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ALL THE FACES OF RESEARCH ON BORDERLINE PERSONALITY PATHOLOGY: DRAWING FUTURE TRAJECTORIES THROUGH A NETWORK AND CLUSTER ANALYSIS OF THE LITERATURE

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Abstract
Borderline Personality Disorder is a severe condition that affects self and interpersonal dimensions and emotional and behavioral regulation. Since the last decades of the 20th century, an impressive amount of research and clinical contributions on BPD came from specific fields such as psychiatry, clinical psychology, psychopharmacology, and, more recently, cognitive neuroscience. All contributions tackled the challenges of finding reliable diagnostic categories, highlighting detailed developmental trajectories, and fostering effective treatment protocols. However, as results come from different areas, it is often challenging to depict a coherent and yet multifaceted framework on this topic. In this study, we conducted a scientometric analysis of the available literature on BPD to provide a systematic and comprehensive overview of research on BPD and emphasize historical changes, intertwining between fields and new areas of investigation. Results clearly show the evolution of research on BPD starting from the initial development of the construct, passing through the studies on treatment efficacy, the results of longitudinal studies, the advances in cognitive neurosciences, and the recent dimensional conceptualization in DSM-5. Moreover, it emphasizes promising areas of investigation, such as the relations of BPD with NSSI, ADHD, and vulnerable features of narcissism.

1. Introduction

Recent data estimated the prevalence of Borderline Personality Disorder at circa 1% in the general population, at 12% in outpatients settings, and 22% in inpatient

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psychiatric clinics (Ellison et al., 2018). Borderline personality pathology significantly affects the life of those who suffer from it: severe identity diffusion, impairment in emotional and behavioral regulation, and issues in interpersonal relationships are the core feature of this enduring and debilitating condition (Paris, 2018). BPD produces severe personal, social, and economic outcomes that lead to a significant household burden, unemployment, physical illnesses, recurrent hospitalizations, and a high suicide rate (around 8%, Chanen et al., 2017). Symptomatology of BPD includes impulsiveness, aggression, fear of abandonment, feelings of emptiness, nonsuicidal self-injury (NSSI) (and suicide attempts), and chaotic relationships (APA, 2013). The combination of these symptoms can widely vary from individual to individual, posing a significant challenge for the study of this disorder and clinical practice.

Since the 1980s, clinical interest in borderline personality pathology fostered a significant increase in scientific production, compared to other PDs (e.g., Lieb et al., 2004; Bateman & Fonagy, 2004; Clarkin et al., 2007; Gunderson, 2009; Linehan, 2018; Paris, 2018). This increased interest has led to a better knowledge of BPD and its psychological and behavioral correlates.

However, an impressive amount of results come from different studies and fields of research (i.e., psychiatry, clinical psychology, psychotherapy, neuroscience), making it challenging to integrate them in a coherent framework of knowledge.

The following paragraph describes the many challenges faced by clinical research in different domains, such as finding reliable diagnostic categories, highlighting detailed developmental trajectories, and fostering effective treatment protocols.

Diagnosis

Recent years have witnessed an intense debate on personality pathology conceptualization (Skodol, 2012). Indeed, the descriptive model provided by the DSM-IV-TR showed several limitations regarding the validity of criteria, the reliability of the diagnostic thresholds, and the numerous comorbidities between personality disorders (PDs). Moreover, BPD is perhaps the disorder that has most clearly shown the limitations of a criteria-based framework, with over 150 combinations of symptoms falling under the same diagnosis (Skodol, 2012).

Overall, empirical research underlined the significant restraints of a merely descriptive focus on PDs and the need for dimensional and developmental models that consider the core aspects of these disorders' early stages (Cicchetti & Crick, 2009). As a consequence, the new edition of the DSM-5 (2013) marked the start of a new phase in PDs diagnoses. A new diagnostic model has been now included in Section III – The Alternative Model for Personality Disorder (AMPD; APA, 2013) - which takes into account the importance of identifying a multifactorial and dimensional understanding of PDs (Ensink et al., 2015). In particular, the AMPD suggests focusing on a dimensional model that accounts for the severity of maladaptive personality functioning, rather than on the presence/absence of criteria, as in the DSM-5 official classification (Section II).

According to the AMPD, personality pathology encompasses maladaptive self-functioning, related to identity and self-directedness, and maladaptive

interpersonal functioning, related to difficulties in empathizing and having intimate relationships with others (Criterion A). Recent evidence suggests that the AMPD Criterion A has a tremendous clinical utility (Di Pierro et al., 2020). The AMPD includes maladaptive personality traits such as negative affectivity, detachment, antagonism, disinhibition, and psychoticism (Criterion B) when describing PDs (Bender et al., 2011).

Developmental trajectories

In a 2015 review, Sharp and Fonagy summarized the complexity of the etiological factors linked to BPD exacerbation (Figure 1). From a psychological point of view, characteristics of the individual, in addition to a long chain of biological factors, might be influenced by developmental aspects that emerge from both contextual factors and individual vulnerabilities such as experiences of maladaptive parenting as well as the presence of disorganized attachment patterns (De Carli et al., 2018; De Carli et al., 2019). From a psychodynamic standpoint, disruptions in the ability to understand behaviors in terms of underlying mental states have proven to be related to BPD core features such as identity disturbances, inappropriate and intense anger, paranoid ideation, chronic feelings of emptiness (which, in turn, may lead to nonsuicidal self-injury behaviors and other pathological outcomes) (e.g., Fonagy & Bateman, 2008; Benzi et al., 2018; Locati et al., 2019).

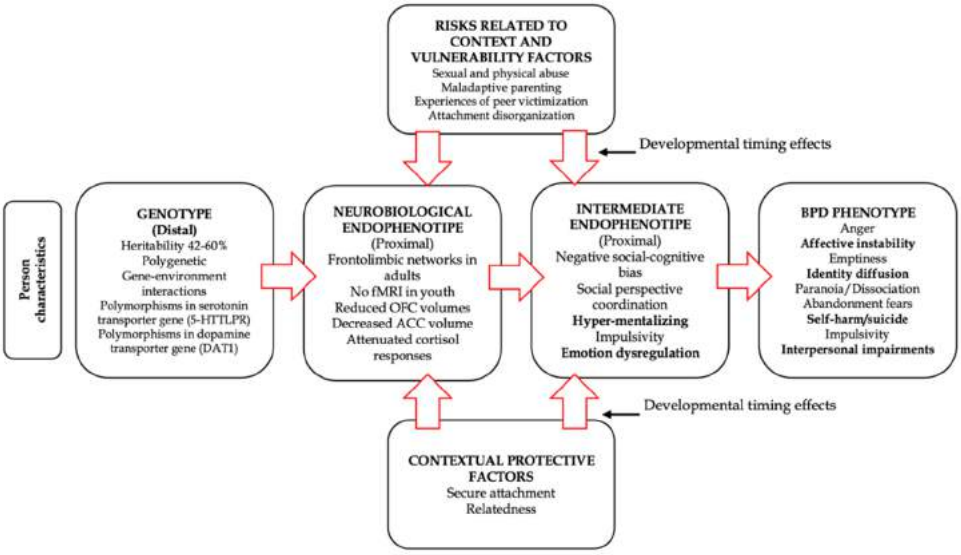

Figure 1. Etiological factors in the development of BPD (adapted with permission from Sharp, C., & Fonagy, P. (2015). Practitioner Review: Borderline personality disorder in adolescence–recent conceptualization, intervention, and implications for clinical practice. *Journal of Child Psychology and Psychiatry*, 56(12), p. 1271)

Overall, research has shown that personality dysfunction during adolescence results in diagnosable PDs that may or may not continue into adulthood; likewise, sub-threshold personality dysfunction in youth in some cases is predictive of BPD in adulthood (Cicchetti, 2014).

Treatment efficacy

Interestingly, it is precisely within the therapeutic relationship that the most "elusive" aspects of borderline personality pathology appear. The difficulty in regulating emotions, the instability of self-image, and of interpersonal relations are just some of the aspects that, despite being so manifest in the clinical context, pose significant challenges at the research level, promoting numerous and challenging questions. Navigating the complexity of the clinical relationship fostered the reflection on topics such as the therapeutic alliance and ruptures, reparations, and transformative processes (Rudge et al., 2020).

While contributions on diagnostic taxonomies proliferated, clinical work with BPD patients witnessed the creation of specific manualized psychotherapeutic interventions. Manualisation has gone hand in hand with developments in investigation techniques (e.g., cognitive neuroscience) on the one hand and the difficulty of finding satisfactory pharmacological treatments.

A recent meta-analysis from Cristea and colleagues (2017) explored the specificities of the different psychotherapeutic treatments for BPD (Dialectical Behavior Therapy, DBT; Cognitive Behavioral Therapy, CBT; Mentalization Based Treatment, MBT; Transference Focused Psychotherapy, TFP). The authors suggested that treatment effectiveness is independent of the type of treatment itself for borderline symptomatology, general psychopathology, NSSI, suicide, and hospitalization compared to control groups. Likewise, they showed that the differences in efficacy between manualized treatments and treatments as usual dissolved if the control group was balanced for manualization of treatment or the study team's participation in it.

Overall, thanks to the numerous and timely reviews available, it is possible to observe the results in the areas mentioned above of diagnosis, developmental trajectories, and the effectiveness of treatments. However, to depict the state of the art of research on BPD, a systematic overview to understand how research has changed over time, how the different fields of study have intersected, and the new investigation areas is essential.

In this study, a scientometric analysis was conducted to comprehensively and objectively explore empirical research on borderline personality pathology. The scientometric approach allows the study of the process of science systematically as a communication network, assessing the impact of research papers and academic journals and understanding the process of science via scientific citations and

identification of specific clusters of study (Cipresso & Immekus, 2017). To our knowledge, no review of this kind on BPD is currently available.

In particular, our contribution aims at providing a systematic overview of the scientific literature on BPD. Moreover, it aims at clarifying how empirical research on BPD changed over time and which topics empirical studies have been focused on across time. Also, it aims at highlighting promising areas of research.

2. Methods

Data collection

The input data for the analyses were retrieved from the scientific databases Web of Science Core Collection based on a topic search for TS=("borderline personality" OR "borderline disorder" OR "borderline disorders" OR "borderline pathology" OR "borderline traits"). Data extraction from WoS was updated on June 18, 2020 all contributions available on the topic published during the whole timespan were covered. Papers were also manually screened to search for unrelated papers.

The resulting dataset contained a total of 12,128 records. The bibliographic record contained various fields, such as author, title, abstract, and all of the references (needed for the citation analysis). The research tool to visualize the networks was Cite space v.5.7.R1 under Java Runtime v.8 update 251 (Development kit 7 update 80, 64-bit).

In this study, we went beyond describing the frequencies for the main issues around BPD and performed a complete computational analysis of the network of co-citations. Representing these results is complex because it includes thousands of articles and the links among them. However, this analysis is critical because it can be used to identify the possible conglomerate of knowledge in the investigated area, which is essential for a systematic understanding of the topic. For this purpose, we conducted cluster analyses (Chen et al., 2010; González-Teruel et al., 2015; Klayans & Boyack, 2017). Statistical analyses were conducted using Stata MP-Parallel Edition, Release 14.0, StataCorp LP.

3. Results

According to the document-type statistics from the Web of Science (WoS), scientific papers were used extensively as outcomes of research, comprising almost 74% of the total (8,958 articles), as indicated in Table 1.

Table 1. Outcome of research distributed per document types.

Field: Document Types	Record Count	% of 12,128
ARTICLE	8.958	73.84%
REVIEW	1.187	9.78%
MEETING ABSTRACT	950	7.83%
EDITORIAL MATERIAL	336	2.77%
PROCEEDINGS PAPER	327	2.70%
LETTER	286	2.36%
BOOK CHAPTER	241	1.99%
BOOK REVIEW	239	1.97%
EARLY ACCESS	86	0.71 %
NOTE	48	0.40 %

On the other hand, considering the huge growth of articles over time, more in-depth analyses were needed, as can be seen in Figure 2.

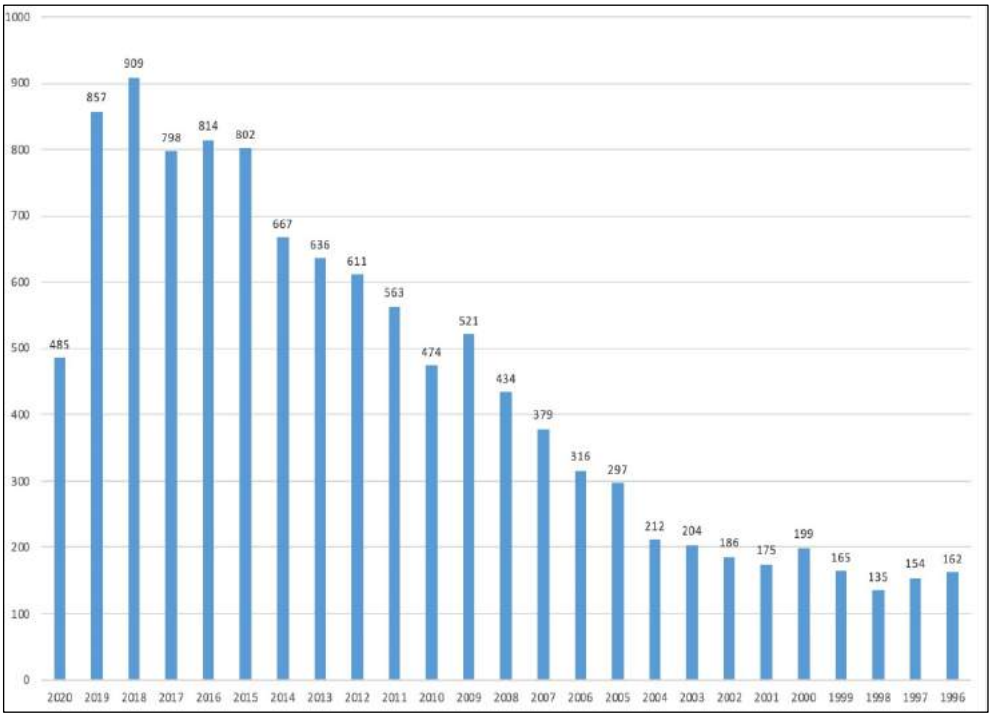

Figure 2. Articles published and indexed in Web of Science / Web of Knowledge over time.

The following paragraphs show the clusters, which are identified with three different algorithms. All the clusters and the related information (including the algorithms used) have been included in the supplementary material for consultation and replication of the study (see Supplementary Materials).

3.1. Categories

The number of articles in every specific category is shown in an extract in Figure 3. We expanded our analyses to citations within the clusters (see Supplementary Materials).

Figure 3. Top 25 categories as described in Web of Science / Web of Knowledge.

Cluster and network analysis of the citations related to categories

The top ranked item by citation counts is "Psychiatry" in Cluster #20.5, with citation counts of **7089**. The second is "Psychology" in Cluster #21.5, with citation counts of **5125**. The 3rd is "Clinical Psychology" in Cluster #21.5, with citation counts of **2534**. The 4th is "Neurosciences & Neurology" in Cluster #21.5, with citation counts of **1962**. The 5th is "Neurosciences" in Cluster #21.5, with citation counts of **1202**. The 6th is "Clinical Neurology" in Cluster #20.5, with citation counts of **1050**. The 7th is "Psychology, Multidisciplinary" in Cluster #22.5, with citation counts of **673**. The 8th is "Pharmacology & Pharmacy" in Cluster #20.5, with citation counts of **455**.

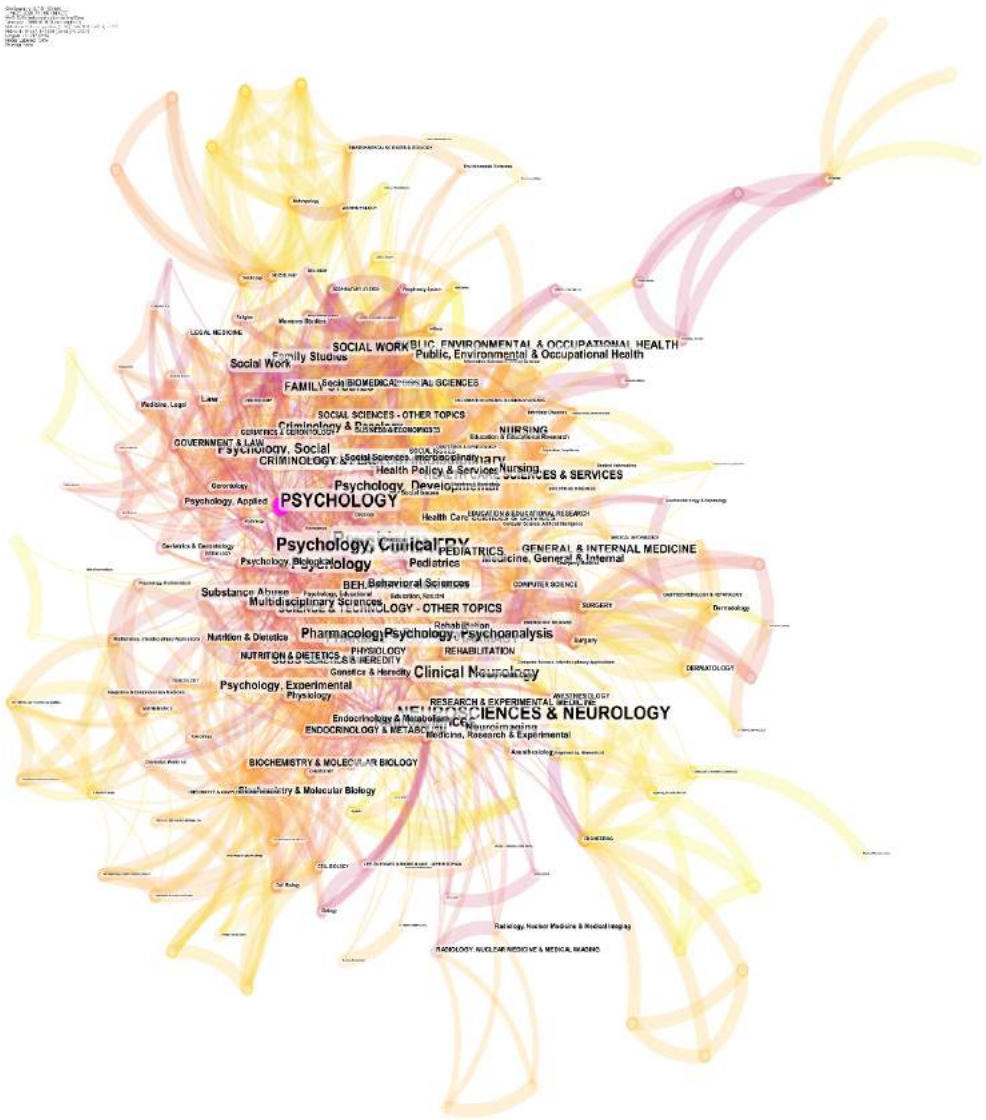

Figure 4. Cluster and network analysis of the citations related to categories

3.2. Authors

Authors and number of articles published are shown in Figure 5. We expanded our analyses to citations within the clusters (see Supplementary Materials).

Figure 5. Top 25 Authors with the number of articles published as described in Web of Science / Web of Knowledge.

The following table enlists the top 10 Authors for number of article published in the field (Table 2).

Table 2. Top 10 Authors for number of articles published.

Field: Authors	Record Count	% of 12,131
BOHUS M	213	1.756%
SCHMAHL C	196	1.616%
ZANARINI MC	189	1.558%
PARIS J	142	1.171%
FONAGY P	117	0.964 %
GUNDERSON JG	109	0.899 %
SIEVER LJ	109	0.899 %
HERPERTZ SC	105	0.866 %
LIEB K	102	0.841 %
GRATZ KL	97	0.800 %

Cluster and network analysis of cited Authors

The top ranked item by citation counts is Christian Schmahl in Cluster #7.5, with citation counts of **149**. The second one is Martin Bohus in Cluster #6.5, with citation counts of **144**. The third is Mary C Zanarini in Cluster #6.5, with citation

counts of **110**. The 4th is Kim L Gratz in Cluster #7.5, with citation counts of **87**. The 5th is Peter Fonagy in Cluster #7.5, with citation counts of **86**. The 6th is Carla Sharp in Cluster #4.5, with citation counts of **81**. The 7th is Stefan Roepke in Cluster #6.5, with citation counts of **76**. The 8th is Sabine C Herpertz in Cluster #7.5, with citation counts of **74**. The 9th is J Paris in Cluster #7.5, with citation counts of **66**. The 10th is Arnoud Arntz in Cluster #5.5, with citation counts of **66**.

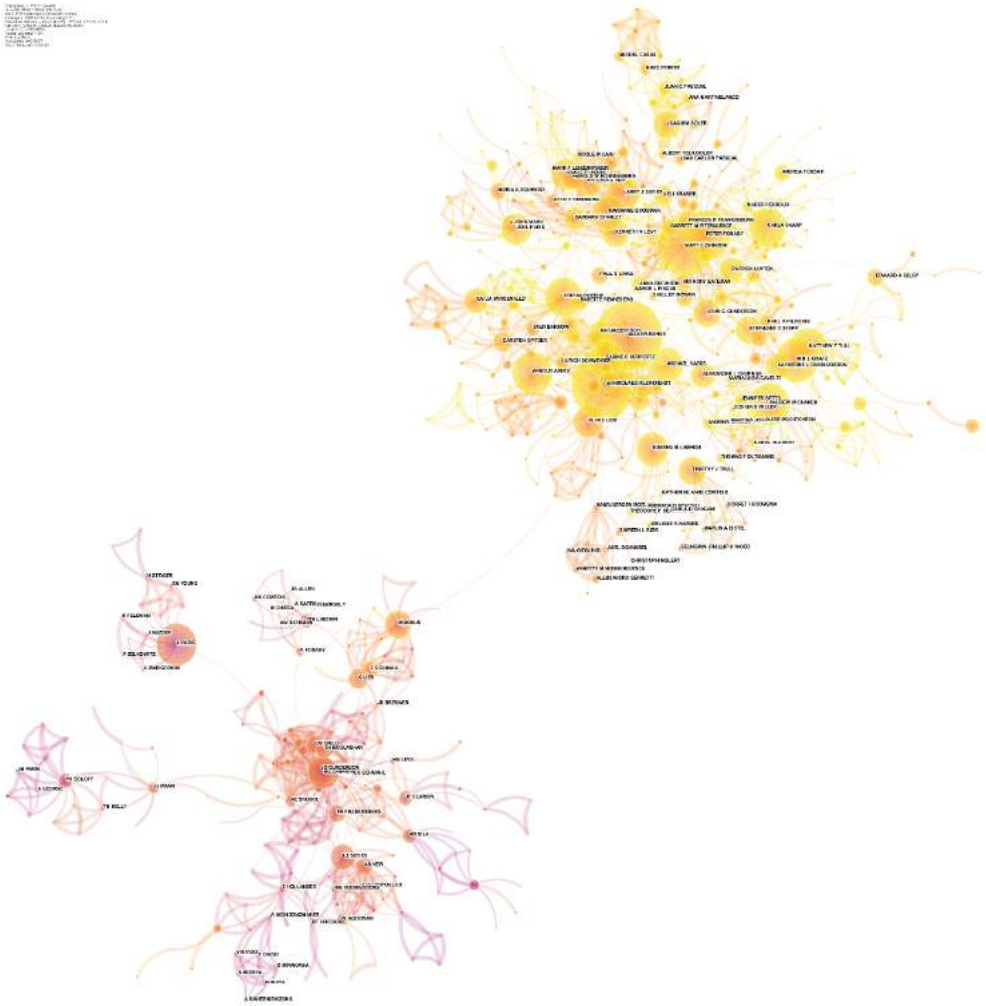

Figure 6. Cluster and network analysis of the citations related to Authors

Centrality network analysis of cited authors

For the authors, it is also crucial to understand their ability to be central in the citation network, i.e., how each author can be a broker (a connection) among

other subgroups. For this purpose, we performed an analysis of a standard centrality index. The top ranked item by centrality is Mary C Zanarini in Clusters #12.5 and #6.5, with centrality of **72**. The second is Martin Bohus in Cluster #6.5, with centrality of **59**. The third one is Christian Schmahl in Cluster #7.5, with centrality of **41**. The 4th is Peter Fonagy in Cluster #7.5, with centrality of **38**. The 5th is Stefan Roepke in Cluster #6.5, with centrality of **32**. The 6th is Sabine C Herpertz in Cluster #7.5, with centrality of **31**. The 7th is Klaus Lieb in Cluster #2.5, with centrality of **30**. The 8th is Marianne Goodman in Cluster #3.5, with centrality of **29**. The 9th is JG Gunderson in Cluster #10.5, with centrality of **28**.

3.3. Countries

The number of articles for specific country were calculated and shown in Figure 7. We expanded our analyses to citations within the clusters (see Supplementary Materials).

Figure 7. Top 25 Countries with the number of articles published as described in Web of Science / Web of Knowledge.

Cluster and network analysis of cited articles per country

The top ranked item by citation counts is USA in Cluster #21.5, with citation counts of **4627**. The second one is Germany in Cluster #22.5, with citation counts of **1589**. The third is England in Cluster #22.5, with citation counts of **997**. The 4th is Canada in Cluster #22.5, with citation counts of **896**. The 5th is Australia in Cluster #22.5, with citation counts of **653**. The 6th is the Netherlands in Cluster #21.5, with citation counts of **511**. The 7th is Italy in Cluster #23.5, with citation counts of **487**.

The 8th is Spain in Cluster #21.5, with citation counts of **426**. The 9th is Switzerland in Cluster #22.5, with citation counts of **354**. The 10th is France in Cluster #18.5, with citation counts of **338**.

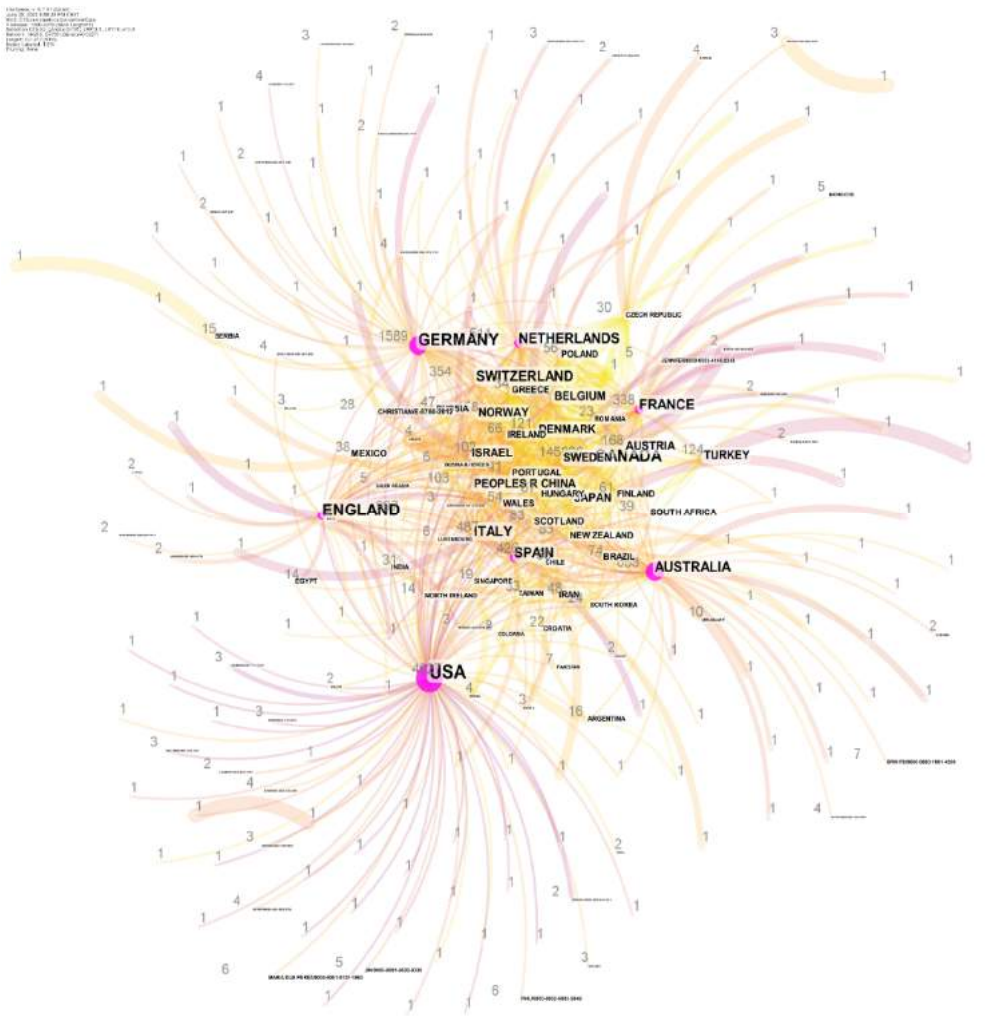

Figure 8. Cluster and network analysis of the citations related to countries

3.4. Institutions

The number of articles, published by authors of specific institutions, were calculated and shown in Figure 9. We expanded our analyses to citations within the clusters (see Supplementary Materials).

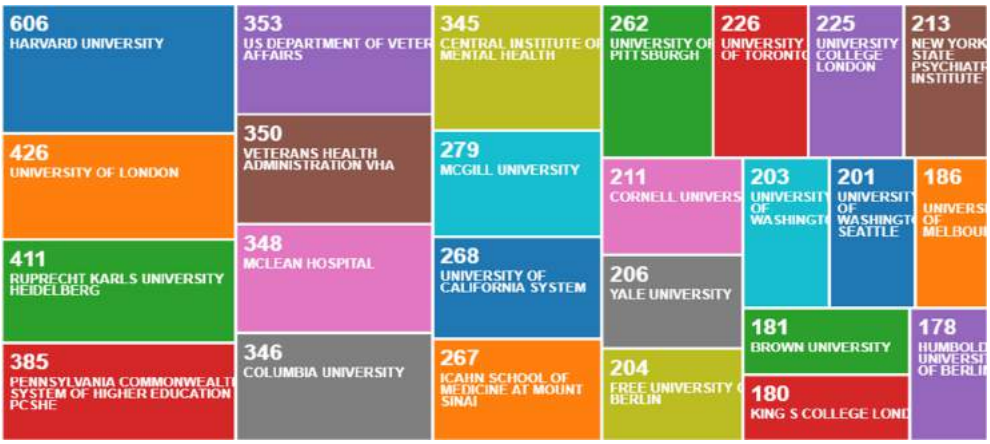

Figure 9. Top 25 institutions with the number of articles published as described in Web of Science / Web of Knowledge.

Cluster and network analysis of cited articles per institutions

The top ranked item by citation counts is Harvard University in Cluster #11.5, with citation counts of **324**. The second one is Heidelberg University in Cluster #11.5, with citation counts of **304**. The third is Columbia University in Cluster #13.5, with citation counts of **238**. The 4th is McGill University in Cluster #13.5, with citation counts of **221**. The 5th is McLean Hospital in Cluster #12.5, with citation counts of **219**. The 6th is University of Pittsburgh in Cluster #12.5, with citation counts of **193**. The 7th is UCL in Cluster #14.5, with citation counts of **182**. The 8th is University of Washington in Cluster #12.5, with citation counts of **181**. The 9th is University of Melbourne in Cluster #12.5, with citation counts of **174**. The 10th is Yale University in Cluster #12.5, with citation counts of **167**.

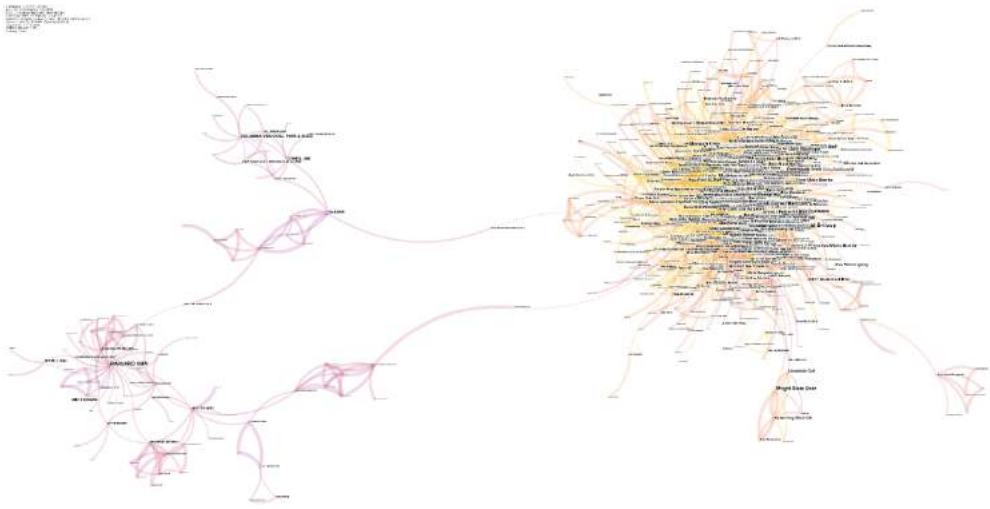

Figure 10. Cluster and network analysis of the citations related to Institutions.

3.5. Journals and hot topics

The number of articles, published by journals, were calculated and shown in Figure 11. We expanded our analyses to citations within the clusters (see Supplementary Materials).

Figure 11. Top 25 Journals with the number of articles published as described in Web of Science / Web of Knowledge.

Cluster and network analysis of cited articles per Journal

The top ranked item by citation counts is AM J PSYCHIAT in Cluster #21.5, with citation counts of **7706**. The second is ARCH GEN PSYCHIAT (currently JAMA PSYCHIAT) in Cluster #20.5, with citation counts of **5874**. The third is J PERS DISORD in Cluster #20.5, with citation counts of **5127**. The 4th is COMPR PSYCHIAT in Cluster #21.5, with citation counts of **3998**. The 5th is DIAGN STAT MAN MENT in Cluster #22.5, with citation counts of **3951**. The 6th is J NERV MENT DIS in Cluster #21.5, with citation counts of **3908**. The 7th is BRIT J PSYCHIAT in Cluster #21.5, with citation counts of **3885**. The 8th is J CLIN PSYCHIAT in Cluster #22.5, with citation counts of **3529**. The 9th is PSYCHOL MED in Cluster #23.5, with citation counts of **3484**.

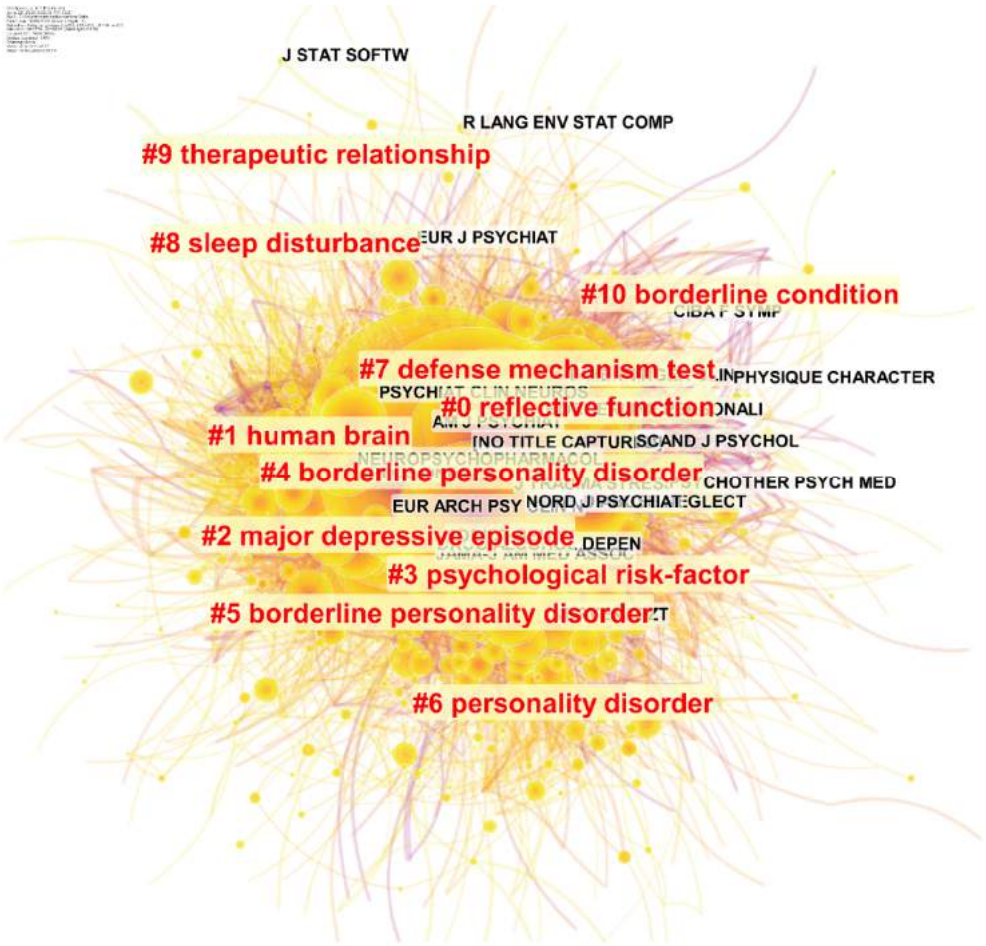

Figure 12. Cluster and network analysis of the citations related to journals. Hot topics in red.

3.6. Document co-citation cluster and network analysis

Another analysis that can be used is the analysis of document co-citation, to focus on the highly-cited documents that generally are also the most influential in the domain (Small, 1973; González-Teruel et al., 2015; Orosz, 2016). The top ranked item by citation counts is the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (2013) in Cluster #3.5, with citation counts of 1058. The second one is Grant et al. (2008) in The Journal of Clinical Psychiatry, 69 in Cluster #5.5, with citation counts of 380. The third is Leichsenring et al. (2011) in The Lancet, 377 in Cluster #4.5, with citation counts of 327. The 4th is Linehan et al. (2006) in Archives of general psychiatry, 63 in Cluster #4.5, with citation counts of 321. The 5th is the

Diagnostic and Statistical Manual of Mental Disorders IV Edition (1994) in Cluster #4.5, with citation counts of 296. The 6th is Lieb et al. (2004) in The Lancet, 364 in Cluster #4.5, with citation counts of 290. The 7th is Clarkin et al. (2007) in American journal of psychiatry, 164 in Cluster #3.5, with citation counts of 250. The 8th is Crowell et al. in Psychological Bullettin, 135 in Cluster #5.5, with citation counts of 248. The 9th is Gunderson et al. (2011) in Archives of general psychiatry, 68 in Cluster #4.5, with citation counts of 245. The 10th is Giesen-Bloo et al. in Archives of general psychiatry, 63 in Cluster #4.5, with citation counts of 234.

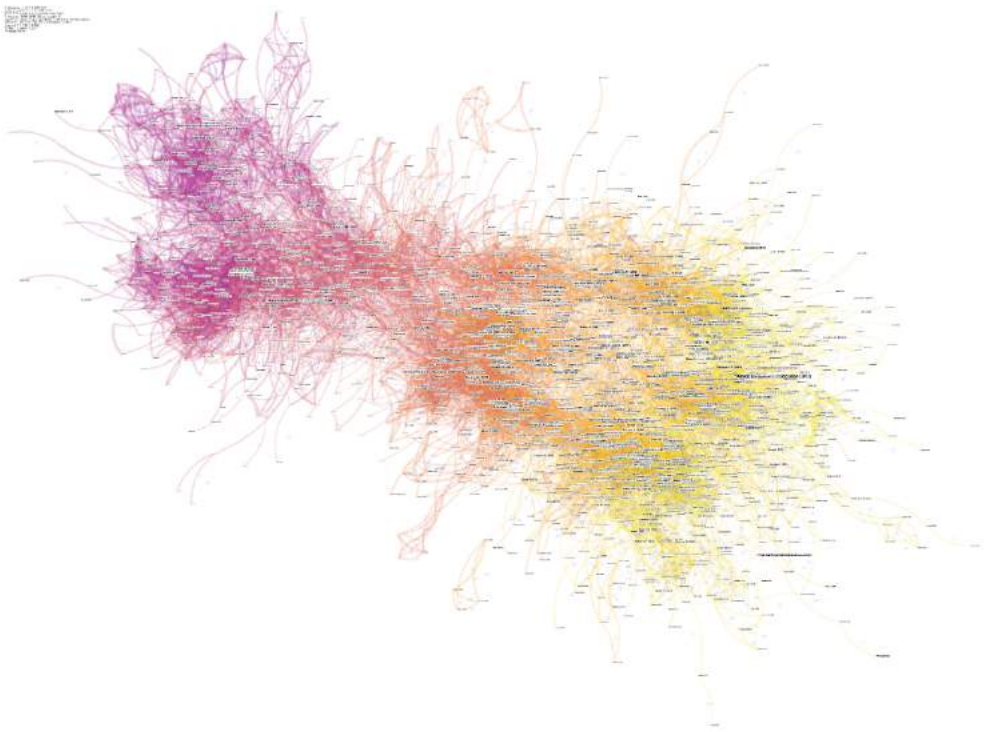

Figure 13. Cluster and network analysis of the co-citations documents.

The network of document co-citations in Figure 13 includes thousands of articles and the links among them and systematically identifies significant areas of knowledge

The identified clusters, starting from the early 1980's of the 20th century, highlights the significant literature on borderline personality pathology, highlighting the multidisciplinary nature of this field. However, the dynamics to identify the present, and future of research on borderline pathology are not clear yet. We analyzed the relationships between these clusters and the temporal dimensions of each article. The results are synthesized in Figure 14.

Figure 14. Network of document co-citations. The nodes' dimension represents centrality, the dimension of the characters represents the rank of the article rank, and the captions on the right describe the individual clusters, highlighting the main areas of investigation over time.

Clusters in Figure 14 were identified through a process of analyses of the three algorithms, one of which (latent semantic indexing, LSI) has been reported in the following Table 3. The others (log-likelihood algorithm, LLR and mutual information, MI) can be found in the supplementary materials. LSI highlights unknown semantic relationships over all the documents while LLR and MI suggest a distinctive aspect of a cluster.

Table 3. Cluster ID and silhouettes as identified with the LSI algorithm.

ID	Size	Silho-uette	Mean (Year)	Label (LSI)
0	280	0.846	2011	borderline personality disorder; interhemispheric structural connectivity; anterior cingulate cortices; daily life; specific motion patterns; measurement; ambulatory activity monitoring progress; new perspective; pathophysiology; extent | patients; borderline personality disorders; consciousness; reflective functioning; extent; dissociative disorders; emotion suppression; borderline patients; emotion vulnerability; psychometric properties
1	273	0.763	1992	borderline personality disorder; implications; bulimia nervosa; platelet; childhood abuse; young women; rorschach; social perceptions; magnetic resonance imaging volumes; neuropsychological function | borderline personality-disorder; developmental brain-dysfunction; young women; rorschach; social perceptions; magnetic resonance imaging volumes; neuropsychological function; clinical synthesis; borderline patients; pharmacological aspects

ID	Size	Silho-uette	Mean (Year)	Label (LSI)
2	243	0.865	2007	borderline personality disorder; outcome; effects; substance use disorder; psychiatric treatment; ten-session; treatment process; controlled trials; psychosocial interventions; implications | treatment; effectiveness; different psychotherapy approaches; psychological difficulties; measuring reflective functioning; relations; benchmarks; severe personality disorders; patients; 36-month pragmatic follow-up
3	193	0.853	2011	borderline personality disorder; auditory verbal hallucinations; avoiding misdiagnosis; representations; personality disorder; emotion regulation; caregiver-child relationship; young children; reflective function; symptom distress | adolescents; likely classification; life span perspective; emotional abuse; adolescent personality disorder; early intervention programme; psychometric properties; negative beliefs; youth; underlying factor structure
4	185	0.867	1990	sexual abuse; women; histories; ego development; rorschach; dissociative disorders; dissociative experiences; borderline patients; risk-factors; family functioning | childhood; eating disorders; relationship; physical abuse; history; japanese patients; impulsive behaviours; sexual abuse cause borderline personality; disorder; validity
5	161	0.897	2007	nonsuicidal self-injury; children; erp study; neural reward responsiveness; female adolescents; emotion-regulation strategies; families; nonclinical control group; parenting behavior; positive urgency | non-suicidal self-injury; daily emotion; development; suicide ideation questionnaire; confirmatory factor analysis; mapping non suicidal self-injury; demographic characteristics; emotional abuse; functions; reductions
6	160	0.928	1986	borderline personality-disorder; treatment; other axis-ii disorders; discriminating borderline personality-disorder; iii-r criteria efficiency; hierarchy; social fear scale; psychometric properties; iii-r axis-ii personality-disorders; borderline patients | patients; relatives; impulsive personality-disorder traits; schizotypal subjects; psychiatric-disorders; families; iii-r axis-ii personality-disorders; borderline patients; psychometric properties; morbidity risk
7	159	0.807	2001	borderline personality disorder; dissociation; clinicians; magnetic resonance; neurocognitive elements; short-term longitudinal study; metabolic responses; public sector; teenagers; predicting change | impulsivity; emotional dysregulation; disturbed impulse control; matter; facet; patients; persistence; first-presentation borderline personality disorder; teenagers; executive functioning
8	148	0.794	2004	borderline personality disorder; evaluation; symptom structure; treatment; impulsive subtype; hyperactivity disorder; schizotypal traits; borderline patients; neuroticism; youth | personality disorders; current status; scientific study; overview; neurobehavioral perspectives; dsm-v; alternative proposal; personality disorder research; borderline patients; disturbed recognition
9	73	0.913	2005	borderline personality disorder; depression; clinical management; mood disorders questionnaire; borderline personality disorder characteristics; bipolar disorder complexity; bipolar ii disorder; depressive mixed state; focus; outpatient | bipolar disorder; medical comorbidities; clinical management; mood disorders questionnaire; borderline personality disorder characteristics; bipolar disorder complexity; bipolar ii disorder; depressive mixed state; focus; outpatient

ID	Size	Silho-uette	Mean (Year)	Label (LSI)
10	57	0.943	1999	australian treatment outcome study; heroin dependence; risk factors; entrants; treatment modalities; prevalence; attempted suicide; heroin users; antisocial personality disorder; risk-taking | borderline personality disorder; magnetic resonance imaging volumes; women; amygdala; early traumatization; hippocampus; preliminary data; suicide risk; putative etiological correlates; relationships
11	55	0.966	2004	borderline personality disorder; adolescents; psychopharmacotherapy; psychiatric treatment; inpatient; outpatient; suicidality; affective instability; open-label study; quetiapine | personality disorders; symptom dimensions; biological treatment; randomised trials; adaptation; anger control; neurochemistry; outpatient; borderline personality disorder meta-analyses; sertraline-resistant patients
12	35	0.98	2012	borderline personality disorder; adults; attention deficit hyperactivity disorder; emotion dysregulation; comparison; literature; controlling impulsive behaviors; roles; emotion-driven difficulties; physical aggression | hyperactivity disorder; attention; cognitive measures; response inhibition differentiate; controlling impulsive behaviors; male patients; attention deficit hyperactivity disorder; criteria; psychiatry; relation
13	33	0.972	2013	borderline personality disorder; dna methylation; psychotherapy; potential biomarkers; response; bipolar ii disorder; aberrant dna methylation; dysphoria dimensions; childhood maltreatment; nonhuman primate | childhood maltreatment; psychopathology; epigenetic modifications; vulnerability; emotion regulation scale; methodological considerations; investigating epigenetic consequences; bipolar ii disorder; aberrant dna methylation; dysphoria dimensions
14	24	0.996	1988	eating disorders; women; predictor; outcome; borderline personality; axis-ii comorbidity; function; mood-independent differences; isolation; bulimics | bulimia-nervosa; patients; changes; clinical correlates; personality-disorder diagnoses; treatment; personality-disorders; anorexia-nervosa; personality-variables; prevalence
15	16	0.981	2006	borderline personality disorder; evidence; review; childhood; roots; standpoint; adolescence; mentalization; approach; cooperation | oxytocin; prosocial effects; therapeutic potential; clinical evidence; trust; translational medicine; evidence; discussion; approach; group psychotherapies
16	5	0.999	2000	trauma; reported history; depressed adolescents; overgeneral autobiographical memory; nondepressed patients; autobiographical memory; borderline personality disorder; long-term psychotherapy | nondepressed patients; autobiographical memory; borderline personality disorder; long-term psychotherapy; trauma; reported history; depressed adolescents; overgeneral autobiographical memory
17	5	0.999	2011	vulnerable narcissism; core; nonlinear association; clinician ratings; implications; instability; borderline personality disorder; grandiose narcissistic features; pathological narcissism; depressive symptoms | clinician ratings; implications; grandiose narcissistic features; expanded narcissistic personality disorder diagnosis; vulnerable narcissism; core; instability; pathological narcissism; depressive symptoms; nonlinear association

ID	Size	Silho-uette	Mean (Year)	Label (LSI)
18	5	0.998	2014	borderline personality disorder; meta-analysis; systematic review; non-psychiatric controls; basal cortisol levels; altered regional brain glucose metabolism; pituitary-adrenal axis; borderline personality; disease; bipolar ii disorder | disease; cognition; health; mineralocorticoid receptor function; bipolar ii disorder; borderline personality; patterns; altered regional brain glucose metabolism; memory; psychophysiological stress response
19	4	0.999	2003	french version; mindfulness; borderline personality disorder samples; mindfulness skills; community; kentucky inventory; alcohol use; measuring mindfulness; negative consequences; relationship | alcohol use; measuring mindfulness; negative consequences; relationship; french version; mindfulness; borderline personality disorder samples; mindfulness skills; community; kentucky inventory

4. Discussion

This contribution provides a systematic overview based on scientometric analysis of the evolution of empirical research on BPD over time, advancing an integrated and dimensional narrative of the most explored areas. As a consequence, our findings also allow to identify emerging research areas of interest, thus making it possible to imagine future trajectories.

The overview of the geographical distribution of the contributions shows that the majority of them come from the United States of America. Globally, European countries (i.e. Germany, UK, the Netherlands, Italy) as well as Canada and Australia are also significant contributors, with a coherent picture in institutions' citation count.

Moreover, the literature analysis clearly shows that the areas of psychiatry and psychology incorporate most of the research contributions: studies on treatment (pharmacological and psychotherapy), as well as those on assessment and clinical outcomes. Simultaneously, neuroscience is an expanding area, motivated by the numerous developments over the last twenty years in terms of brain areas involved in BPD.

An interesting scenario is depicted by the centrality of the different authors, which understandably reflects the areas most explored in the last 40 years of BPD studies: Mary C Zanarini with her seminal contribution to the classification of BPD with longitudinal studies and assessment measures (Zanarini et al., 2000); Martin Bohus with his studies on DBT and emotional regulation in BPD patients (Bohus ert al., 2004); Christian Schmahl with studies on BPD also in the light of its neural correlates (Schmahl & Bremner, 2006); Peter Fonagy that, along the attachment framework, understood the consequences of deficits in reflective functioning and in mentalization (Fonagy, 1991); Stephan Roepke, who contributed to relevant studies in the area of social cognition (Roepke et al., 2013).

The great advantage of scientific research lies in exploring reality through the lens of methodology. However, as the epistemology of science accurately exemplifies, methodology itself is liable to error (Van Witteloostuijn, 2016). Moreover, a significant downside of the hyper-specialized approach is often the loss of the overall picture (Livesley, 2007; Bateman & Fonagy, 2015). In a sense, this could be one of the reasons for the lack of coherence in the scientific literature on BPD, struggling to integrate results and theoretical frameworks.

In this regard, Figure 14 allows us to appreciate globally how the study of borderline personality pathology has significantly increased and diversified in terms of areas of investigation and outcomes since the 80s of the last century.

The first phase of research on borderline personality pathology started with the publication of the DSM-III and worked on the definition of the construct until the first half of the 90s, which will see the publication of the DSM-IV and an opening to new areas of exploration. At this time, literature is still affected by psychodynamic theories on assessment procedures, which include numerous contributions on diagnosis via projective techniques, and studies on the etiology of the disorder, rooted in the experiences of physical abuse and maltreatment (Herman et al., 1989). Thus, several of the studies analyzed reliability of criteria and stability over time (e.g., Tarnopolsky & Berelowitz, 1987).

The second phase highlighted from the data begins right in the middle of the "decade of the brain" and witnesses the start of contemporary investigation levels (Jones & Mendel, 1999). Indeed, thanks to the development of neuroimaging techniques and the new edition of the DSM-IV (Krause-Utz et al., 2014), research is no longer limited to the validation of the BPD diagnosis but begins to systematically investigate other aspects that are peculiar of patients with BPD. An example that emerges from the data is the investigation on comorbidities such as depression and substance use disorders (Soloff et al., 2000; Trull et al., 2000). In the same years, studies on the efficacy of treatments for BPD started: pharmacological treatments, on the one hand, and psychotherapeutic protocols, on the other (Clarkin et al., 1999; Soloff, 2000; Gabbard, 2001; Linehan et al., 2001). All in all, this second phase witnessed an impressive diversification of research on BPD that pushed over the boundaries of the diagnostic description to investigate more in-depth the efficacy of different treatments on symptoms' severity and general functioning (e.g., Paris, 1994; Bateman & Fonagy, 2000).

Social cognition and cognitive neuroscience studies open a new era of contributions after the advances in neuroimaging applications of the 1990s that further try to answer to the question: "What is borderline personality pathology?" (Lieb et al., 2004; Schmal & Bremner, 2006; Lis et al., 2007; Leichsenring et al., 2011). Meanwhile, while not very satisfactory results come from the effectiveness of pharmacological approaches, the investigation of the effectiveness of treatments is at its peak (Verehul et al., 2003; Linehan et al., 2006; Verheul & Herbrink, 2007). The first decade of the 21st century paves the way to a new paradigm shift which,

due to the limitations of the criteria-based model of personality disorders, will lead to the proposition of the DSM-5 AMPD in 2013 (Skodol, 2012). Another significant line of research that emerges from the data is the amount of research on developmental trajectories published in these years, which constitute a conceptual push for an essential evolutionary perspective, oriented to the identification of specific dimensions to describe the prodromes of borderline functioning such as emotion regulation, identity and interpersonal relationships (Di Pierro et al., 2015; Benzi et al., 2019).

Our findings also open for contemporary and future areas of investigation.

An interesting node we appreciate is the explosion of studies on NSSI related to borderline pathology. NSSI behaviors represent a heavy burden in clinical practice, being related to emotional dysregulation and higher suicidality rates (Klonsky et al., 2014), as well as impulse dyscontrol (Di Pierro et al., 2014). In particular, systematic research on the phenomenon only started at the beginning of the 21st century: the publication of DSM-5 represents a milestone with the inclusion of a new proposed diagnosis, that is the NSSI disorder (NSSID), which intended to increase its recognition as a unique clinical entity (Klonsky et al., 2014). Indeed, NSSI was initially considered only a symptom of BPD (Turner et al., 2015). However, clinical data profusely highlighted that it can occur as a standalone psychopathology: we might suggest that from here on, the paths of BPD and NSSI will separate, while continuing to run on parallel tracks.

Social cognition and cognitive neurosciences as well as developmental studies are also pushing forward two important facets of research on BPD: ADHD and genetics and heritability. Recent research has shown that internalizing and externalizing symptoms are significant predictors of the pathological functioning of personality (Sharp & Walls, 2017). The overlap of emotional dysregulation, impulsiveness and interpersonal difficulties between BPD and ADHD guides research to identify the specificities of risk and protective factors in the development of borderline personality disease (Weiner et al., 2019). Furthermore, research on emotion dysregulation, a core element of borderline personality, is currently highlighting its biological foundations and advancing heritability models that might help in better understanding nature and nurture contributions (Rappaport et al., 2020).

Last but not least, a newly area of empirical interest appears from our findings: the overlap between borderline features and vulnerable aspects of narcissism. This new area of investigation has started from the introduction of both dimensional aspects and maladaptive personality traits in conceptualizing personality pathology (i.e., the AMPD, APA, 2013). Adopting a network analysis, a recent study showed that pathological narcissism comprises both grandiose and vulnerable traits (Di Pierro et al., 2019). In particular, individuals with prevailing traits of vulnerable narcissism usually show hypersensitivity to others feedback, need for reassurance and emotional instability (Miller et al., 2010; Pincus & Lukowitsky, 2010; Miller et al., 2013), which are core features also of patients with

BPD. In this sense, future studies should clarify both overlapping and specific aspects of vulnerable narcissism and BPD. In line with this, recent contributions highlighted the importance of distinguishing clinical manifestations of borderline and narcissistic features for tailored treatments and interventions (Hörz-Sagstetter et al., 2018).

Conclusions

The results of this study can be better understood in the context of its limitations. First, we did not consider literature included in the Scopus database but not in the WoS database (Mongeon & Paul-Hus, 2016): this is a methodological aspect to address given that not all clinical contributions might be enlisted on the WoS. Further research is needed to tackle this issue. Second, the use of the scientometric approach does not address the quantitative results of studies as a meta-analysis does: however, as more than 1100 reviews on BPD are currently available, no scientometric analysis has been done yet. This contribution addresses this gap in the literature, stressing the advantages of a systematic approach to BPD literature to highlight a comprehensive framework for research on this topic (Cipresso, 2015; Cipresso et al., 2018). Finally, as citations are a significant reference, contemporary contributions and developments are not evident yet: however, we were able to consider almost 35 years of research, which is a robust starting point to emphasize a coherent and reliable historical background.

All in all, as this contribution highlights a cohesive storyline of the evolution of research on BPD over time, it is clear that a global reflection on the lines of research might foster fruitful insights on how the clinical understanding of the disorder is affected not only by changes in diagnostic models but also in advances in investigative technologies and evidence-based treatments. A scientometric approach provides evidence of current research areas reflecting the clinical complexity of such a disabling disorder in the complexity of theoretical and applicative trajectories that explore BPD.

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