The structure of mania: An overview of factorial analysis studies

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Abstract

Background. Operational definitions of mania are based on expert consensus rather than empirical data. The aim of this study is to identify the key domains of mania, as well as the relevance of the different signs and symptoms of this clinical construct.

Methods. A review of latent factor models studies in manic patients was performed. Before extraction, a harmonization of signs and symptoms of mania and depression was performed in order to reduce the variability between individual studies.

Results. We identified 12 studies fulfilling the inclusion criteria and comprising 3039 subjects. Hyperactivity was the clinical item that most likely appeared in the first factor, usually covariating with other core features of mania, such as increased speech, thought disorder, and elevated mood. Depressive–anxious features and irritability–aggressive behavior constituted two other salient dimensions of mania. Altered sleep was frequently an isolated factor, while psychosis appeared related to grandiosity, lack of insight and poor judgment.

Conclusions. Our results confirm the multidimensional nature of mania. Hyperactivity, increased speech, and thought disorder appear as core features of the clinical construct. The mood experience could be heterogeneous, depending on the co-occurrence of euphoric (elevated mood) and dysphoric (irritability and depressive mood) emotions of varying intensity. Results are also discussed regarding their relationship with other constitutive elements of bipolar disorder, such as mixed and depressive states.

Introduction

In his original description of manic-depressive insanity, Kraepelin [1] proposed that the structure of mania was based on three fundamental clinical features: euphoria, pressured speech, and hyperactivity. This triad remained among the signs and symptoms that expert textbook authors primarily considered them for the diagnosis of mania in western psychiatry until 1960 [2]. Later, when formalized diagnostic criteria for mania were generated, some of them retained the focus on the presence of all three clinical features [3] or, alternatively, on only two of them [4]. It is important to highlight that, throughout this period, no primacy was given to any sign or symptom over another, which made it possible to diagnose mania without any elevation of mood [4].

This historical perspective changed with the publication of the Feighner criteria [5], the Research Diagnostic Criteria [6], DSM-III (APA, 1980) and successive DSM editions, all of which prioritized an elevated, expansive, or irritable mood (Criterion A) over other manic symptoms and signs (Criterion B). These operational definitions were based on expert consensus rather than empirical data [7], and subsequent studies showed the relevance of activation as a clinical feature of mania as reviewed by Scott et al. [8]. The prominence of such mood abnormalities was partially reversed in the DSM-5 (2013), with bipolar disorder (BD) and related conditions being removed from the mood disorders chapter, and persistent increased activity or energy was included as part of Criterion A for the diagnosis of mania. However, the empirical support for the other criteria included in the current definition of mania is limited.

One empirical approach for studying and clarifying key clinical features of mania is to undertake factor analytic studies. Factor analysis, reduces multiple correlated variables (i.e., different clinical items) to fewer latent dimensions or factors that define the key constructs. Thus, factor analysis has the capacity to clarify how manic features covary, as well as the relative relevance of each sign or symptom (by their loadings) to defining identified dimensions. Although factor analytic studies of manic features have shown the multidimensional nature of the syndrome, findings have been inconsistent [9–13]. The lack of consensus in defining the factors underlying mania could reflect several methodological issues, such as some studies including non-manic subjects; differences in age of the patients (i.e., children–youth vs. adults); differing sets of manic symptoms and signs (with or without sets of depressive or...
non-affective features); and reliance on self-report data that can be less reliable and valid than interview methods (particularly when manic patients may lack insight). In order to overcome some of these limitations, we conducted a review of factor analytic studies to determine if a dominant or relatively consistent model could be identified for defining the key constructs of mania, as well as the relative relevance of individual clinical items to each construct.

Methods

Search strategy and study selection criteria

A comprehensive search of the literature was undertaken by accessing PubMed and PsycINFO databases on August 10, 2019 using combinations of the following search terms: “bipolar” or “mania” or “manic” and “factorial” or “principal component”, restricted to English studies in human individuals. Two reviewers (D.J.M. and M.P.V.) independently conducted the title/abstract screen and the subsequent full-text assessment. Areas of disagreement were resolved by discussion until consensus was reached.

Studies were included in the present review if they met the following criteria: (a) were published in a peer-reviewed English language journal; (b) assessed a clinical sample of subjects aged 18 years or older and who were experiencing a manic episode diagnosed by operationalized criteria; (c) employed interview methods (i.e., health professional-rated scales) to assess clinical variables (studies using self-reported scales were excluded); and (d) used latent factor models, such as analysis of principal components or exploratory factorial analysis to define syndrome dimensions. For studies with overlapping content based on the same patient sample, only the data from the study with the largest sample were considered. Since our review focuses on the structure of mania, we excluded those studies that included combined samples of patients with manic and mixed episodes, and that did not report the results of the factor analysis separately for these subsets of patients [11,14–17].

Data extraction

Data extraction was performed in duplicate by two reviewers (D.J.M. and M.P.V.). The main information extracted and reported from each study were: the number of factors, the composition and amount of variance explained by each factor, and the amount of variance included in our findings. First, a major limitation inherent to all studies that have included four additional studies to the review, obtaining a final number of 12 studies and comprising 3039 manic patients. Only 6 of our 37 clinical variables were included in all studies: elevated mood, hyperactivity, increased speech, irritability, thought disorder, and altered sleep. Three historical features of mania in Kendler’s review [2] were not included in any study: change in moral standards, hypergraphia, and weight changes. The main characteristics and the factors found in each study are shown in Table 2.

Hyperactivity emerged in the first factor in nine of the studies reviewed, and was also the variable with the highest loading in six.

Elevated mood was the first factor in only five studies, whereas irritability emerged as the first factor in three studies. Elevated mood appeared more frequently in the factor that included hyperactivity, increased speech, and thought disorder. Irritability appeared associated with both elevated mood in some studies as well as in a separate domain linked to disruptive-aggressive behavior in others.

Anxious and depressive symptoms tended to covary, comprising the first factor in two studies and the second in three studies. Altered sleep was frequently an isolated factor, while psychosis appeared related to grandiosity, lack of insight, and poor judgment. Increased sociability and increased sexuality frequently covaried, in some studies, being associated with core features of mania and in others, emerging as a separate factor.

For those clinical variables evaluated in more than a third of the studies included in our review, the probability of being identified in the first three factors is shown in Figure 1.

Overall, quality of included studies was good, except for the lack of assessment of potential sources of bias and the lack of description of any missing data.

Discussion

Compared to other disorders, such as schizophrenia or unipolar depression, there is a relative paucity of factor analytic studies of manic symptoms. In addition, despite our objective of harmonizing data from different published studies, there were a number of methodological issues that should be taken into account before interpreting our findings. First, a major limitation inherent to all studies that have explored the factorial structure of mania in naturalistic samples is that medication and different stages of recovery from the episode can confound symptom assessment. Similarly, due to the characteristics of the included individual studies, it was not possible to explore the influence of comorbidity (e.g., anxiety disorders) or age at illness onset on the reported factors. Second, the variables assessed in these studies should provide representative measures of each expected
Table 1. List of synonymous signs and symptoms used for the harmonization of clinical variables extracted from reviewed studies

| Signs/symptoms                        | Synonymy                                                                 | Mania | Mixed |
|---------------------------------------|--------------------------------------------------------------------------|-------|-------|
| Elevated mood                         | Euphoric mood/sense of humor/looks happy and cheerful/excitement/elated mood | 12    | 7     |
| Hyperactivity                         | Increased motor activity-energy/moves from one place to another/is active/absence of fatigue | 12    | 7     |
| Increased speech                      | Increased rate and quantity of speech/is talking/pressured speech/accelerated speech | 12    | 7     |
| Irritability                          | Is angry/is argumentative/makes threats/anger/impatience                  | 12    | 7     |
| Grandiosity                           | Has grandiose ideas/inflated self-esteem/exaggerated self-esteem/confident/optimistic | 9     | 4     |
| Poor judgments                        | Poor judgments in new activities/activities with high potential for painful consequences/makes unrealistic plans/bizarre behavior | 4     | 1     |
| Psychosis                             | Delusions/paranoia/hallucinations/unusual thought content/is suspicious/distrustfulness/item 8 (content) of the Young Mania Rating Scale | 11    | 1     |
| Distractibility                       | Is distractible/concentration difficult/inability to think               | 5     | 4     |
| Thought disorder                      | Disorganization of speech/flight of ideas or racing thoughts/jumps from one subject to another/jumps subject/flight of thought/altered thinking and speech/conceptual disorganization | 12    | 7     |
| Altered sleep                         | Initial insomnia/middle insomnia/terminal insomnia/general insomnia/decreased need for sleep/decreased sleep | 12    | 7     |
| Change in moral standards             |                                                                          | 0     | 0     |
| Feelings of well-being                | Increased drive                                                          | 2     | 0     |
| Increased sexuality                   | Is sexually preoccupied/talks about sex/sexual interest                   | 9     | 4     |
| Appetite                              | Poor appetite/increased appetite                                         | 1     | 1     |
| Hypergraphia                          |                                                                          | 0     | 0     |
| Weight changes                        | Weight loss, weight increased                                           | 0     | 0     |
| Impulsivity                           | Has diminished impulse control                                           | 2     | 1     |
| Appearance                            | Dresses inappropriately/is careless about dress and grooming/self-neglect | 7     | 2     |
| Mood lability                         | Is unstable                                                              | 4     | 1     |
| Lack of insight                       | Poorer insight                                                           | 7     | 6     |
| Disruptive–aggressive behavior        | Is combative or destructive/aggression/hostility/uncooperativeness        | 10    | 5     |
| Increased sociality                   | Demands contact with others/seeks out others/increased contact            | 6     | 3     |
| Psychomotor agitation                 | Agitation/mannerisms and posturing/motor restlessness/inner tension      | 3     | 2     |
| Disorientation                        |                                                                          | 1     | 0     |
| Impaired functioning                  | Reduced work                                                             | 2     | 0     |
| Depressed mood                        | Looks depressed/dysphoria/sad appearance/crying/reported and apparent sadness | 9     | 7     |
| Depressed feelings                    | Verbalizes depressive feelings/guilt/self-reproach/negative self-evaluation/discouragement/helpless-hopeless/feeling of impoverishment/ruminating/inadequacy | 7     | 6     |
| Anxiety                               | Anxiety/worry/phobias/somatic anxiety/psychic anxiety/panic/obsessions/somatic concerns | 4     | 5     |
| Suicide                               | Suicidal tendencies                                                      | 5     | 6     |
| Social withdrawal                     |                                                                          | 0     | 2     |
| Fatigue                               | Tiredness and pains/loss of vitality                                     | 4     | 3     |
| Anhedonia–loss of interest            |                                                                          | 1     | 1     |
| Psychomotor retardation               | Retarded movement and speech/motor retardation                           | 1     | 2     |
| Indecisiveness                        |                                                                          | 0     | 1     |
| Mood non-reactivity                   | Retardation (emotional)/apathy/blunted affect/emotional withdrawal/inability to feel/apathy | 3     | 2     |
| Memory impairment                     |                                                                          | 0     | 1     |
| Diurnal variation                     | Mood worse in morning/mood worse in afternoon                            | 1     | 0     |

The mania and mixed columns indicate the number of studies in which the variable was analyzed.
Table 2. Summary of studies included in the review

| Study | n/setting/diagnosis | Items/no. of factors | Rotation | Factor 1/ variance | Factor 2/ variance | Factor 3/ variance | Factor 4/ variance | Factor 5/ variance | Factor 6/ variance | Factor 7/ variance | Total variance |
|-------|---------------------|----------------------|----------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------|
| [19]  | 81/int/DSM-III | 26 items Manic-State Raring Scale/3 | Varimax | Hyperactivity, impulsivity, increased sociality, thought disorder, increased speech, appearance/NS | Irritability, elevated mood, depressive feeling, depressed mood/NS | Grandiosity, psychosis, feelings of well-being, poorer judgments, disruptive-agressive behavior/NS | | | | | |
| [10]  | 124/int/DSM-IIIR | 22 items Bech-Rafaelsen Mania and Melancholia/5 | Varimax | Hyperactivity, increased speech, thought disorder, increased sociality, increased sexuality, elevated mood, grandiosity/29.4% | Depressive feelings, depressed mood, fatigue, anxiety, impaired functioning/18.9% | Psychomotor retardation, non-reactivity mood/7.5% | Disruptive-aggressive behavior/6.0% | Altered sleep/4.9% | | | 66.7% |
| [20]  | 100/out/ICD-10 | 20 items Scale for Manic States/3 | Varimax | Hyperactivity, increased speech, thought disorder, increased sociality/18.3% | Irritability, disruptive-aggressive behavior, irritability/14.0% | Depression, lack of insight/14.0% | | | | | 46.1% |
| [13]  | 104/int/DSM-IV | 26 items Manic State Raring Scale/7 | Varimax | Increased sociality, hyperactivity, mood lability, thought disorder, increased speech/NS | Irritability, disruptive-agressive behavior/NS | Appearance, distractibility, poor judgments/NS | Grandsiosity, psychosis/NS | Elevated mood, Feelings of well-being/NS | Depressive mood, depressive feelings, impulsivity/NS | Increased sexuality/NS |
| [9]   | 363/int/DSM-IV | 12 items Young Mania Rating Scale and total score from Hamilton Depression Rating Scale score/5 | Varimax | Hyperactivity, elevated mood, increased speech/24% | Psychosis, poor judgments, lack of insight/18% | Depressive mood (HDRS score), irritability/11% | Thought disorder/11% | Altered sleep/10% | | | 73% |
| [21]  | 88/int/ICD-10 | 24 items Brief Psychiatric Rating Scale/4 | Varimax | Hyperactivity, elevated mood, distractibility, grandiosity, poor judgments/13.74% | Mood non-reactivity, thought disorder, disorientation/13.16% | Psychiatry/8.72% | Disruptive-aggressive behavior, psychomotor agitation/6.78 | | | | 51% |
| [22]  | 225/out/ICD-10 | 20 items Scale for Manic State/6 | Oblimin | Psychosis, grandiosity/17.01% | Irritability, disruptive-aggressive behavior, lack of insight, elevated mood/13.32% | Depressive mood, mood lability, anxiety/9.29% | Thought disorder, increased speech/7.63% | Increased sexuality, increased sociality/6.43% | Hyperactivity, altered sleep/5.70% | | 59.29% |
| [23]  | 131/int/ICD-10 | 11 items Young Mania Rating Scale/3 | Promax | Irritability, hyperactivity, disruptive-aggressive behavior/NS | Thought disorder, elevated mood, increased sexuality, lack of insight/NS | Psychosis, appearance, altered sleep, increased speech/NS | | | | | |
| [12]  | 1535/NS/DSM-IV | 21 items Young Mania Rating Scale and Montgomery-Asberg Depression Rating Scale/5 | Varimax | Depressive mood, mood non-reactivity, depressive feelings, fatigue, suicide/19.0% | Increased speech, thought disorder, elevated mood, hyperactivity, psychosis/12.8% | Altered sleep, distractibility/7.8% | Lack of insight, appearance, increased sexuality/6.6% | Irritability, disruptive-aggressive behavior/5.7% | | 51.9% |

Continued
The structure of mania

A factor found with some consistency across the studies was one containing suggested core features of mania (i.e., items such as hyperactivity, increased speech, thought disorder, and elevated mood). In some studies, increased sociability and sexuality were associated with such core features of mania, whereas in others they comprised a separate factor. Hyperactivity was the feature most likely to be identified in the first factor of the studies, and had the highest loading in most. This finding is consistent with a recent review detailing the relevance of activation in BD [8], and with increased activity or energy being added to Criterion A for the diagnosis of mania in DSM-5 (2013). Likewise, both increased speech and thought disorder appeared more frequently and with greater loadings than elevated mood in the first factor of our reviewed studies. This finding is in agreement with a set of diagnostic criteria suggested by Taylor and colleagues [3], and which positioned elevated mood, hyperactivity, and sleep disturbance as separate factors. Hyperactivity was the feature most likely to be identified in the first factor of the studies, and had the highest loading in most. This finding is consistent with a recent review detailing the relevance of activation in BD [8], and with increased activity or energy being added to Criterion A for the diagnosis of mania in DSM-5 (2013). Likewise, both increased speech and thought disorder appeared more frequently and with greater loadings than elevated mood in the first factor of our reviewed studies. This finding is in agreement with a set of diagnostic criteria suggested by Taylor and colleagues [3], and which positioned elevated mood, hyperactivity, and rapid or pressured speech as having equivalent salience for the diagnosis of mania, as against successive iterations of the DSM manuals, in which increased speech and thought disorder were relegated to the symptoms of Criterion B. Importantly, our results do not empirically support the primacy given to elevated or expansive mood for the diagnosis of mania in both the Feighner criteria and DSM editions from DSM-III to DSM-5.

Other mood abnormalities generated different factors. Irritability was frequently associated with disruptive-aggressive behavior in a separate factor, whereas depressive-anxious features emerged as another salient dimension. These results are consistent with the review by Goodwin and Jamison [29] that found a high prevalence of irritability, mood lability, and depression during manic episodes. Different empirical approaches also converge in showing the coexistence of euphoric and dysphoric emotions during manic episodes. Based on a small factor analytic study, Murphy et al. [30] concluded that mania does not seem well characterized by elation, but more by a state of overall activation with enhanced affective expression together with lability of affect. Similarly, based on a principal component analysis combining clinical assessment and self-report in the French EPIMAN study, Akiskal et al. [31] proposed a redefinition of mania, in which four mood alterations were specified: elation, depression, anxiety, and irritability. Likewise, in a series of studies using different clinical assessment instruments, Henry and colleagues proposed that those in both manic and mixed states evidence an increase in all emotions [32–34]. They suggested that it might be
studies (Table 3). It is noteworthy that, in line with some previous proposals of other authors [4,31], these criteria would allow the diagnosis of mania in the absence of an elevated or expansive mood (euphoric).

B-criterion
- Increased mood reactivity (at least one).
- Elevated or expansive mood (elevated mood).
- Irritability (irritability).
- Depressive mood (depressed mood).

C—Other manic features
- Expansiveness, over-confidence, or grandiosity (grandiosity).
- Decreased need for sleep (altered sleep).
- Distractibility (distractibility).
- Excessive involvement in activities that have a high potential for painful consequences (poor judgment).
- Additional features (lack of insight/distractive-aggressive behavior).

Finally, a commonly identified factor in our assessed studies was one constituted by psychosis, poor judgment, and lack of insight. This finding could provide some support for the current specifier of mania with psychotic features in DSM-5. Altered sleep tended to appear as an isolated domain, while distractibility—another current B criterion—was evaluated in only a few studies.

Overall, based on the factor distribution and loadings of the variables included in our review, we propose a redefinition of the diagnostic criteria for mania to be evaluated in future studies (Table 3). It is noteworthy that, in line with some previous proposals of other authors [4,31], these criteria would allow the diagnosis of mania in the absence of an elevated or irritable mood.

**Table 3. Tentative redefinition of the diagnostic criteria for DSM-5 mania to be evaluated in future studies (in parentheses the clinical features as defined in our review)**

- A distinct period of abnormality lasting at least 1 week (or any duration if hospitalization is necessary) in which five or more of the following criteria are met:
  - Increased activity, speech, and thought (at least one).
  - More talkative than usual or pressure to keep talking (increased speech).
  - Flight of ideas or subjective experience that thoughts are racing (thought disorder).
  - Elevated or expansive mood (elevated mood).
  - Irritability (irritability).
  - Depressive mood (depressed mood).
  - Additional features (lack of insight/distractive-aggressive behavior).

Mixed states are viewed as highly heterogeneous entities, and with the prevalence among manic patients varying from 14 to 67% [36]. This diversity is generally explained as reflecting a dimensional approach [33] or the existence of several categories of mixed states [37]. However, similar to mania, both the definition of mixed episodes in DSM-IV (1994), as well as the replacement of a mixed-state specifier in DSM-5 (2013), has been criticized for their lack of empirical support and of clinical consensus [38–40].

The two studies with larger sample sizes evaluated in our review had, in addition to patients with mania, patients diagnosed as having mixed episodes [9,12]. The main characteristics and the factors found in these mixed episodes samples are shown in Table 4. In both studies, the factorial structure in those with either manic or mixed episodes did not show a substantial difference. Moreover, the study by Swan et al. [12] was the only one that included a sample of patients with mixed episodes that were evaluated with an extensive list of manic and depressive items. The factors that emerged in that study were very similar to those found in our review of studies of mania (i.e., depressive-anxious, manic core features, irritability-aggressive behavior, and altered sleep). Therefore, the few empirical data available to date are compatible with the notion that manic and mixed states might not be different types of episodes, supporting the removal of the mixed episode and its replacement by the mixed specifier in DSM-5. Alternatively, it could be proposed that the fundamental difference could be a dimensional variation of mood, in which core features factor identified in our review (and therefore the elevated mood) predominates in “pure” mania, while depressive and irritable factors (and therefore depressive or irritable mood) dominate in “mixed” mania. This view agrees with the results of most studies that, using cluster analysis, have identified forms of pure (or classical or euphoric), dysphoric (or irritable or aggressive), and depressive mania [11–14,16]. The redefinition of the diagnostic criteria proposed in Table 3, as there were no restrictions due to the tonality of mood abnormalities would allow us to include
within the category of mania all these dimensional variations. Comparison of the factorial structure of mania with and without mixed-state specifier could be the focus of future studies in order to further clarify this issue.

Of course, the similarity in factorial structure across those with pure mania and those with mixed mania does not preclude the evidence that those with the former profile (so-called mixed states) are more difficult to treat, have a more severe course, and have a higher risk of suicide [41,42].

**Relationship between mania and depressive states**

The current conceptualization of the positions of BDs hypo/mania and depression are at opposite poles of a unitary disease entity. Our findings on the structure of mania contradict that conception, since depression seems to be a relevant dimension that can form part of a manic state. In fact, it is important to note that the depressive dimension identified in some of our studies was seemingly not necessarily restricted to a mood abnormality such as “mood lability,” but included other manifestations of major depressive episode, such as depressive thoughts, fatigue, and anxiety or suicidality. The exact nature of the association between mania and depression remains speculative. Depressive symptoms could be inherent features of mania that manifest in a subset of bipolar patients. Alternatively, our findings might be compatible with the “two-illness model” of BD proposed by some authors [43,44], according to which major depression is a comorbid condition that can occur before, during, or after a manic episode (such as occurs in schizophrenia or others psychiatric/medical disorders). Moreover, two recent family studies [45,46] that demonstrated the independence of the inheritance pattern of mania and depression also challenged the traditional view of BD. We suspect that there are several contributing factors linking mania with depression. Future studies are needed to elucidate the nature of the depressive features found during manic episodes, and identify the key models.

Findings from the present study show that the core clinical features of mania appear at the opposite pole to key melancholic features rather than to those of the more heterogeneous major depressive episode construct. In a recent review, the clinical variables that best identified melancholic depression were mood non-reactivity, motor retardation, and retardation of speech and thought [47]. Therefore, mania and melancholia might be considered as opposite poles (increase and decrease, respectively) of three core features: mood-reactivity, motor activity, and speech and thought. This approach has points of agreement both with Kraepelin’s conception [48] and with recent proposals about mood disorder modeling [49,50]. Moreover, this highlights the need to address an under-studied topic in the BD field, such as differences in the clinical meaning (i.e., clinical course, family aggregation, and therapeutic response) of melancholic and non-melancholic depressions.

**Conclusions**

Despite several limitations mentioned above, the current review summarizes the empirical evidence available on the factorial structure of mania. Results suggest a multidimensional structure of mania, in which hyperactivity, increased speech and thought disorder are key constructs. The abnormality of mood during mania could be heterogeneous and would depend on the co-occurrence of euphoric and dysphoric emotions.
The preliminary findings of our review may be a source of future research. Our results do not support the current primacy given to the elevated, expansive, or irritable mood in the definition of mania, so alternative definitions should continue to be empirically tested. Confirmatory factor analysis could be used to corroborate the general structure of pure and mixed mania. Studies should include relevant variables poorly studied to date, such as lability of mood, distractibility, and impulsivity. Our review was focused on mania. As most of the included studies were performed on inpatient populations, our results might not be representative of milder forms of mania present in outpatients. Moreover, although some authors argue that Bipolar I and Bipolar II disorders are the same illness [51,52], our preliminary results should not be extrapolated to the factor structure of hypomania, which could also be the focus of future studies. Clarification of the structural nature of mania would also be useful to evaluate the response to different treatments and to better understand the pathophysiological substrate of this disorder.

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