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PERSPECTIVES

Psychopathological Dissection of Bipolar Disorder and ADHD: Focussing on Racing Thoughts and Verbal Fluency

Gilles Bertschy [1–3], Emilie Martz[2], Sebastien Weibel[1,2], Luisa Weiner[1,4,5]

[1]Pôle de Psychiatrie, santé mentale & addictologie des Hôpitaux Universitaires de Strasbourg, Strasbourg, F-67000, France; [2]INSERM U1114, Strasbourg, F-67000, France; [3]Fédération de Médecine Translationnelle de Strasbourg, Université de Strasbourg, Strasbourg, F-67000, France; [4]Laboratoire de Psychologie des Cognitions, Strasbourg, F-67000, France; [5]Faculté de Psychologie, Université de Strasbourg, Strasbourg, F-67000, France

Correspondence: Gilles Bertschy, Pôle de Psychiatrie, santé mentale & addictologie des Hôpitaux Universitaires de Strasbourg, 1 Place de L'hôpital, BP 426, Strasbourg Cedex, F-67091, France, Tel +33 388 11 65 48, Fax +33 388 11 54 23, Email gilles.bertschy@chru-strasbourg.fr

Abstract: In the present study, we propose a review and a synthesis of the work of our group about the phenomenology and the cognitive mechanisms of racing thoughts in bipolar disorder (BD) and ADHD. Contrary to the mainstream idea according to which racing thoughts are pathognomonic of BD, our work suggests that racing thoughts are enhanced in ADHD compared to hypomanic episodes of BD, whereas in euthymic episodes of BD self-reported racing thoughts are similar to the rates reported by healthy controls. Using verbal fluency tasks, we found many similarities between bipolar and ADHD subjects with one clear difference: lexical search strategy in hypomania is based on phonemic similarities rather than semantic-relatedness. However, this distinction observed in this cognitive task is certainly difficult to grasp during a clinical interview aiming to differentiate mild hypomania from combined ADHD presentation. The main landmark to distinguish them remains the episodic nature of bipolar disorders as opposed to the lifelong presentation of ADHD symptoms, a dichotomous view that is not so clear-cut in clinical practice.

Keywords: bipolar disorders, ADHD, racing thoughts, verbal fluency, adult

Introduction
Context

Psychiatry occupies a specific place among the medical disciplines[1] as it remains an essentially, not to say purely, clinical specialty. Laboratory or imaging exams are of no help to the differential diagnosis of a mental disorder with respect to another mental disorder. The diagnosis process relies only on a meticulous descriptive psychopathology based both on the reports made by the patient of their inner experience and the clinical observation. Access to the inner experience of patients relies on a detailed clinical interview and may sometimes benefit from the use of self-report instruments. Psychopathological signs and symptoms are numerous and are often multi-faceted. Moreover, they may co-occur in different disorders and it is often difficult to partial out the normal from the pathological, hence allowing for a large diversity of clinical pictures for the same disorders. All these elements contribute to the difficulty of building highly valid classifications of psychiatric disorders and obtaining appropriate diagnosis. This complexity contributed to bring together psychopathologists and statisticians in the use of increasingly sophisticated mathematical methods aiming at carving the nature at its joints, as suggested by Kendell half a century ago.[2] The complex epistemological issues of our field are far from being resolved (for a recent reflection about these issues see for instance[3]).

In this paper, we will focus on a very tiny parcel of the psychopathological maze: the distinction within adults with bipolar disorder (BD) and adults with attention deficit hyperactivity disorder (ADHD) by focusing on racing thoughts and a specific cognitive task aiming to determine the cognitive mechanisms of racing thoughts, ie, verbal fluency. The use of the term "dissecting" in the title of our paper echoes the "carving of the nature at its joints" of Kendell.[2] The studies led

by our team summarized in this paper result from a long process. We started twenty years ago with works aiming to distinguish pure depression and mixed depression in BD by focussing on irritability and dysphoria.[4] Given our results, we started to consider irritability as a secondary and not a primary symptom found in mixed depression. This led us to focus on racing thoughts as the main symptom of mixed depression that could aid the distinction of pure and mixed depression.[5] Through our focus on racing thoughts in BD, we first aimed at developing self-report methods to tackle this phenomenon, and then to better understand its cognitive mechanisms via verbal fluency tasks. However, our expertise in patients with mood disorders led us to acknowledge that ADHD was a common comorbidity, on the one hand, and, on the other hand, that pure ADHD shared a number of characteristics with BD that made the differential diagnosis of ADHD, ADHD+BD, and pure BD extremely challenging in clinical settings.

The Distinction Between Bipolar Disorders and Attention-Deficit/Hyperactivity Disorder (ADHD)

BD is a complex group of severe and chronic mood disorders that includes bipolar I disorder, defined by the occurrence of at least one syndromal manic episode, and bipolar II disorder, defined by the occurrence of at least one syndromal, hypomanic episode and at least one major depressive episode.[6] Although the precise pathogenesis of BD is unknown, the disorder has a high heritability (approximately 70%).[6] Bipolar I and bipolar II disorders have a global lifetime prevalence around 1%, but when considering subthreshold cases the lifetime prevalence is more than 2%.[7] The field is still waiting for validated biomarkers either in the domain of neuroimaging, peripheral measurements or genetics.[8–10]

The American Psychiatric Association's DSM-5 defines ADHD in adults as the presence of five or more symptoms in either the inattentive or hyperactive and impulsive domains or both.[11] Its lifetime prevalence in adults is around 2.5%.[12] Subthreshold symptoms are frequent, as the disorder is thought to lie on a continuum: "ADHD is best understood as the extreme end of a continuum and that people with ADHD differ from those without ADHD by degree rather than in kind".[13] The heritability is estimated between 70% and 80%, but this rate has not been confirmed by some genome-wide association studies, probably because gene–environment interactions were not considered.[13] There is no clear biochemical biomarker[14] or neuro-imaging characteristics,[15] particularly for adults.[16] There are some encouraging perspectives concerning electrophysiological characteristics.[17]

There is a high level of comorbidity between BD and ADHD. Among adults with ADHD, meta-analyses suggest that the lifetime prevalence of BD could be 8%[18] or even 17%.[19] The lifetime prevalence of ADHD in adult bipolar subjects could reach 17%.[18] The comorbidity ADHD+BD, compared to BD alone, is associated with more functional impairment and worse prognosis of the mood disorder,[20] in particular with more rapid cycling episodes. The latter can be linked to genetic factors as attested by a higher polygenic risk score for ADHD in bipolar patients with rapid cycling episodes.[21] Family studies provide strong arguments in favour of common factors behind these high levels of comorbidity: there is a higher prevalence of ADHD among relatives of bipolar probands and a higher prevalence of bipolar I disorder among relatives of ADHD probands.[22]

There are a number of overlapping symptoms between ADHD and BD, especially when hypomanic symptoms are present.[20,23,24] In hypomania, patients are more talkative than usual, whereas in ADHD they can talk excessively. In hypomania, patients may present with distractibility or constant changes in activity or plans. Comparatively, ADHD patients are easily distracted, exhibit constant changes in activity or plans, have difficulties in sustaining their attention, fail to give close attention to details and may make careless mistakes. Increased activity or physical restlessness is a symptom of hypomania, whereas ADHD patients fidget, have a difficulty remaining seated, run or climb about inappropriately, have a difficulty for engaging in calm leisure activities or are often on the go as if driven by a motor. Finally, if hypomanic patients may lack inhibition in social situations, ADHD patients usually interrupt or butt in uninvited, blurt out answers before questions have been completed or have a difficulty waiting turns. The distinction between ADHD and BD is therefore not easy when focussing on ongoing symptoms: instead of focussing on current symptoms, it is recommended to consider the "worst ever" manic symptoms.[25]

Consistent with the recommendations of the DSM-5 about the differential diagnosis between ADHD and BD,[11] Asherson et al[23] wrote that:

> The time-course of symptom presentation is critical to differentiating ADHD from BD, ie. bipolar patients present with symptoms in discrete episodes of mania/hypomania and depression (…), whereas symptoms associated with ADHD follow a persistent trait-like course.

However, things are probably not as straightforward. The concept of bipolar episodes as discrete episodes with a clearly defined onset and end interspersed by intervals with no symptoms is a simplification. Subthreshold hypomanic and depressive symptoms are frequent outside of characterized (hypo)manic or depressive episodes.[26] Bipolar-I patients may be symptomatic for almost half of the weeks during long-term follow-ups.[26] Subthreshold hypomanic symptoms may be present for a long time in youth before a first full-blown manic episode.[27] Concerning ADHD, the initial view was that ADHD was a paediatric disorder and only recently it has come to public awareness that it could persist during adulthood with different developmental trajectories:[13] early onset or middle childhood onset with a persistent course, middle childhood onset with adolescent offset and adolescent or adult onset with a persistent course. It is only recently that this last profile has been identified,[28–30] contradicting the classical view of a childhood disorder that either remits or persists at the end of the adolescence. Yet the rule remained that when persisting into adulthood, it has a stable trajectory. However, recent works have shed new light on this issue. In a longitudinal study, it was found that most participants with ADHD had fluctuating periods of remission and recurrence over time.[31] Thus, the distinction between BD and ADHD on the basis of their longitudinal evolution is not so clear cut. To a certain extent, both of them may display a waxing and waning evolution.

Racing Thoughts
Racing Thoughts and BD
Overview About Racing Thoughts in BD
Racing thoughts refer to a subjective acceleration and overproduction of thoughts.[5,32] Initially, they were mainly associated with manic episodes in BD: racing thoughts and their verbal equivalent, flight of ideas, are extremely characteristic of manic thinking.[33] In his historical textbook on manic-depressive illness at the beginning of the twentieth century, Kraepelin was the first to use the term "flight of ideas". This last term refers to both the experience of speeded thought pressure and its expression in the patient's speech.[34] Kraepelin's definition of racing thought was strongly linked to his conception of mixed states, developed with Weygandt.[35] Racing thoughts are among the criteria of manic states in the DSM-5,[11] similar to the previous versions of the manual[36–39]: "flight of ideas or subjective experience that thoughts are racing". An important change in the DSM-5[11] is the acknowledgement that racing thoughts could be associated with a depressive syndrome, in the context of a "depression with mixed features", labelled by the historical figures of the field as "mixed depression".[40] Clinical researchers[41–43] described that when racing thoughts occurred during mixed depression, the symptom does not convey a sense of speed and flow, associated with pleasant emotions. On the contrary, thoughts are described as numerous and "overcrowded" in the patient's head and are associated with unpleasant feelings. These phenomenological descriptions supported a binary conception of racing thoughts: in addition to the typical hypomanic "racing thoughts", there was a depressive subtype of racing thoughts, labelled "crowded thoughts". In clinical practice, it is extremely difficult to assess racing thoughts, as the agreement between self-assessment and clinicians' rating of racing thoughts is low.[44]

Our Studies About Racing Thoughts in BD
We started our studies on racing thoughts with a qualitative analysis of audiotaped interviews exploring the subjective experience of thought overactivation in 45 patients with mood disorders.[45] We found five conceptual categories that characterized thought overactivation: sequential thought flow (ie, one thought leading to another), overstimulation, competition for resource allocation, unexpected/unexplained onset of thoughts, and association with mood and emotions. In parallel of the qualitative study, we developed a 16-item self-report questionnaire to study thought overactivation.[45] In the same study, using a principal component analysis, we found that a single component explained 55.9% of the variance with major and exclusive contributions from 9 items. Therefore, as suggested by one of our recent studies,[32]

> This component did not support a dualistic view of racing thoughts versus crowded thoughts and suggested instead that subjective thought overactivation encompasses an overproduction of thoughts but also thoughts getting muddled, as well as the unrestrained/uncontrollable nature of thought flow.

This conclusion subtended the qualitative analysis results:[45] thoughts are perceived as unexpected, easily triggered, difficult to inhibit and competing for resource allocation. These qualitative findings suggested that racing thoughts was a multi-faceted concept, even though the results from our first questionnaire did not support these findings.[45] To address the multi-faceted nature of racing thoughts,[45] we developed a 34-item self-rating scale partially based on our initial scale – the Racing and Crowded Thoughts Questionnaire (RCTQ) – assessing thought overactivity during the past 24 hours.[46] The items were rated on Likert scale ranging from zero ("not at all") to four ("completely agree"). Some of them were related to the phenomenology of classic (hypo)manic racing thoughts including thought velocity or sequential and easy unfolding. Others were related to the phenomenology of crowded thoughts referring to an increased amount of simultaneous thoughts or to the negative consequences of thought overactivation.

Since racing thoughts might be present in healthy subjects,[47] we first investigated the psychometric properties of the RCTQ with an exploratory factor analysis in 197 healthy subjects.[46] A three-factor solution was found, labeled "thought overactivation", "burden of thought overactivation", and "thought overexcitability", which explained 60.2% of the variance. The "thought overactivation" factor was selectively associated with current elated mood and included items conveying both the notion of increased amount and velocity of thoughts, akin to racing thoughts in hypomania. The "burden of thought overactivation" factor was associated with current low mood, akin to the concept of crowded thoughts. The "thought overexcitability" factor included items conveying the notion of distractibility and was associated with both elated and low mood.

In a subsequent study,[48] we investigated the psychometric properties of the RCTQ in a clinical sample including 221 French, Italian and Belgian patients with BD and 120 French healthy controls. The three-factor solution of the RCTQ yielded the best fit indices when compared to a single-factor model proposed by our initial study[45] or a two-factor model built on the basis of a dualistic racing versus crowded thoughts conception. These results confirmed the notion according to which racing thoughts is a multifaceted phenomenon in mood disorders and that it lies on a continuum between healthy and symptomatic mood states. Finally, through the removal of redundant and less discriminant items within the three factors of the RCTQ, we built the short 13-item RCTQ which had the strongest psychometric properties.[48]

There are some important results when considering the different subgroups of patients in acute episodes of BD. First, irrespective of their mood state, patients presenting with an acute episode had higher scores on the three factors than euthymic patients and control subjects. Second, relative to pure depression (depression without any hypomanic symptom), results for the three RCTQ factors were higher in other depression subgroups with hypomanic symptoms, including a group with depression with very mild hypomanic symptoms.[48] This suggests that very mild hypomanic symptoms may be associated with racing thoughts during depressive episodes. Third, the scores on the second and third factors (ie, burden of thought overactivation and thought overexcitability) were similar in pure hypomania as compared with mixed subgroups and it was only for the first factor (ie, thought overactivation) that the score was significantly higher in pure hypomania compared to pure depression. This supports the view that the hypomania is essentially associated to the first factor.

It should also be noted that anxiety and worry symptoms, as well as hypomanic symptoms, were important predictors of RCTQ subscale scores.[48] By contrast, rumination was unrelated to racing thoughts both in healthy individuals and in patients with BD,[48] confirming that rumination and racing thoughts are distinct phenomena.

Racing Thoughts and ADHD
Overview About Racing Thoughts in ADHD

According to the DSM-5, racing thoughts can only be found in depressive and bipolar disorders.[11] Thus, racing thoughts are not expected to be found in adults with ADHD. The only clinical dimension that resembles that of racing thoughts is "unrelated thoughts" as an alternative to "distractibility by extraneous stimuli" in older adolescents and adults, one of the nine symptoms of inattention in the DSM-5 diagnostic criteria of ADHD.[11] When examining the overlapping diagnostic

symptoms between bipolar (hypo)mania and ADHD symptoms according to the DSM-5,[23] suggested that distractibility and irritability display a high degree of overlap, whereas talkativeness and psychomotor agitation overlap only to a moderate degree. The item "flight of ideas/racing thoughts" is among manic symptoms under the label of "little degree of overlap". The authors added regarding this symptom:[23]

> Adult patients with ADHD typically experience a distracted type of ceaseless mental activity and wandering mind (everyday thoughts flitting from one topic to another), whereas in BD thoughts may be "racing" and may be perceived as particularly sharp or "on the ball".

It is worth noting that they refer to the classic hypomanic conception of racing thoughts, and they did not consider the perspective of crowded thoughts.

However, in a more recent review about key conceptual issues of adult ADHD,[49] they stressed that another common feature of adult ADHD is excessive mind-wandering, also referred to as mental restlessness and akin to the unrelated thoughts of the DSM-5 we mentioned above. As they wrote,

> Mind-wandering occurs when a person's mind drifts away from a task and focuses on internal thoughts and images that are unrelated to the task or situation at hand.[49]

They highlight that mind-wandering is associated with performance deficits and cognitive performance errors. They then describe it in a perspective relatively close to the concept of racing thoughts:

> Adults with ADHD frequently report a distractible mental state with multiple unrelated thoughts that are constantly on the go and jump from one topic to another.[49]

However, this clinical phenomenon is only discussed through the lens of mind-wandering, or as a feature of other mental health disorders, eg, depressive ruminations and obsessional thoughts, whereas racing thoughts are not mentioned at all.

Our Results About Racing Thoughts in ADHD

Our interest in racing thoughts in ADHD was initiated following our studies about racing thoughts in mood disorders.[46,48] Considering racing thoughts as a potential transdiagnostic phenomenon involved in mood instability, we used the RCTQ, as developed in BD, in adults with ADHD.

The only study regarding racing thoughts in ADHD is the one recently published in our group.[50] In this study, using the 13-item RCTQ, we compared the self-reported racing thoughts of 37 adults with ADHD with 31 healthy controls. The total score on the 13-item RCTQ and the scores on the three RCTQ subscales were higher in the ADHD group than the healthy control group,[50] suggesting that racing thoughts are clearly significant in ADHD.

Our Results Comparing Racing Thoughts in Adult ADHD and BD

In our first study using the RCTQ in healthy subjects, we assessed the current mood and affective temperaments, but we did not assess ADHD symptoms (Weiner et al, 2018). In a more recent study[51], we compared the scores on the 13-item RCTQ in 30 subjects with the comorbidity ADHD+BD, 54 adults with ADHD inattentive subtype, 123 adults with ADHD combined subtype, 31 patients with BD in a hypomanic episode and 20 euthymic patients with BD. We did not have a group of ADHD subjects with the purely hyperactive subjects as these patients are very rare. Our results show that scores on the three factors of the RCTQ were higher in the ADHD-combined group relative to the ADHD-inattentive group, the hypomanic bipolar group and the euthymic group. Scores on the three factors did not differ between the ADHD-inattentive group and the hypomanic bipolar group but were higher than the euthymic group.[51] This result is surprising inasmuch as racing thoughts in the combined ADHD presentation group were increased compared to the BD hypomanic group. The fact that

> The combined presentation subgroup exhibited higher scores on the three factors, suggested that hyperactivity in combined presentation, includes not only motor hyperactivity, but also thought hyperactivity.[51]

In the DSM-5, the basic description of the item 2.c ("often runs about or climbs in situations where it is inappropriate") was completed by a note specifying that "in adolescents or adults, may be limited to feeling restless". But this reference

to the concept of inner agitation does not include any clear mention of mental agitation which could actually be a form of racing thoughts.[11]

Using multiple regression analyses, we examined the predictors of the scores of the three factors of the RCTQ in the ADHD-combined group and in the ADHD-inattentive group. Cyclothymic temperament traits were the main predictor for the three RCTQ factors in the ADHD-combined group, whereas it was not the case in the ADHD-inattentive group (although there was a trend for the RCTQ factor "thought overexcitability"). The anxiety level also predicted the scores in the RCTQ factor "thought overactivation" but only in the ADHD-inattentive group. ADHD hyperactivity severity also predicted the scores in the RCTQ factor "thought overactivation" in both ADHD subgroups, whereas ADHD inattention severity was not associated with RCTQ scores in both ADHD subgroups. This led us to suggest that "hyperactivity, hyperarousal and anxiety, but not cyclothymic traits, might contribute to racing thoughts in inattentive individuals".[51] Concerning the difference between the inattentive and the combined ADHD subtypes (higher scores on the three factors in ADHD-combined group relative to the ADHD-inattentive group), two explanations were proposed:[51] firstly, the relationship between cyclothymic temperament traits and racing thoughts, and, secondly, the already known[52,53] link between affective dysregulation and the hyperactivity found in the combined presentation only.

In this study, racing thoughts in the ADHD subsamples were also assessed with a five-point scale at different times of the day. We found that the scores were higher in the evening and at bedtime, compared to morning and afternoon in the ADHD combined group and the comorbid ADHD+BD group whereas such was not the case in the ADHD-inattentive group.[51] This suggests that racing thoughts in ADHD might fluctuate as a state-dependent symptom. Unfortunately, data regarding the circadian variation of racing thoughts in BD is lacking, but it seems similar in the ADHD-combined subgroup and in the ADHD+BD subgroup.[51] Finally, it is interesting to note that we found a correlation between racing thoughts at bedtime and severity of insomnia,[51] similar to results we found in primary insomnia patients,[54] consistent with the view that "ceaseless mental activity" in adults with ADHD could be involved in their sleep-onset difficulties.[55]

Our Results Comparing Racing Thoughts in ADHD Alone and in ADHD + Bipolar Disorder Patients

We found that scores on RCTQ and its factors did not differ between the ADHD-combined group (N = 30) and the comorbid ADHD+BD group (N = 123). This suggested that racing thoughts in our ADHD subjects were not due to BD and could be considered as intrinsically related to ADHD.[51] To our knowledge, ours is the only study that has investigated racing thoughts in BD, ADHD+BD, and ADHD. Subjects with ADHD+BD were euthymic.

The Cognitive Mechanisms of Racing Thoughts Tackled by Verbal Fluency Tasks

Verbal Fluency Tasks and Bipolar Disorder

Overview About Verbal Fluency Tasks in BD

Language disturbances such as speech pressure or poverty are among the main symptoms of, respectively, manic and depressive states and have been well described in classic works using associational fluency as a measure of creativity and thinking style in mania.[34] Consistently, the DSM-5[11] acknowledges increased verbal fluency as part of the B3 criterion of a manic episode: "More talkative than usual or pressure to keep talking". It is specified in the text about diagnostic features that:

> Speech can be rapid, pressured, loud and difficult to interrupt. Individuals may talk continuously and without regard for others' wishes to communicate, often in an intrusive manner or without concerns for the relevance of what is said. Speech is sometimes characterized by jokes, puns, amusing irrelevancies, and theatricality, with dramatic mannerisms, singing, and excessive gesturing.

In major depressive episodes, the DSM-5 A5 criterion[11] refers more generally to "Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down)". The diagnostic feature specifies that

> Psychomotor changes include…retardation (eg. slowed speech, thinking, and body movements; increased pauses before answering; speech that is decreased in volume, inflection, amount, or variety of content, or muteness)

Some studies suggested that language disturbances such as speech pressure or poverty are present not only during acute episodes but also during periods of remission.[56]

During the last decades, the focus switched from associational fluency during manic states to language impairment, including during euthymic phases, that can be measured, from a neuropsychological perspective, using verbal fluency tasks. In such tasks verbal fluency is assessed with more restrained instructions, such as

> To generate words according to specified rules based on phonemic or semantic criteria ("letter" and "semantic" fluency, respectively), or in the absence of a specified criterion. (free word generation)[57]

The production of words is typically assessed only in a quantitative manner (number of words or errors). However, more complex methods have emerged in recent years, allowing to assess the production of words also in a qualitative manner through the identification of clusters both in semantic tasks (eg a subcategory within a category) and letter tasks (eg words that rhymes). This allows to assess the ability to produce words within semantic or phonological clusters (clustering) but also the ability to switch to a new category (switching).[57]

A recent meta-analysis[58] revealed a moderate verbal fluency impairment both in "letter" and "semantic" fluency tasks in BD compared to healthy controls, whereas comparisons between mood states showed significant differences between euthymic and manic patients and only on the semantic verbal fluency condition. Specifically, the authors found a greater impairment in the semantic verbal fluency production in euthymic compared to manic patients. They made the hypothesis that the relative preservation of performance in manic phases was linked to an over-activation of the semantic network.[58] This means that

> During manic episodes, the oral production of a given word might lead to faster than usual spreading of activation, hence facilitating the retrieval of more remotely associated words.[57]

Our Results on Verbal Fluency Tasks in BD

In our study,[57] we measured total word count as well as clustering and switching in three conditions of verbal fluency tasks – ie, letter, semantic, and free condition. We calculated semantic and phonological cluster ratios (ie, number of clusters/number of words), mean cluster sizes, and the raw number of switches. The study sample included 25 bipolar patients in a hypomanic/manic phase, 12 in a mixed manic phase, 20 in a mixed depression phase (including depression with a minimal level of hypomanic symptoms), 17 in a depression phase and 20 in euthymic phase as well as 31 control subjects.

For word and error counts, we found no clear differences between mood episodes:[57] only the depression patients tended to produce fewer words compared to controls and hypomanic patients in the semantic task, consistent with previous studies.[58] The number of words produced by hypomanic patients was not increased, a counterintuitive result given the classical manic symptom of talkativeness. For clustering and switching, we found differences only in the free but not in the constrained (letter or semantic) condition: hypomanic patients switched more often and had reduced semantic cluster ratios than controls and depressive patients.

Our results[57] do not support the view that mania induces an inhibition deficit (in constrained tasks there is no greater amounts of errors, no smaller cluster ratios and no increased switches) but rather support the view of Raucher-Chéné et al[58] of an over-activation of the semantic network. Indeed, the unrestrictive nature of the free task

> May have enhanced diffuse semantic activation and favored the retrieval of more remotely associated words within the semantic network, which were not required to be inhibited in this task.[57]

It is interesting to note that the results were similar for the mixed depression group and the hypomanic group when they were compared to the pure depression group: both showed an increase in the number of switches compared to pure depression suggesting that "very few activation symptoms concurrent with depression might give rise to speech and thought abnormalities similar to those found in mania".[57]

Concerning the depressive side of BD, we found results analogous to those found in unipolar depression by others:[59] reduced verbal output and switches, especially in the semantic task; these findings were correlated to executive dysfunction and reduced psychomotor speed.

Finally, we must highlight that in euthymia, results from patients do not differ from the healthy control group.[57]

Verbal Fluency Tasks and ADHD
Overview About Verbal Fluency Tasks in ADHD Patients

Talkativeness is a classic ADHD symptom and the DSM-5[11] mentions it in the criterion 2.f as one of the nine symptoms of hyperactivity and impulsivity: "Often talks excessively". This can be seen as a form of hyperactivity leading to an excessive verbal production. The following criterion, 2.g, proposes another aspect of verbal output more related to the concept of impulsivity: "Often blurts out an answer before a question has been completed (eg, complete people's sentences; cannot wait for turn in conversation)".

As reviewed in our paper,[50] the vast majority of studies using verbal fluency tasks in adults with ADHD used a quantitative approach (number of words produced). Even though there is some discrepancy between studies, most have found either a lack of impairment or impaired performances in the semantic and letter (ie, constrained) conditions of verbal fluency tasks (Martz et al, 2022). Only one study[60] used a qualitative approach and found that adults with ADHD produced fewer words, especially in the letter condition, compared to healthy controls. In addition, the authors reported fewer number of switches and a tendency for a reduction of cluster sizes, suggesting that the retrieval of words, subtended by executive functions, in particular, is impaired in ADHD.

Our Results on Verbal Fluency Tasks in ADHD Patients

Similar to our study in BD,[57] in our study in adult ADHD,[50] we measured total word count as well as clustering and switching in three conditions of verbal fluency tasks – ie, letter, semantic, and free condition. We calculated semantic and phonological cluster ratios (ie, number of clusters/number of words), mean cluster sizes, and the raw number of switches.

When comparing ADHD only patients (n = 37) and healthy controls (n = 31) in the free, the letter and the semantic conditions,[50] we found no differences in the number of produced words or of repetitions (a subtype of error). Concerning the rule breaks (another subtype of error), there was no difference in the letter condition, yet in the semantic condition ADHD patients showed fewer errors than the healthy controls, a rather unexpected result. Concerning cluster analyses (semantic cluster size, ratio of semantic clusters, phonological cluster size, ratio of phonological clusters), there were no differences. As for switches, there was no difference in the letter and semantic conditions, whereas in the free condition, the number of switches was increased in the ADHD group relative to the healthy control group. Thus, switches were increased in the absence of speech overproduction.[50]

In the ADHD group, we performed a neuropsychological assessment. Our results showed that patients with ADHD had better performances on the Intellectual Quotient estimation and the Vocabulary test (Wechsler Adult Intelligence Scale-Third Edition) than healthy controls.[50] They did not differ on other measures of processing speed and attention switching (Trail Making Test), of working memory (digit-span task of the Wechsler Adult Intelligence Scale-Third Edition), but adults with ADHD had more errors on a semantic inhibition task (using the Hayling Test) compared to healthy subjects. We also examined the correlations between these neuropsychological performances and verbal fluency measures.[50] Vocabulary size, processing speed and global executive functioning were related to greater verbal output in all the conditions of verbal fluency tasks. Increased vocabulary size and rapid reaction times were related to more efficient semantic clustering in the free condition. Concerning the switching strategy, increased processing speed, greater working memory capacity, efficient inhibitory control, and more efficient cognitive flexibility abilities were associated with the increased number of switches in the free condition. However, no correlations were found between inattention and hyperactive symptoms and verbal fluency measures.

Through our neuropsychological results, we can hypothesize that an increase in switching without speech overproduction[50] could be involved in rapid conceptual shifts resulting in the production of single words instead of clusters of semantically related words in the free condition. This, in turn, could result in a total word output that is similar to that of healthy controls, although the mechanisms involved differ. Some of our results in free condition support this

view as ADHD + BD patients had a smaller cluster size and patients with ADHD had a reduced cluster ratio compared to healthy controls. Three explanations could account for these results: ie, (i) a poor semantic stock, (ii) executive dysfunction, and (iii) enhanced spontaneous associative processes in ADHD. A first supportive element for the latter explanation is the fact that ADHD patients had better performances on the Vocabulary test compared to healthy controls, thus the hypothesis of a poor semantic stock in these groups is unlikely. Second, unlike results from other studies,[60,61] our participants with ADHD did not present with a widespread executive dysfunction. Indeed, verbal output was not impaired in the constrained conditions (the semantic and letter), and among all the neuropsychological measures, only the number of errors in the Hayling test was higher in ADHD patients compared to healthy controls. Moreover, instead of being suggestive of diminished semantic inhibition abilities, increased number of errors in the Hayling task was negatively correlated with switching in the free condition, indicating that fewer errors are actually associated with increased switches in this free condition task.

> Thus, instead of presenting with a widespread executive dysfunction it is plausible that patients with ADHD present an atypical way of proceeding during a retrieval task, resulting in increased switches in unrestrictive conditions.[50]

In the free condition of the verbal fluency task, patients with ADHD in comparison to healthy controls

> Seem to retrieve information from semantic memory based on an associative process (ie. wandering across random long-distanced concepts) rather than a categorical process. (ie. investigating in depth semantic categories and subcategories)[50]

Our Results Comparing Verbal Fluency Tasks in ADHD and BD

When comparing patients with ADHD (n = 37) and hypomanic patients with BD (n = 25) in the free, the letter and the semantic conditions,[50] we found no differences in the number of produced words and in the number of repetitions (a subtype of error). Concerning the rule breaks (another subtype of error), there was no difference in the letter condition, yet in the semantic condition patients with ADHD showed fewer errors than the hypomanic patients with BD. Concerning semantic cluster analyses (semantic cluster size and ratio of semantic clusters), there was no differences between ADHD and hypomanic patients. It was different, however, for phonological cluster analyses: hypomanic patients had larger phonological clusters and higher ratio of phonological clusters compared to the ADHD group in the semantic condition of the task. Regarding the number of switches, there was no difference between the two groups and both switched more often than healthy controls in the free condition.[50]

Our Results Comparing Verbal Fluency Tasks in ADHD Alone and in ADHD + BD Patients

In our study including subjects with ADHD and BD,[50] we compared patients with ADHD (n = 37) and participants with ADHD + BD (n = 22). ADHD + BD participants were euthymic. We found no differences between the two groups in all of the measures of the verbal fluency tasks: ie, number of words, number of errors, cluster analyses and number of switches, irrespective of the condition (free, letter, semantic).[50]

Racing Thought and Verbal Fluency Interactions: Our Results
Relationship Between Self-Reported Racing Thoughts and Verbal Fluency Measures

In our study focusing on verbal fluency in BD,[57] racing thoughts were assessed via the RCTQ. We found an association between racing thoughts (total RCTQ score and "overexcitability" factor subscore) and fewer words in the letter and semantic verbal fluency tasks but not in the free condition. This echoed the finding according to which hypomanic patients switched more often and had lower semantic cluster ratios than controls and depressive patients only in the free condition of the task. This finding led us to consider that hypomanic patients may have enhanced diffuse semantic activation and favoured the retrieval of more remotely associated words within the semantic network, which were not required to be inhibited in the free task.[57]

We also found a link between higher RCTQ scores and a decreased phonological cluster ratio in the letter condition (for RCTQ total score and for each of the three-factor subscores). How to explain these differences between free and constrained tasks? A critical question is the role of distractibility.[57] In the free condition, it might have favoured

conceptual shifts, promoting the production of single words instead of clusters in hypomanic patients. In this case could distractibility be detrimental to performance in constrained tasks? This is contradicted by the fact that manic symptoms do not affect neither the total word output nor the error count. Moreover, we even found increased phonological cluster sizes in the semantic condition, suggesting that patients with hypomanic symptoms are spontaneously more flexible.

> More specifically, when they had to produce animal names, manic subjects did so while rhyming and using other sound-based associations, akin to clanging, more than any other group.[57]

This could be hardly explained by an increase in executive functions as they were generally impaired in our manic group. There remains another possible explanation: semantic overactivation. In mania, unrelated "representations might rather be spontaneously activated through semantic spreading and subtend sound-based associations".[57]

Racing Thought and Verbal Fluency Interaction in Our Study in ADHD Patients

In ADHD patients (n = 59, sample including both ADHD only and ADHD + BD euthymic patients),[50] a relationship was observed between racing thoughts and verbal fluency measures only in the semantic condition.

> First, there was a positive correlation between the score of the factor 2 "burden of thought overactivation" of the 13-item RCTQ and the semantic cluster ratio in the semantic condition.[50] If we consider the hypothesis of enhanced spontaneous associative processes as discussed before, it is not surprising that greater cluster ratios, and probably reduced switching, would occur in this constrained condition in association with "crowded thoughts".[46]

> Second, there was a negative correlation between the score of the factor 1 "thought overactivation" of the 13-item RCTQ and the number of rule breaks in the semantic condition.[50] The factor 1 of the RCTQ refers to the increased amount and velocity of thoughts and is specifically associated with pure hypomania, elated mood and hyperthymic temperament.[46] It conveys also an aspect of cognitive fluidity (item 4 "There is a succession of thoughts in my mind, racing from one to the other with incredible ease").[48] This could be explained by the fact that, to a certain extent (if they are not excessively enhanced), increased thought overactivation could improve performance and reduce the risk of errors during the task.

Discussion

Our work on racing thoughts through a quantitative psychopathology approach has revealed that racing thoughts are multi-faceted as through the self-report questionnaire we developed – the RCTQ – three factors, labeled "thought overactivation", "burden of thought overactivation", and "thought overexcitability", were found both in BD and in healthy subjects.[46,48] Table 1 summarizes our findings.

> In adults with ADHD, we then found that scores on the three subscales of the RCTQ were similar in inattentive patients with ADHD and in hypomanic participants with BD. Importantly, self-reported racing thoughts were even higher in the combined ADHD group compared to the hypomanic group, a finding that is unrelated to comorbid BD or depression.[51] Thus, our works suggest that racing thoughts are present in ADHD to a greater extent than in hypomania. Racing thoughts are no more present in euthymic bipolar patients than in controls,[48] a finding that is congruent with the lack of difference between patients with ADHD and patients with the comorbidity ADHD + euthymic BD.[50] This suggests that when focusing on racing thoughts, the main difference is the time-course of symptom presentation:

> Bipolar patients present with symptoms in discrete episodes of mania/hypomania and depression (…) whereas symptoms associated with ADHD follow a persistent trait-like course.[23]

However, our works also have revealed that racing thoughts are present even with a very low level of hypomanic symptoms in patients with BD with or without depressive symptoms[48] and in the general population.[46] It is interesting to note that, when considering the association of dysphoria and irritability to major depression, similar findings have been reported: ie, in cases with very mild symptoms of depression associated with hypomanic symptoms.[62] Thus, racing thoughts are clearly a much more common phenomenon than the DSM-5 classification could suggest, as they can be found in cases with very mild hypomanic symptoms, in BD but also in healthy subjects.[63] Moreover, racing thoughts may be present for a long time in youth before a first full-blown manic episode.[27] Smartphone-based ecological momentary

Table 1 Comparison of Scores of the RCTQ Three Factors (F1, F2, F3) Between Different Clinical Groups

	Healthy Controls	Euthymics Bipolar	Pure Depression	Non Pure Depression	Mixed Depression	Mixed Hypomania	Pure Hypomania	Inattentive ADHD	Combined ADHD	ADHD+ Bipolar
Healthy controls		= F1 = F2 = F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3			
Euthymics bipolar			< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3
Pure depression				< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3	< F1 < F2 < F3			
Non pure depression					= F1 = F2 = F3	= F1 = F2 = F3	< F1 = F2 = F3			
Mixed depression						= F1 = F2 = F3	< F1 = F2 = F3			
Mixed hypomania							< F1 = F2 = F3			
Pure hypomania								= F1 = F2 = F3	< F1 < F2 < F3	< F1 < F2 < F3
Inattentive ADHD									< F1 < F2 < F3	< F1 < F2 < F3
Combined ADHD										= F1 = F2 = F3
ADHD+ bipolar										

Notes: To read the table: < F1 in an intersection case means that the F1 score in the group on the line is significantly lower than the F1 score in the group of the column. = F2 in an intersection case means that the F2 score in the group on the line is not significantly from the F2 score in the group of the column. The results are extracted from two studies (references 48 and 50) with different samples. Non pure depression means depression with minimally hypomanic symptoms.

assessment could be a pertinent method to capture racing thoughts in ecological settings in people with BD with subthreshold symptoms who do not meet the criteria for a full-blown mood episode.[64]

Finally, one differentiating point between racing thoughts in hypomania and ADHD could be their subjective functional impact. The score of the hypomanic patients on the second factor of the RCTQ, labelled "burden of thought overactivation", which conveys the negative impacts of racing thoughts, are much closer to the scores of euthymic and control subjects than the scores of the first and third factors which conveys more positive aspects.[48] It has been shown that subsyndromal hypomanic symptoms appear to enhance psychosocial functioning in bipolar-II patients.[65] As we developed elsewhere,[32] in hypomanic states, it is possible that an inverse U-shaped relationship between racing thoughts and well-being/functioning. In mild hypomania, the cognitive ability to process new thoughts is well balanced with the speed of thinking: one is therefore not overwhelmed and the experience is that thinking is fluid and pleasant. By contrast, in more severe hypomanic states, the cognitive ability to process new thoughts is overwhelmed by an excessive acceleration of thought production and the subjective experience is unpleasant. This model is supported by a recent latent class analysis on eight binary self-reported symptoms of manic and irritable mood. This study showed that patients in the "focused creative" latent class have more racing thoughts than patients in the "minimally affected" latent class but less than the patients of the "inactive restless" or "active restless" or "extensively affected" latent classes.[66] In our work, when we compared BD and ADHD,[51] the scores were overall higher on the three factors of the RCTQ in ADHD. In

addition, scores between ADHD and hypomania tended to differ more on the second RCTQ factor (burden of thought overactivation) than for the first and third factor. This supports the view according to which racing thoughts in ADHD might be more overwhelming than in hypomania. This is in agreement with our perception as clinicians: moderately hypomanic patients do not complain about racing thoughts as the experience is pleasant, convey the notion of fluidity and the feeling of a very efficient mind which inflates their self-esteem. On the contrary, our experience with adults with ADHD is that they complain about their overactive mind, using metaphors such as "I wish I had a stop button" and linking it to the highly unpleasant feeling of mental exhaustion. As written by:[23]

> Adult patients with ADHD typically experience a distracted type of ceaseless mental activity and wandering mind (everyday thoughts flitting from one topic to another), whereas in BD thoughts may be "racing" and may be perceived as particularly sharp or "on the ball".

Concerning verbal fluency tasks, there was no difference between euthymic people with BD and controls. In addition, we found that hypomanic patients with BD had a similar word rate than healthy controls, but in the unconstrained (free) condition, they switched more often and had lower semantic cluster ratios than controls, supporting the view of an over-activation of the semantic network.[58] Similar to self-reported racing thoughts using the RCTQ, we found that verbal fluency performance may be different when patients present with very mild hypomanic symptoms, associated or not with depression.[57] In ADHD, we found many similarities with results in BD: akin to the results for self-reported racing thoughts, patients with BD and hypomanic patients with BD switched more often from a conceptual unit to another in the unconstrained (free) condition of the task,[50] but this was not found in euthymic patients with BD, whose performance resembled that of healthy controls.[57] This is consistent with the lack of difference between ADHD alone and ADHD + BD in both self-reported racing thoughts and the number of switches in the free condition of verbal fluency tasks.[50] Therefore, these results may lead to focus on the episodic nature of BD as opposed to the lifelong presentation of ADHD symptoms as a way to distinguish them.[23] However, we argue here that this should be nuanced. Firstly, modification of verbal fluency measures may occur when patients present with mild hypomanic symptoms[57]. Secondly, patients with BD present with frequent subthreshold symptoms,[27,63] whereas people with ADHD may develop a waxing and waning evolution.[31] This perspective therefore differs from the classic perspective according to which ADHD is a constant and stable clinical state in adult subjects. However, from a neuropsychological standpoint, we found one distinguishing feature between ADHD and hypomania: hypomanic patients with BD had larger phonological clusters and higher ratio of phonological clusters compared to the ADHD group. In the experimental conditions of the verbal fluency tasks,

> Lexical search strategy in hypomania is based on phonemic similarities (eg., rhymes) rather than semantic-relatedness (eg., subtypes of animals), resulting in greater and larger phonological cluster compared to ADHD[50]

Which is very evocative of (hypo)manic speech peculiarities.[67] Yet, how can one rely on this finding to discriminate between ADHD and BD in clinical settings? For most clinicians, speech peculiarities, such as puns and alliterations, evocative of flight of idea, can be easily detected during a clinical interview with a patient in a manic state. However, the phenomenon is more subtle and less visible during a moderate hypomanic state and it is exactly in these cases that the differential diagnosis with ADHD is more difficult.

Importantly, from a mechanistic standpoint, even though there might be a shared mechanism of over-activation of the semantic network that subtends thinking and language peculiarities in BD and ADHD, the phonological specificities of hypomanic word production in verbal fluency tasks suggest that there are differences as well. Consistently, different patterns of correlations were found between self-reported racing thoughts and verbal fluency measures in BD and in ADHD. In hypomania, correlations concerned mainly the letter condition, whereas in ADHD they referred only to the semantic condition.[50]

Finally, while we focused in this review on racing thoughts only, we should mention that other psychological dimensions related to racing thoughts might also be found in both BD and ADHD. For instance, emotional dysregulation is not included among the diagnostic criteria of ADHD nor BD[11] but it is a core symptomatic domain in adult ADHD[68]

and BD. Interestingly, comparative studies have reported that in euthymic patients with BD, emotion responsiveness is higher than in controls but lower than in patients with ADHD, whereas emotion lability does not differ between the two clinical groups.[69] It is worth highlighting that emotional dysregulation is a core dimension of borderline personality disorder which is highly comorbid with both ADHD[70] and bipolar disorder.[71] Yet, a recent update about the links between bipolar disorder and borderline personality disorder did not mention the issue of ADHD.[72] It is also important to highlight that we found higher self-reported racing thought scores in the ADHD-combined group relative to the ADHD-inattentive group. The link between affective dysregulation and hyperactivity has been reported in the combined ADHD presentation only.[52,53] Another aspect related to racing thoughts is creativity. The relationship between creativity and BD has been frequently discussed with some reviews pointing to a possible contribution of mildly positive mood states[73] and to the fact that "three core features of the creative process – fluency of association, use of cognitive imagery and positive affect are commonly reported".[74] In a qualitative study exploring the links between the phenomenology of creativity and bipolar disorder, four key themes were constructed to reflect and convey the collective accounts: two of them were strongly related to the role of racing thoughts, one labelled "high mood leads to an expanding mind" and the other "full steam ahead".[75] Similarly, in a qualitative investigation of successful adults with ADHD,[76] the first of the six core themes the authors found was labelled "cognitive dynamism". Several sub-themes defined cognitive dynamism, among them divergent thinking:

> The participants described divergent thinking as a natural aspect of their ADHD. They reported being swamped by ideas that fleeted from one to the next or being "outside-the-box" thinkers,….

Divergent thinking seems to be a key component, but a recent review[77] pointed that most studies find evidence for increased divergent thinking for individuals with high ADHD traits (subclinical) but not for those with the disorder (clinical). Hence, in ADHD but also in hypomanic states, mild overactive states are better than severe overactivation.

We must also[78] acknowledge some limitations of our studies. The sample sizes were limited, patients with BD were taking psychotropic medications, whereas most patients with ADHD were medication free and had higher IQ than patients with BD and healthy controls (although there was no difference in the number of years of education).[50,51]

Conclusion

Our works suggest that racing thoughts are enhanced in ADHD and in hypomanic phase of BD, whereas in euthymic patients with BD racing thoughts are similar to that reported by healthy controls. Concerning word production in verbal fluency tasks, we found many similarities between hypomania and ADHD with one clear difference: the lexical search strategy found in hypomania is based on phonemic similarities rather than semantic relatedness in the semantic task. However, this distinction may be difficult to notice in clinical settings. The main landmark to distinguish them remains the episodic nature of racing thoughts in BD as opposed to the lifelong presentation of ADHD symptoms, a dichotomized view that is nevertheless far from clear-cut in clinical practice. Given the high heritability of the two disorders[6,13] and their high level of comorbidity,[18,19] there are strong arguments to consider that common family factors[22] are behind this comorbidity and more specifically genetic factors.[21] However, we must also consider that genetics is not the only determinant and both BD[79] and ADHD[78] are associated to a higher level of childhood adversity, even if the causality is not always unidirectional.[78] Finally, even if there is still a long way to understand the brain mechanisms of ADHD[80] and BD,[81] understanding the mechanisms by which pharmacological treatment for ADHD and BD work may help refine treatments for both.[82]

Disclosure

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