between self-consciousness and mind-wandering dynamics. A) Correlational analysis to test the degree of correlation between SCSR and MW-Spontaneous, MW-Deliberate. B) Hotelling-Williams test to investigate the equality of the two correlation coefficient sharing one variable in common (Self-Consciousness). C) Partial correlation analysis showing the statistic of each correlation controlling for the effect of the third variable in the model.

at a weaker level with MW-D ($r = 0.206, p < 0.001$, 95 %CI [0.11, 029]) (Fig. 2A). The Hotelling-Williams test resulted significant ($z = 3.003$; $p = 0.002$) indicating that the correlation between SCSR and MW-S was significantly stronger than the correlation between SCSR and MW-D (Fig. 2B). Partial correlation yielded a significant positive association between self-consciousness and MW-S when controlling for the effect of MW-D ($rp = 0.286$, $p < 0.001$), a significant positive association between MW-S and MW-D when

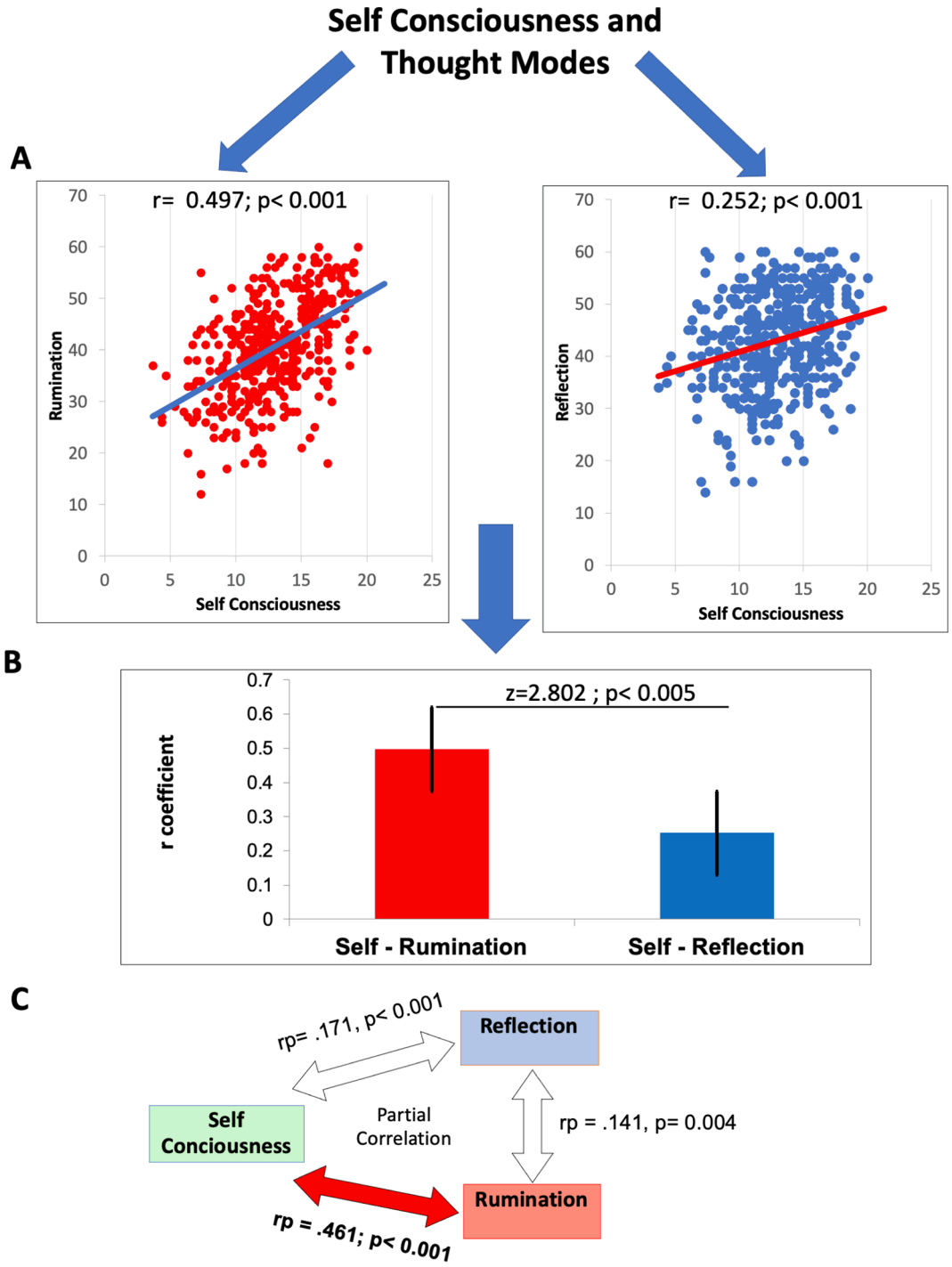

Fig. 3. The relationship between self-consciousness and thought functional modes. A) Correlational analysis to test the degree of correlation between Self-Consciousness and Rumination, Reflection. B) Hotelling-Williams test to investigate the equality of the two correlation coefficient sharing one variable in common (Self-Consciousness). C) Partial correlation analysis showing the statistic of each correlation controlling for the effect of the third variable in the model.

controlling for the effect of self-consciousness ($rp = 0.475$, $p < 0.001$), but no significant association between self-consciousness and MW-D when controlling for the effect of MW-S ($rp = 0.38$, $p = 0.448$; Fig. 2C). Intriguingly, MW-S and MW-D correlated with each other, in line with previous assumption (Chiorri & Vannucci, 2019), suggesting a shared mechanism between the two forms of MW. These findings suggest that while the two forms of spontaneous and deliberate mind wandering activities were associated with each other, self-consciousness was prevalently associated with spontaneous MW.

3.2. The relationship between self-consciousness and thought functional modes

Results showed that SCSR was associated with RUM at a moderate-to-large level ($r = 0.497$, $p < 0.001$, 95 %CI [0.421, 0.567]) while only at a weaker level with REF ($r = 0.252$, $p < 0.001$, 95 %CI [0.159, 0.340]). The Hotelling-Williams test resulted significant ($z = 2.802$; $p = 0.005$) indicating that the correlation between SCSR and RUM was significantly stronger than the correlation between SCSR and REF (Fig. 3B). Partial correlation yielded a significant positive association between SCSR and RUM when controlling for the effect of REF ($rp = 0.461$, $p < 0.001$) and a weak although statistically significant association between RUM and REF when controlling for the effect of SCSR ($rp = 0.171$, $p < 0.001$) and between SCSR and REF when controlling for the effect of RUM ($rp = 0.141$, $p = 0.004$; Fig. 3C). Altogether these analyses suggest that increased levels of self-consciousness are more associated with ruminative modes of thinking then reflective modes, suggesting that reflexivity require the individual ability to take a more adaptive distance from oneself.

3.3. Mediation models: the relationship between self-consciousness, rumination and spontaneous mind-wandering

To investigate the triangular relationship between the degree of self-focus, i.e. self-consciousness, and the thought functional modes, i.e. rumination, and mind-wandering, in its spontaneous form mediation models were tested.

The prerequisite necessary to perform a mediation analysis were considered (Baron & Kenny, 1986). We excluded multicollinearity problems: no tolerance values were below 0.2 (Menard, 2002) ($0.58 \leq$ tolerance ≤ 0.84), no variance inflation factor (VIF) values were greater than 10 (Bowerman & O'Connell, 1990; Myers, 1990) ($1.19 \leq$ VIF ≤ 1.71), and the average VIF was close to 1 (average VIF = 1.42). Mediational models were controlled for the effect of the covariates of sample characteristic (*e.g.* age, sex, level of education). No significant effect of covariates was found in any models.

We here tested the two constellations of the relationship between self-consciousness, rumination and spontaneous mind-wandering as outlined in two different mediation models testing the mediating role RUM and MW-S respectively.

In the first mediation model, we tested the mediating role of RUM in the relation between SCSR and MW-S. The parameter estimation of the mediation analysis is described in detail in Fig. 4a. We observed a significant difference between direct and indirect effects in the relationship between SCSR and MW-S (direct effect: $c' = 0.17$ [-0.01, 0.36]; $p = 0.07$; $se = 0.04$; Indirect effect: $c = 0.70$ [0.52, 0.88]; $p < 0.001$; $se = 0.09$). Together, these results show that the relationship of SCSR and MW-S is fully mediated by the effect of RUM.

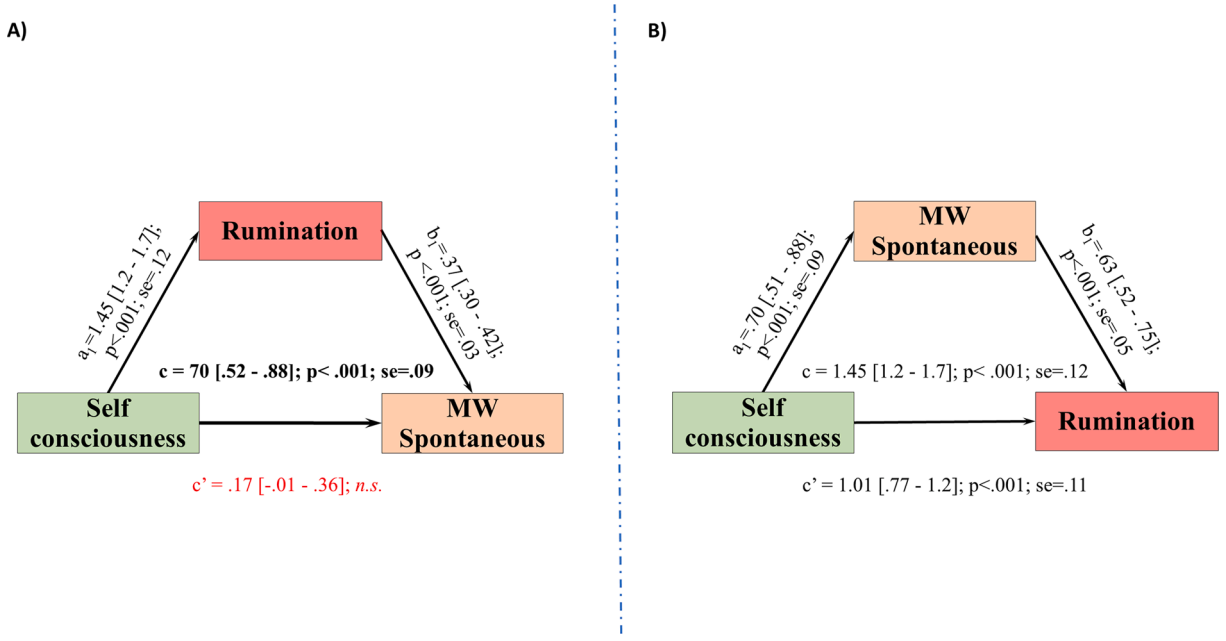

Fig. 4. Two mediation models investigating the triangular relationship between Self-consciousness, Rumination and MW-Spontaneous. The first Mediation model (A) considers Rumination as mediator between Self-consciousness and MW-Spontaneous. The second Mediation model (B) consider MW-Spontaneous as mediator between Self-consciousness and Rumination.

In the second mediation model, we tested the mediating role of MW-S in the relation between SCSR and RUM. In this case we did not observe any difference between the direct or indirect effect of MW-S as a mediator (direct effect: $c' = 1.01$ [0.77–1.2]; $p < 0.001$; $se = 0.11$; indirect effect: $c = 1.45$ [1.2–1.7]; $p < 0.001$; $se = 0.12$). Together these results suggest that MW-S only partially mediate the relationship between SCSR and RUM.

3.4. Correlations with depressive symptoms and a proposed serial multiple mediational model

In order to test the relevance of the relationship between the self and its thought we included a DSM-5 screening measure to assess depression and mania symptomatology, and: i) correlations of all variables included in the study were performed with depression scores and with mania scores as a control condition ii) serial multiple mediation model was proposed to investigate the underlining mechanism on the relation between increased self-focus and depressive symptomatology. Because of the sample size, we hereby highlight only correlations of moderate magnitudes $r > 0.3$ (Dancey & Reidy, 2011) considering not relevant the correlation of weak magnitude $r \leq 0.2$.

Results showed a moderate-to-large relationship between SCSR and depressive symptoms ($r = 0.497$, $p < 0.001$, 95 %CI [0.214, 0.391]), moderate relationships between MW-S and depressive symptoms ($r = 0.396$, $p < 0.001$, 95 %CI [0.311, 0.475]) and RUM and Depression ($r = 0.438$, $p < 0.001$, 95 %CI [0.356, 0.713]), whereas REF and depressive symptoms did not show any significant correlation ($r = 0.044$, $p = 0.37$, 95 %CI [-0.054, 0.140]). Also, a small correlation between MW-D and depressive symptoms ($r = 0.163$, $p = 0.001$, 95 %CI [0.067, 0.256]) was observed (See Fig. 5A).

Using mania symptoms as control, our results showed a weak correlation between SCSR and mania ($r = 0.125$, $p = 0.011$, 95 %CI [0.067, 0.256]), a weak correlation between RUM and mania ($r = 0.124$, $p = 0.012$, 95 %CI [0.027, 0.219]), a weak correlation between MW-S and mania ($r = 0.223$, $p = 0.001$, 95 %CI [0.129, 0.313]), a weak correlation between MW-D and mania ($r = 0.223$, $p = 0.001$, 95 %CI [0.107, 0.293]), finally also depressive showed a weak relation with mania ($r = 0.223$, $p = 0.001$, 95 %CI [0.107, 0.293]) (See Table 2).

Our proposed model considers self-consciousness as the independent variable, depressive symptoms as the dependent variable and RUM and MW-S as mediators (Fig. 5B describes the causal order of mediators).

The parameter estimation of the mediation analysis is described in detail in Fig. 5B. The analysis showed a significant total effect of the model (Indirect effect $c = 0.10$ [0.07, 0.13]; $p < 0.001$, $se = 0.02$), whereas the direct effect resulted not significant (Direct effect $c' = 0.03$ [-0.01, 0.06]; $p = 0.06$.). These findings suggest that the relationship between increased level of self-consciousness and depressive symptoms are fully mediated by the effect of RUM and MW-S. Intriguingly RUM plays a key role in explaining this relationship since standardized indirect effects Ind1 (Self → RUM → Depression; [0.07, 0.19]) and Ind3 (Self → RUM → MW-S → Depression; [0.02, 0.08]) were significant while Ind2 (Self → MW-S → Depression; [-0.01, 0.04]) was not significant.

4. Discussion

We tested for the relationship between self, thoughts modes and dynamics, and depressive symptoms. Our overall findings show that self-consciousness is related to both forms of mind-wandering, spontaneous and deliberate, as well as to the two thought

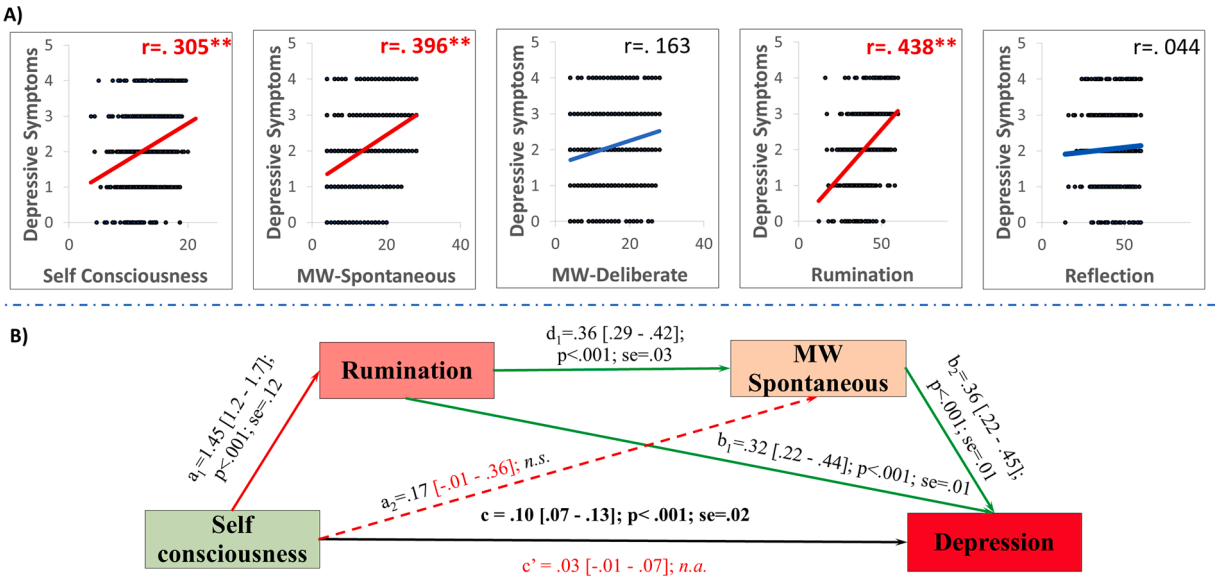

Fig. 5. A) Correlation between Depressive symptoms and Self-consciousness, MW-Spontaneous and Deliberate, Rumination and Reflection. B) Serial multiple mediation model to investigate the relation between increased self-focus and depressive symptomatology.

Table 2
Correlational analysis.

			1.	2.	3.	4.	5.	6.	7.
1. SCSR	**Pearson's *r***		–						
	p		–						
	95% CI	*LL*	–						
		UL	–						
2. RRQ Rumination	**Pearson's *r***		0.50*	–					
	p		< 0.001	–					
	95% CI	*LL*	0.42	–					
		UL	0.57	–					
3. RRQ Reflection	**Pearson's *r***		0.25*	0.270*	–				
	p		< 0.001	< 0.001	–				
	95% CI	*LL*	0.16	0.36	–				
		UL	0.34	0.18	–				
4. MW-S	**Pearson's *r***		0.35*	0.56*	0.20*	–			
	p		< 0.001	< 0.001	< 0.001	–			
	95% CI	*LL*	0.26	0.625	0.29	–			
		UL	0.43	0.50	0.105	–			
5. MW-D	**Pearson's *r***		0.21*	0.25*	0.24*	0.51*	–		
	p		< 0.001	< 0.001	< 0.001	< 0.001	–		
	95% CI	*LL*	0.11	0.34	0.33	0.58	–		
		UL	0.30	0.16	0.15	0.43	–		
6. Depressive symptoms	**Pearson's *r***		0.31*	0.44*	0.04	0.40*	0.16	–	
	p		< 0.001	< 0.001	0.38	< 0.001	< 0.001	–	
	95% CI	*LL*	0.21	0.51	0.14	0.475	0.26	–	
		UL	0.39	0.36	−0.05	0.31	0.07	–	
7. Manic symptoms	**Pearson's *r***		0.125	0.12	0.10	0.22*	0.20*	0.17*	–
	p		0.01	0.01	0.04	< 0.001	< 0.001	< 0.001	–
	95% CI	*LL*	0.03	0.22	0.195	0.31	0.29	0.265	–
		UL	0.22	0.03	0.003	0.13	0.11	0.08	–

SCSR = Self-Consciousness Scale Revised; *MW-S* = Mind Wandering Spontaneous Scale; *MW-D* = Mind Wandering Deliberate Scale; *RRQ* = Rumination Reflection Questionnaire. *LL* and *UL* are used to represent lower limit and upper limit of *95% CI* (Confidence Interval), respectively. *p < 0.001 bonferroni corrected

functional modes, reflective and ruminative. This supports the idea that the self is "present" in both forms of mind-wandering as well as in the two forms of thought modes – they share the self as commonly underlying component. At the same time, we saw differences in the relationship of the self with the distinct forms of mind-wandering: i) the relationship between the degree of self-consciousness and mind-wandering dynamics is stronger for the spontaneous type of MW than the deliberate one; ii) the relationship between the degree of self-consciousness and thought functional modes is stronger for rumination than reflection; iii) rumination fully explains the relationship between self-consciousness and its spontaneous MW dynamics, suggesting that the functional modes of self-thought influences thought dynamics; and iv) that the relationship between higher levels of self-consciousness and depressive manifestation is characterized by a high degrees of both rumination and spontaneous MW dynamics.

The here observed close relationship between self, thought, and depressive symptoms provides insight into the psychological role of the self to its own mind-wandering and thought modes. They are well compatible with the idea that the self serves as reference or "psychological baseline" just as analogous to the neuronal role of the default-mode network in the case of the brain which, even more interesting, is strongly recruited during self-referential tasks. Hence, the self may serve as "psychological baseline" just as similar to the neuronal role the DMN takes on for the rest of the brain.

4.1. The self and its thought dynamics and functional modes

At a neuronal level, in addition to different experimental tasks associated with the self (e.g. Sui et al., 2012; Sui et al., 2013; Yankouskaya et al., 2020), the brain's spontaneous activity (or resting state) and its most relevant active network, i.e. default mode network (DMN; Raichle et al., 2001; Raichle, 2009; Buckner et al., 2008) have also been associated with both the self (rest-self overlap/containment, Bai et al., 2016; Northoff, 2016a; Scalabrini et al., 2018) and mind-wandering (Smallwood & Schooler, 2006; Christoff et al., 2016). Accordingly, the relationship between self and mind-wandering dynamics (and thought functional modes) observed in the current study may be traced neuronally to the DMN as their common source may be intimately linked, as observed in our psychological data.

In the last years, a growing number of studies highlighted the importance of the distinction between spontaneous and deliberate mind-wandering dynamics (*see*, Seli et al., 2016) as associated with different psychological and neural dimensions (Seli et al., 2016; Fox et al., 2015; Golchert et al., 2017). This is, in part, also reflected in our data. We show close relation between self-consciousness and MW thought dynamics, particularly with the spontaneous type of MW. This suggests that self and MW dynamics are essentially characterized by spontaneity (also when controlling for the effect of the deliberate type).

We observed a somewhat similar pattern for the relationship of self and thought functional modes, i.e., rumination and reflection. Our data showed that self-consciousness is related with both modes of thought, albeit its relationship with rumination is stronger than

with reflection. The closer relation between self-consciousness and rumination again suggests how the self might be characterized by a deeper non-voluntary level that is beyond our deliberate control. Rumination in this case might be seen as an excessive lack of voluntary control where the dynamics is too strong to be controlled by an even increased self-focus – this comes with psychological distress and psychopathological traits (Ingram, 1990; Baer & Sauer, 2011; Fleckhammer, 2009).

Moreover, our data support that the relation between self, spontaneous MW dynamics and ruminative thought functional modes is better explained by a model where rumination fully mediates the relationship between self and spontaneous MW. This suggests that the perceived uncontrollability of thought dynamics might depend upon the ruminative structural and cyclic form of self-focus.

Neuroscience proposed the concept of "default mode functionality" or "physiological baseline" (Raichle, 2015) where especially the DMN provide the neuronal baseline or default of the brain. Interestingly, the DMN has been associated with both self-referential and mind wandering activity (Gusnard & Raichle, 2001; D'Argembeau et al., 2005; Moran et al., 2006; Northoff et al., 2010; Whitfield-Gabrieli et al., 2011; Hu et al., 2016). This suggests that the DMN may provide the neuronal baseline or default functionality of self and mind-wandering. If so, one would expect an analogous baseline or default on the psychological level – one can then speak of a "psychological default mode functionality" or "psychological baseline". Albeit tentatively this is suggested by our data as self correlated with both forms of MW dynamics and both forms of thought functional modes (albeit in distinct degrees). Rather than being a higher-order function, the self may then be conceived as a most basic function, the baseline or default of our psychological life including its thoughts. This amounts to what recently has been introduced as the basis model of self-specificity (BMSS, Northoff, 2016a), postulating that self-specificity is a basic internally-based function acting through spatiotemporal schemata and encoded in terms of past and possible future input–output relationships.

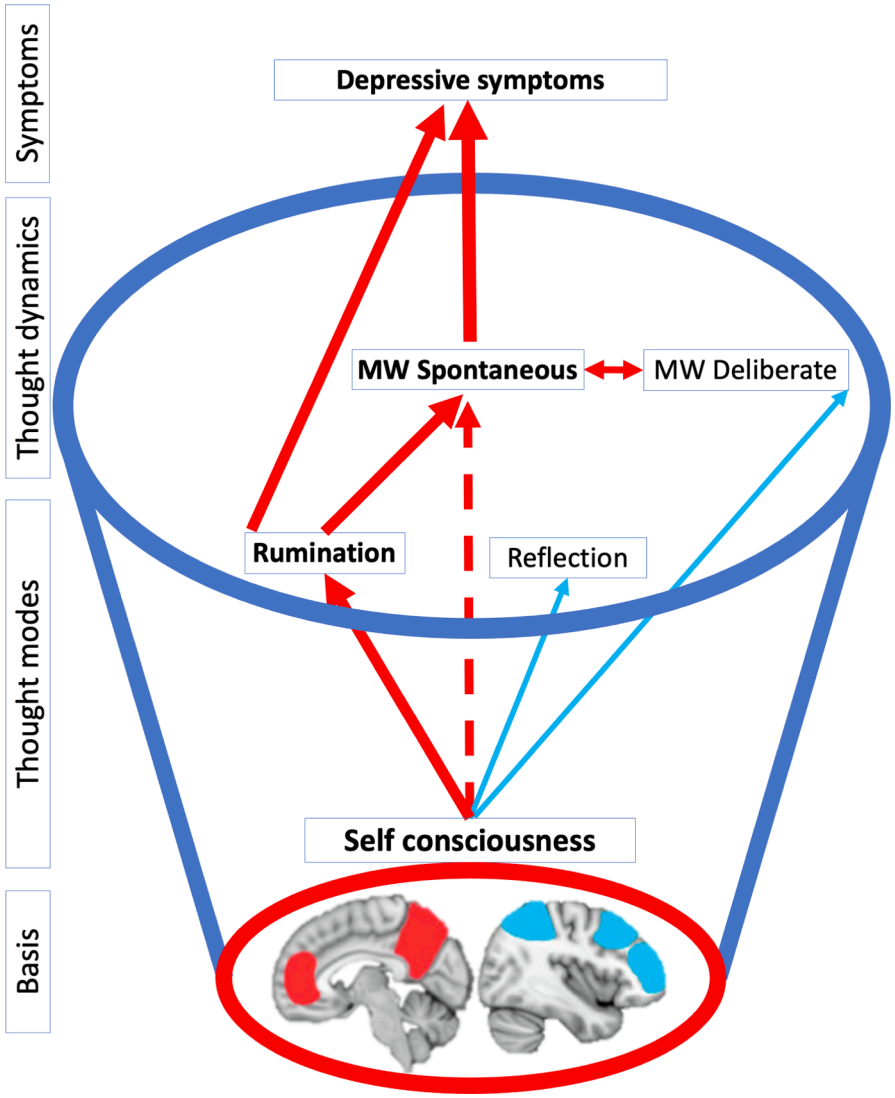

Fig. 6. Overview and visualization of the findings and their relevance for depressive symptomatology. The self as a baseline – A psychological prior.

4.2. The self and its depression

Depression is a psychopathological manifestation that has been associated with both spontaneous MW dynamics and increased level of rumination (Andrews-Hanna et al., 2014; Klinger, 1996; Vannucci et al., 2020; Watkins, 2008; Clark & Sahakian, 2008; Gotlib & Joormann, 2010; Hamilton et al., 2015; Kim et al., 2012; Silveira & Kauer-Sant'Anna, 2015; Nolen-Hoeksema et al., 2008). This intrinsic relation raises the question about the role of self-consciousness and its thought functional modes and dynamics. Our data suggest how especially rumination together with spontaneous MW play a key role in mediating the relationship between high levels of self-consciousness and depressive manifestation. These findings suggest that only when the self and its thoughts are featured by rumination and by spontaneous dynamics of MW, it may become depressed. In contrast, spontaneous MW dynamics itself, i.e., independent of self and thought modes does not necessarily lead to depressive symptomatology (see Fig. 6).

Interpreting these findings at the light of recent neuroscientific findings (Scalabrini et al., 2020a; Scalabrini, Xu, & Northoff, 2021), the increased levels of self-consciousness might parallel the increased spontaneous neuronal activity in DMN found in major depressive disorder. Neuronally the increased global activity of the DMN and psychologically the high levels of self-focus act as a "magnet" enslaving the information processing of these individual resulting in depressive symptomatology. Our psychological findings suggest that here the self's ruminative thought functional modes, together with spontaneous MW dynamics, might act as a *"magnet on the psychological level"* where everything revolves around depression.

What was neuronally showed in terms of disbalanced DMN-nonDMN relation is here mirrored at a psychological level in the relation of the self with rumination and spontaneous MW (corresponding to DMN) at the expense of reflection and deliberate MW (as corresponding to non-DMN). Hence the neuronal topographical organization of depression (where everything revolves upon the abnormal DMN-nonDMN relation) found here may find its analogue, its *"common currency"* at a psychological level (where everything revolves upon the abnormal relation of self-thought functional mode and dynamics).

Intriguingly these findings are also coherent with a psychodynamic perspective that posits the intrinsic relation between the self and depression. Particularly authors such as Klein (1935) theorized the depressive position as a necessary process beginning in infancy leading to a more realistic awareness of self and others and that recurs throughout life. At the same way, Jung first and Fordham later, referred to the individuation process as involving the conflict of opposites which can lead to a more realistic sense of oneself and the other (Jung, 1958), which start with a depressive position (Fordham & Heath, 1989). This further support the notion that internalizing manifestation such as depressive symptomatology are related with self-consciousness while externalizing manifestation (e.g. mania symptoms) may be not.

4.3. The self as baseline – A psychological prior

Is our model of self as "psychological baseline" (see also basis model of self-specificity - BMSS, Northoff, 2016a, 2016b; Scalabrini, Xu & Northoff, 2021) compatible with predictive coding (Friston, 2010)? Departing from the neuronal level we may assert that the main function of spontaneous brain activity is the maintenance and optimization of the brain's generative models for future interactions, i.e., priors, (Pezzulo et al., 2021). Similarly, albeit tentatively, the self as a "psychological baseline" or "psychological default" suggest that the incoming signals are processed on the base of the levels of self. This, together with predictive coding, is consistent with our previous theory of "rest-self overlap" and "rest-self containment" (Bai et al., 2016; Northoff, 2016b, 2013, 2011; Scalabrini et al., 2018) that underlies brain activity and represent the organizational structure for the brain and self for processing the subsequent input–output relationship. As based on most likely prior and early life events at a neuronal level (e.g., Duncan et al., 2015) and at a psychological level (e.g., Mucci, 2013, 2018a,b, 2021; Mucci & Scalabrini, 2021; Scalabrini, Mucci, Lucherini Angeletti, & Northoff, 2020b) the self is here considered a basis function/prior rather than a higher-order cognitive function/prediction error that contains and shape its own different layers and components.

Intriguingly, even if at a speculative level, we suggest that the so called "psychological baseline" is not only limited to human but also occurs across mammalian species at different levels. This is based on the evidence that the SELF, as defined by Panksepp (2004), provides a complex network organization similar across mammalian species and represent the interoceptive and affective foundation allowing the organism to integrate diverse bodily and brain states with environmental stimuli. This is the necessary "baseline" for the construction of higher levels of self and self-specificity (Northoff & Panksepp, 2008).

In our investigation we tried to disentangle the different thought components of self, focusing on its mind-wandering dynamics (spontaneous vs. deliberate) and on its thought functional modes (rumination vs. reflection). Presumably the different components are nested within each other with the lowest level of cognitive function (Rumination and MW-S) being more related to the self. This seems to suggest that a measure of self-consciousness, even if investigated at an explicit "representational level", inherently contains the deeper layers behind the representation that is what we intend with "psychological baseline". Accordingly, the self-related information hiddenly encoded in resting-state activity (in spatiotemporal terms) (Northoff, 2016a) may be recruited in yielding predictions of self-relatedness of potentially incoming stimuli both at brain and psychological level. Even more intriguingly, Pezzulo et al. (2021) suggest that some psychopathological disorders, as in the case of depression, reflect excessively strong "priors" that render patients insensitive to low-level stimuli or abnormally sensitive to prediction error signals. This seems to be in line with our data suggesting that level of self and its thought components are the base for depressive symptoms being strongly related to rumination and spontaneous mind-wandering dynamics.

This also extends other models of self, such as the predictive coding model of self (Apps & Tsakiris, 2014) with the prediction and predictive coding being rooted in the spatiotemporal topography and dynamic of brain and psychological self at the same time (see also Northoff & Scalabrini, 2021 for a conceptual analysis of brain and psyche sharing the same topography and dynamic). Neuronally, a

recent meta-analysis on the self (Frewen et al., 2020; Qin et al., 2020) proposed an iterative and hierarchical three-level processing model of self with the aim of illustrating how the brain integrates bodily information and external-environment information in self-processing. This is well compatible with the here-suggested model of self as a psychological baseline being related with the different components of thoughts and psychopathological manifestations.

4.4. Limitations

Although our findings might be useful for a better comprehension for the relation between self and internally oriented cognition and their relevance for depression, some limitation of the study have to be mentioned. Our sample was first only recruited online and secondly was not constituted by clinical individuals suffering from depression, thus limiting the generalizability of our findings. Future research needs different recruiting sample procedures and the study should be expanded to clinical samples in order to confirm the observed trend and mechanism. Our sample is also only composed by Italians, this raises the problem of cultural differences. Future research may need to expand these findings to other nationalities and their related sense of self, which, as we know, might be also culturally influenced (Scalabrini et al., 2021). Moreover, we adopted a cross sectional design that did not allow us to establish causal relationships between the observed variables. Future research might need to implement longitudinal design. Furthermore, another limitation concerns the use of self-report measures to assess our psychological variables, which investigate only the explicit psychological understanding at the expense of more implicit and processual features that might be especially involved in complex concepts as self-thought functional modes and mind-wandering dynamics. Future studies might be required to test and confirm our findings with specific laboratory task.

5. Conclusion

In conclusion our psychological findings show a relationship of the self with both forms of mind-wandering, i.e., spontaneous and deliberate, as well as both ruminative and reflective thought modes. At the same time, we observe that such shared relationship includes the distinction of the two mind-wandering forms and the thought modes with respect to the self. Together, these findings support the view that the self may serve as reference for mind-wandering and thought modes without being identical with the latter – this is well compatible with our assumption of the self serving as psychological baseline.

How can the self serve as psychological baseline for its own mind-wandering and thoughts? Our data suggest how the self might be featured by a spontaneous and dynamic nature and that higher levels of self-focus might take the ruminative cyclic forms where there is not much space for other "*external, non-self*" information processing. This conclusion is further supported by our model showing the key role of rumination within the relationship between self and spontaneous mind-wandering.

These data are coherent with the recent proposed basic model self-specificity (BMSS, Northoff, 2016a; Scalabrini, Xu & Northoff, 2021), which shows how the self might represent the "*psychological basis or default mental state*" where everything revolves as it is realized in higher degrees of depression.

Authors contribution

A.Sca designed the psychological study with.G.N. . A.Sca and M.DA. collected and analyzed the data. A.Sca and G.N. wrote the article together that was critically revised by A. Sch, PP, FB and CM. All the authors approved the final version of the manuscript

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This project/research was supported by "Search for Excellence – UdA" (University G. d'Annunzio of Chieti Pescara) to A.Sca. for the project SYNC (The Self and its psYchological and Neuronal Correlates – Implications for the understanding and treatment of depression as a disorder of Self), by the Michael Smith Foundation Canada Research Chair, by the grant from the Ministry of Science and Technology of China, National Key R&D Program of China (2016YFC1306700) and from the European Union's Horizon 2020 Framework Program for Research and Innovation under the Specific Grant Agreement No. 785907 (Human Brain Project SGA2), the ERANET grant, NFRF grant, and Team grant from uOMBRI to GN.

The authors report no relevant financial conflicts.

The authors would like to thank Rosy Esposito, Jessica Sigismondi and Laura Marozzi for their help in collecting and organizing the data during the first stage of the project.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). http://dx.doi.10.1176/appi.books.9780890425596.
American Psychiatric Association. (2015). *Scale di valutazione Adulti. DSM-5*. Raffaello Cortina Editore.

Andrews-Hanna, J. R., Kaiser, R. H., Turner, A. E., Reineberg, A., Godinez, D., Dimidjian, S., & Banich, M. (2013). A penny for your thoughts: Dimensions of self-generated thought content and relationships with individual differences in emotional wellbeing. *Frontiers in psychology, 4*, 900. https://doi.org/10.3389/fpsyg.2013.00900

Andrews-Hanna, J. R., Reidler, J. S., Sepulcre, J., Poulin, R., & Buckner, R. L. (2010). Functional-anatomic fractionation of the brain's default network. *Neuron, 65*(4), 550–562. https://doi.org/10.1016/j.neuron.2010.02.005

Andrews-Hanna, J. R., Smallwood, J., & Spreng, R. N. (2014). The default network and self-generated thought: Component processes, dynamic control, and clinical relevance. *Annals of the New York Academy of Sciences, 1316*(1), 29–52. https://doi.org/10.1111/nyas.12360

Apps, M. A., & Tsakiris, M. (2014). The free-energy self: A predictive coding account of self-recognition. *Neuroscience & Biobehavioral Reviews, 41*, 85–97. https://doi.org/10.1016/j.neubiorev.2013.01.029

Baer, R. A., & Sauer, S. E. (2011). Relationships between depressive rumination, anger rumination, and borderline personality features. *Personality Disorders: Theory, Research, and Treatment, 2*(2), 142–150. https://doi.org/10.1037/a0019478

Bai, Y.u., Nakao, T., Xu, J., Qin, P., Chaves, P., Heinzel, A., … Northoff, G. (2016). Resting state glutamate predicts elevated pre-stimulus Alpha during self-relatedness: A combined EEG-MRS study on "rest-self overlap". *Social Neuroscience, 11*(3), 249–263. https://doi.org/10.1080/17470919.2015.1072582

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*(1), 617–645. https://doi.org/10.1146/psych.2008.59.issue-110.1146/annurev.psych.59.103006.093639

Barsalou, L. W., Simmons, W. K., Barbey, A. K., & Wilson, C. D. (2003). Grounding conceptual knowledge in modality-specific systems. *Trends in cognitive sciences, 7*(2), 84–91. https://doi.org/10.1016/s1364-6613(02)00029-3

Borghi, A.M., Caruana, F. (2015). Embodiment Theory. In J. D. Wright (editor-in-chief), *International Encyclopedia of the Social & Behavioral Sciences* (*2nd ed.,* Vol. 7, pp. 420–426). Oxford: Elsevier. ISBN: 978008097086.

Bowerman, B. L., & O'Connell, R. T. (1990). *Linear statistical models: An applied approach*. Pws Publishing Company.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network. *Annals of the New York Academy of Sciences, 1124*(1), 1–38. https://doi.org/10.1196/annals.1440.011

Carriere, J. S., Seli, P., & Smilek, D. (2013). Wandering in both mind and body: Individual differences in mind wandering and inattention predict fidgeting. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 67*(1), 19–31. https://doi.org/10.1037/a0031438

Caruana, F., & Borghi, A. M. (2013). Embodied Cognition: Una nuova psicologia. *Giornale italiano di psicologia, 40*(1), 23–48.

Chiorri, C., & Vannucci, M. (2019). Replicability of the Psychometric Properties of Trait-Levels Measures of Spontaneous and Deliberate Mind Wandering. *European Journal of Psychological Assessment, 35*(4), 459–468. https://doi.org/10.1027/1015-5759/a000422

Christoff, K., Gordon, A. M., Smallwood, J., Smith, R., & Schooler, J. W. (2009). Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. *Proceedings of the National Academy of Sciences, 106*(21), 8719–8724. https://doi.org/10.1073/pnas.0900234106

Christoff, K., Irving, Z. C., Fox, K. C., Spreng, R. N., & Andrews-Hanna, J. R. (2016). Mind-wandering as spontaneous thought: A dynamic framework. *Nature Reviews Neuroscience, 17*(11), 718–731. https://doi.org/10.1038/nrn.2016.113

Clark, L., & Sahakian, B. J. (2008). Cognitive neuroscience and brain imaging in bipolar disorder. *Dialogues in clinical neuroscience, 10*(2), 153.

Comunian, A. L. (1994). Self-consciousness scale dimensions: An Italian adaptation. *Psychological Reports, 74*(2), 483–489. https://doi.org/10.2466/pr0.1994.74.2.483

D'Argembeau, A., Collette, F., Van der Linden, M., Laureys, S., Del Fiore, G., Degueldre, C., … Salmon, E. (2005). Self-referential reflective activity and its relationship with rest: A PET study. *Neuroimage, 25*(2), 616–624. https://doi.org/10.1016/j.neuroimage.2004.11.048

Dancey, C., & Reidy, J. (2011). *Statistics without maths for psychology. Book* (5th ed.). Rotolito Lombarda, Italy: Prentice Hall.

DaSilveira, A., DeSouza, M. L., & Gomes, W. B. (2015). Self-consciousness concept and assessment in self-report measures. *Frontiers in psychology, 6*, 930. https://doi.org/10.3389/fpsyg.2015.00930

Davey, C. G., Pujol, J., & Harrison, B. J. (2016). Mapping the self in the brain's default mode network. *NeuroImage, 132*, 390–397. https://doi.org/10.1016/j.neuroimage.2016.02.022

Duncan, N. W., Hayes, D. J., Wiebking, C., Tiret, B., Pietruska, K., Chen, D. Q., … Northoff, G. (2015). Negative childhood experiences alter a prefrontal-insular-motor cortical network in healthy adults: A preliminary multimodal rsfMRI-fMRI-MRS-dMRI study. *Human Brain Mapping, 36*(11), 4622–4637. https://doi.org/10.1002/hbm.22941

Duval, S., & Wicklund, R. A. (1972). *A theory of objective self awareness*. New York: Academic.

Enzi, B., de Greck, M., Prösch, U., Tempelmann, C., Northoff, G., & Reif, A. (2009). Is our self nothing but reward? Neuronal overlap and distinction between reward and personal relevance and its relation to human personality. *PLoS One, 4*(12), e8429. https://doi.org/10.1371/journal.pone.000842910.1371/journal.pone.0008429.s00110.1371/journal.pone.0008429.s00210.1371/journal.pone.0008429.s00310.1371/journal.pone.0008429.s00410.1371/journal.pone.0008429.s00510.1371/journal.pone.0008429.s00610.1371/journal.pone.0008429.s00710.1371/journal.pone.0008429.s00810.1371/journal.pone.0008429.s009

Fleckhammer, L. E. (2009). *Insight into the Self-Absorption Paradox: Self-Conscious Ruminative and Reflective Thoughts*. Saarbrücken: VDM Verlag Dr. Müller.

Fordham, M., & Heath, B. (1989). The infant's reach reflections on maturation in early life. *Psychological Perspectives, 21*(1), 59–76. https://doi.org/10.1080/00332928908407594

Fox, K. C., Spreng, R. N., Ellamil, M., Andrews-Hanna, J. R., & Christoff, K. (2015). The wandering brain: Meta-analysis of functional neuroimaging studies of mind-wandering and related spontaneous thought processes. *NeuroImage, 111*, 611–621. https://doi.org/10.1016/j.neuroimage.2015.02.039

Frewen, P., Schroeter, M. L., Riva, G., Cipresso, P., Fairfield, B., Padulo, C., … Northoff, G. (2020). Neuroimaging the consciousness of self: Review, and conceptual-methodological framework. *Neuroscience & Biobehavioral Reviews, 112*, 164–212. https://doi.org/10.1016/j.neubiorev.2020.01.023

Friston, K. (2010). The free-energy principle: A unified brain theory? *Nature reviews neuroscience, 11*(2), 127–138. https://doi.org/10.1038/nrn2787

Fritz, M. S., & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science, 18*(3), 233–239. https://doi.org/10.1111/j.1467-9280.2007.01882.x

Golchert, J., Smallwood, J., Jefferies, E., Seli, P., Huntenburg, J. M., Liem, F., … Margulies, D. S. (2017). Individual variation in intentionality in the mind-wandering state is reflected in the integration of the default-mode, fronto parietal, and limbic networks. *NeuroImage, 146*, 226–235. https://doi.org/10.1016/j.neuroimage.2016.11.025

Gotlib, I. H., & Joormann, J. (2010). Cognition and depression: Current status and future directions. *Annual Review of Clinical Psychology, 6*(1), 285–312. https://doi.org/10.1146/clinpsy.2010.6.issue-110.1146/annurev.clinpsy.121208.131305

Gusnard, D. A., & Raichle, M. E. (2001). Searching for a baseline: Functional imaging and the resting human brain. *Nature reviews neuroscience, 2*(10), 685–694. https://doi.org/10.1038/35094500

Hamilton, J. P., Chen, M. C., & Gotlib, I. H. (2013). Neural systems approaches to understanding major depressive disorder: An intrinsic functional organization perspective. *Neurobiology of disease, 52*, 4–11. https://doi.org/10.1016/j.nbd.2012.01.015

Hamilton, J. P., Farmer, M., Fogelman, P., & Gotlib, I. H. (2015). Depressive rumination, the default-mode network, and the dark matter of clinical neuroscience. *Biological psychiatry, 78*(4), 224–230. https://doi.org/10.1016/j.biopsych.2015.02.020

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* ((2nd ed.).). Guilford Publications.

Hu, C., Di, X., Eickhoff, S. B., Zhang, M., Peng, K., Guo, H., & Sui, J. (2016). Distinct and common aspects of physical and psychological self-representation in the brain: A meta-analysis of self-bias in facial and self-referential judgements. *Neuroscience & Biobehavioral Reviews, 61*, 197–207. https://doi.org/10.1016/j.neubiorev.2015.12.003

Huang, Z., Obara, N., Davis, H. H., IV, Pokorny, J., & Northoff, G. (2016). The temporal structure of resting-state brain activity in the medial prefrontal cortex predicts self-consciousness. *Neuropsychologia, 82*, 161–170. https://doi.org/10.1016/j.neuropsychologia.2016.01.025

Ingram, R. E. (1990). Self-focused attention in clinical disorders: Review and a conceptual model. *Psychological bulletin, 107*(2), 156. https://doi.org/10.1037/0033-2909.107.2.156

James, W. (1890). *The principles of psychology* (Vol. 1). Henry Holt and Co. http://dx.doi.10.1037/10538-000.

Jung, C. G. (1958). Prefatory note to "The transcendent function". *Coll., wks*, 8.

Kaiser, R. H., Andrews-Hanna, J. R., Wager, T. D., & Pizzagalli, D. A. (2015). Large-scale network dysfunction in major depressive disorder: A meta-analysis of resting-state functional connectivity. *JAMA psychiatry, 72*(6), 603–611. https://doi.org/10.1001/jamapsychiatry.2015.0071

Kim, S., Yu, B. H., Lee, D. S., & Kim, J. H. (2012). Ruminative response in clinical patients with major depressive disorder, bipolar disorder, and anxiety disorders. *Journal of Affective Disorders, 136*(1–2), e77–e81. https://doi.org/10.1016/j.jad.2011.06.034

Klein, M. (1935). A contribution to the psychogenesis of manic-depressive states. *International Journal of Psycho-Analysis, 16*, 145–174.

Klinger, E. (1996). The contents of thoughts: Interference as the downside of adaptive normal mechanisms in thought flow. In I. G. Sarason, G. R. Pierce, & B. R. Sarason (Eds.), *Cognitive interference: Theories, methods, andjhdings* (pp. 3–23). Mahwah, NJ: Lawrence Erlbaum.

Kolvoort, I. R., Wainio-Theberge, S., Wolff, A., & Northoff, G. (2020). Temporal integration as "common currency" of brain and self-scale-free activity in resting-state EEG correlates with temporal delay effects on self-relatedness. *Human brain mapping, 41*(15), 4355–4374. https://doi.org/10.1002/hbm.25129

Logothetis, N. K., Murayama, Y., Augath, M., Steffen, T., Werner, J., & Oeltermann, A. (2009). How not to study spontaneous activity. *Neuroimage, 45*(4), 1080–1089. https://doi.org/10.1016/j.neuroimage.2009.01.010

Marchetti, I., Koster, E. H., Klinger, E., & Alloy, L. B. (2016). Spontaneous thought and vulnerability to mood disorders: The dark side of the wandering mind. *Clinical Psychological Science, 4*(5), 835–857. https://doi.org/10.1177/2167702615622383

Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007). Wandering minds: The default network and stimulus-independent thought. *Science, 315*(5810), 393–395. https://doi.org/10.1126/science.1131295

McKenzie, K. S., & Hoyle, R. H. (2008). The Self-Absorption Scale: Reliability and validity in non-clinical samples. *Personality and Individual Differences, 45*(8), 726–731. https://doi.org/10.1016/j.paid.2008.07.020

Mead, G. H. (1934). *Mind, self and society* (Vol. 111). Chicago: University of Chicago Press.

Menard, S. (2002). *Applied logistic regression analysis* (Vol. 106). Sage.

Moran, J. M., Macrae, C. N., Heatherton, T. F., Wyland, C. L., & Kelley, W. M. (2006). Neuroanatomical evidence for distinct cognitive and affective components of self. *Journal of cognitive neuroscience, 18*(9), 1586–1594. https://doi.org/10.1162/jocn.2006.18.9.1586

Mucci, C. (2013). *Beyond individual and collective trauma: Intergenerational transmission, psychoanalytic treatment, and the dynamics of forgiveness*. Karnac Books.

Mucci, C. (2018). Implicit memory, unrepressed unconscious, and trauma theory: The turn of the screw between contemporary psychoanalysis and neuroscience. In *Unrepressed unconscious, implicit memory, and clinical work* (pp. 99–129). Routledge.

Mucci, C. (2018b). *Borderline bodies: Affect regulation therapy for personality disorders (Norton series on interpersonal neurobiology)*. W. W. Norton & Company.

Mucci, C. (2021). Intersubjectivity and psychopathology: Borderline and psychosomatic bodies "at the mind's limits". *International Forum of Psychoanalysis, 30*(3), 156–166. https://doi.org/10.1080/0803706X.2021.1950930

Mucci, C., & Scalabrini, A. (2021). Traumatic effects beyond diagnosis: The impact of dissociation on the mind–body–brain system. *Psychoanalytic Psychology, 38*(4), 279–289. https://doi.org/10.1037/pap0000332

Myers, R. H. (1990). *Classical and modern regression with applications*. Duxbury Press.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). *Rethinking rumination. Perspectives on psychological science, 3*(5), 400–424. https://doi.org/10.1111/j.1745-6924.2008.00088.x

Northoff, G. (2007). Psychopathology and pathophysiology of the self in depression—neuropsychiatric hypothesis. *Journal of Affective Disorders, 104*(1-3), 1–14.

Northoff, G. (2013). Brain and self – a neurophilosophical account. *Child and Adolescent Psychiatry and Mental Health, 7*(1), 28. https://doi.org/10.1186/1753-2000-7-28

Northoff, G. (2016a). Is the self a higher-order or fundamental function of the brain? The "basis model of self-specificity" and its encoding by the brain's spontaneous activity. *Cognitive neuroscience, 7*(1–4), 203–222. https://doi.org/10.1080/17588928.2015.1111868

Northoff, G. (2016b). Spatiotemporal psychopathology I: No rest for the brain's resting state activity in depression? Spatiotemporal psychopathology of depressive symptoms. *Journal of affective disorders, 190*, 854–866. https://doi.org/10.1016/j.jad.2015.05.007

Northoff, G. (2017). Personal identity and cortical midline structure (CMS): Do temporal features of CMS neural activity transform into "self-continuity"? *Psychological Inquiry, 28*(2–3), 122–131. https://doi.org/10.1080/1047840x.2017.1337396

Northoff, G. (2018). How does the brain's spontaneous activity generate our thoughts? *Oxford Handbooks Online*. https://doi.org/10.1093/oxfordhb/9780190464745.013.9

Northoff, G., & Bermpohl, F. (2004). Cortical midline structures and the self. *Trends in Cognitive Sciences, 8*(3), 102–107. https://doi.org/10.1016/j.tics.2004.01.004

Northoff, G., & Panksepp, J. (2008). The trans-species concept of self and the subcortical–cortical midline system. *Trends in cognitive sciences, 12*(7), 259–264. https://doi.org/10.1016/j.tics.2008.04.007

Northoff, G., & Scalabrini, A. (2021). *"Project for a Spatiotemporal Neuroscience" – Brain and psyche share their topography and dynamic* (p. 4500). Frontiers in Psychology.

Northoff, G., Duncan, N. W., & Hayes, D. J. (2010). The brain and its resting state activity—Experimental and methodological implications. *Progress in Neurobiology, 92*(4), 593–600. https://doi.org/10.1016/j.pneurobio.2010.09.002

Northoff, G., Wainio-Theberge, S., & Evers, K. (2020). Is temporo-spatial dynamics the "common currency" of brain and mind? In Quest of "Spatiotemporal Neuroscience". *Physics of Life Reviews, 33*, 34–54. https://doi.org/10.1016/j.plrev.2019.05.002

Northoff, G., Wainio-Theberge, S., & Evers, K. (2020). Spatiotemporal neuroscience–what is it and why we need it. *Physics of Life Reviews, 33*, 78–87.

Northoff, G., Wiebking, C., Feinberg, T., & Panksepp, J. (2011). The 'resting-state hypothesis' of major depressive disorder—A translational subcortical–cortical framework for a system disorder. *Neuroscience & Biobehavioral Reviews, 35*(9), 1929–1945. https://doi.org/10.1016/j.neubiorev.2010.12.007

Panksepp, J. (2004). *Affective neuroscience: The foundations of human and animal emotions*. Oxford University Press.

Pezzulo, G., Zorzi, M., & Corbetta, M. (2021). The secret life of predictive brains: What's spontaneous activity for? *Trends in Cognitive Sciences, 25*(9), 730–743. https://doi.org/10.1016/j.tics.2021.05.007

Qin, P., Wang, M., & Northoff, G. (2020). Linking bodily, environmental and mental states in the self—A three-level model based on a meta-analysis. *Neuroscience & Biobehavioral Reviews, 115*, 77–95. https://doi.org/10.1016/j.neubiorev.2020.05.004

Qin, P., & Northoff, G. (2011). How is our self related to midline regions and the default-mode network? *NeuroImage, 57*(3), 1221–1233. https://doi.org/10.1016/j.neuroimage.2011.05.028

Raichle, M. E. (2009). A paradigm shift in functional brain imaging. *Journal of Neuroscience, 29*(41), 12729–12734. https://doi.org/10.1523/jneurosci.4366-09.2009

Raichle, M. E. (2015). The restless brain: How intrinsic activity organizes brain function. *Philosophical Transactions of the Royal Society B: Biological Sciences, 370*(1668), 20140172. https://doi.org/10.1098/rstb.2014.0172

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences, 98*(2), 676–682. https://doi.org/10.1073/pnas.98.2.676

Scalabrini, A., Mucci, C., & Northoff, G. (2018). Is our self related to personality? A neuropsychodynamic model. *Frontiers in human neuroscience, 12*, 346. https://doi.org/10.3389/fnhum.2018.00346

Scalabrini, A., Vai, B., Poletti, S., Damiani, S., Mucci, C., Colombo, C., & Northoff, G. (2020a). All roads lead to the default-mode network—global source of DMN abnormalities in major depressive disorder. *Neuropsychopharmacology, 45*(12), 2058–2069. https://doi.org/10.1038/s41386-020-0785-x

Scalabrini, A., Xu, J., & Northoff, G. (2021). What COVID -19 tells us about the self: The deep intersubjective and cultural layers of our brain. *Psychiatry and Clinical Neurosciences, 75*(2), 37–45. https://doi.org/10.1111/pcn.13185

Scalabrini, Andrea, Mucci, Clara, Lucherini Angeletti, Lorenzo, & Northoff, Georg (2020b). The self and its world: a neuro-ecological and temporo-spatial account of existential fear. *Clinical Neuropsychiatry*, *17*(2). *Clinical Neuropsychiatry, 12*(2), 46–58. https://doi.org/10.36131/CN20200203

Scheier, M. F., & Carver, C. S. (1985). The self-consciousness scale: A revised version for use with general Populations1. *Journal of Applied Social Psychology, 15*(8), 687–699. https://doi.org/10.1111/jasp.1985.15.issue-810.1111/j.1559-1816.1985.tb02268.x

Schneider, F., Bermpohl, F., Heinzel, A., Rotte, M., Walter, M., Tempelmann, C., … Northoff, G. (2008). The resting brain and our self: Self-relatedness modulates resting state neural activity in cortical midline structures. *Neuroscience, 157*(1), 120–131. https://doi.org/10.1016/j.neuroscience:2008.08.014

Seli, P., Risko, E. F., Purdon, C., & Smilek, D. (2017). Intrusive thoughts: Linking spontaneous mind wandering and OCD symptomatology. *Psychological research, 81*(2), 392–398. https://doi.org/10.1007/s00426-016-0756-3

Seli, P., Risko, E. F., Smilek, D., & Schacter, D. L. (2016). Mind-wandering with and without intention. *Trends in cognitive sciences, 20*(8), 605–617. https://doi.org/10.1016/j.tics.2016.05.010

Seli, P., Smallwood, J., Cheyne, J. A., & Smilek, D. (2015). On the relation of mind wandering and ADHD symptomatology. *Psychonomic Bulletin & Review, 22*(3), 629–636. https://doi.org/10.3758/s13423-014-0793-0

Silveira, É. D. M., Jr, & Kauer-Sant'Anna, M. (2015). Rumination in bipolar disorder: A systematic review. *Brazilian Journal of Psychiatry, 37*(3), 256–263. https://doi.org/10.1590/1516-4446-2014-1556

Simsek, O. F. (2013). Self-absorption paradox is not a paradox: Illuminating the dark side of self-reflection. *International Journal of Psychology, 48*(6), 1109–1121. https://doi.org/10.1080/00207594.2013.778414

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological bulletin, 132*(6), 946–958. https://doi.org/10.1037/0033-2909.132.6.946

Spivey, M. (2008). *The continuity of mind*. Oxford University Press.

Stawarczyk, D., Majerus, S., Maj, M., Van der Linden, M., & D'Argembeau, A. (2011). Mind-wandering: Phenomenology and function as assessed with a novel experience sampling method. *Acta Psychologica, 136*(3), 370–381. https://doi.org/10.1016/j.actpsy.2011.01.002

Steiger, J. H. (1980). Tests for comparing elements of a correlation matrix. *Psychological Bulletin, 87*(2), 245–251. https://doi.org/10.1037/0033-2909.87.2.245

Sui, J., Chechlacz, M., & Humphreys, G. W. (2012). Dividing the self: Distinct neural substrates of task-based and automatic self-prioritization after brain damage. *Cognition, 122*(2), 150–162. https://doi.org/10.1016/j.cognition.2011.10.008

Sui, J., Rotshtein, P., & Humphreys, G. W. (2013). Coupling social attention to the self forms a network for personal significance. *Proceedings of the National Academy of Sciences, 110*(19), 7607–7612. https://doi.org/10.1073/pnas.1221862110

Takano, K., & Tanno, Y. (2009). Self-rumination, self-reflection, and depression: Self-rumination counteracts the adaptive effect of self-reflection. *Behaviour research and therapy, 47*(3), 260–264. https://doi.org/10.1016/j.brat.2008.12.008

Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *Journal of personality and social psychology, 76*(2), 284–304. https://doi.org/10.1037/0022-3514.76.2.284

Vannucci, M., & Chiorri, C. (2018). Individual differences in self-consciousness and mind wandering: Further evidence for a dissociation between spontaneous and deliberate mind wandering. *Personality and Individual Differences, 121*, 57–61. https://doi.org/10.1016/j.paid.2017.09.022

Vannucci, M., Chiorri, C., Nocentini, A., & Menesini, E. (2020). Distinguishing spontaneous from deliberate mind wandering in adolescents: The role of attentional control and depressive symptoms. *British Journal of Developmental Psychology, 38*(3), 434–441. https://doi.org/10.1111/bjdp.v38.310.1111/bjdp.12325

Watkins, E. D., & Teasdale, J. D. (2001). Rumination and overgeneral memory in depression: Effects of self-focus and analytic thinking. *Journal of abnormal psychology, 110*(2), 353. https://doi.org/10.1037/0021-843x.110.2.333

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*(2), 163–206. https://doi.org/10.1037/0033-2909.134.2.163

Whitfield-Gabrieli, S., Moran, J. M., Nieto-Castañón, A., Triantafyllou, C., Saxe, R., & Gabrieli, J. D. (2011). Associations and dissociations between default and self-reference networks in the human brain. *NeuroImage, 55*(1), 225–232. https://doi.org/10.1016/j.neuroimage.2010.11.048

Wolff, A., Di Giovanni, D. A., Gómez-Pilar, J., Nakao, T., Huang, Z., Longtin, A., & Northoff, G. (2019). The temporal signature of self: Temporal measures of resting-state EEG predict self-consciousness. *Human Brain Mapping, 40*(3), 789–803. https://doi.org/10.1002/hbm.v40.310.1002/hbm.24412

Yankouskaya, A., Bührle, R., Lugt, E., Stolte, M., & Sui, J. (2020). Intertwining personal and reward relevance: Evidence from the drift-diffusion model. *Psychological research, 84*(1), 32–50. https://doi.org/10.1007/s00426-018-0979-6

Zhu, Y. (2004). Neuroimaging studies of self-reflection. *Progress in Natural Science, 14*(4), 296–302. https://doi.org/10.1080/10020070412331343511