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## Shadows and darkness in the brain of a genius: Aspects of the neuropsychological literature about the final illness of Maurice Ravel (1875–1937)

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### Summary

In 1948 the famous French neurologist Théophile Alajouanine published the article “Aphasia and artistic realization”, a landmark in the field of research about aphasia, which discussed the case of the composer Maurice Ravel (1875–1937). Since then, many researchers have explored the final illness of the composer. In 2003 *Medical Science Monitor* published 2 articles about the case. In this article we intend to present works published on the Ravel case, to discuss them, and to suggest a general overview on the topic.

Many hypotheses have been proposed by researchers, but complete diagnosis is still an enigma, since no post-mortem was made. The most up-to-date perspective seems to point to comorbidity of superimposed elements, which might date back to the composer’s fragile youth.

**key words:** aphasia • music • brain • Ravel • Alajouanine

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## BACKGROUND

In 1948 Théophile Alajouanine, an eminent neurologist of the last century, published a very relevant article about aphasia and artistic creation, a landmark publication on this topic, concerned in part with Ravel's final illness. Researchers have been studying the Ravel case since 1948. A complete diagnosis of Ravel's final illness is still an enigma, since no post-mortem was performed; moreover, some documents concerning Ravel's health during the war years – his health had been fragile since his youth – are situated in the Army Medical Archives at Limoges, and are inaccessible until 2025.

After some remarks about Ravel's personality, we shall review the neuropsychological literature produced about the case, discuss it, and provide a neuroscientific perspective on the tragic decline of a genius.

In 1932 Ravel was injured in a taxi accident in Paris; some months later he wrote to De Falla that the accident "...was not so serious: chest bruises and some facial cuts. Yet I was incapable of doing anything, except sleep and eat" (Baeck) [1]. After 1932, relevant events can be traced in Ravel's life to reveal the progressive decline leading to his death in 1937.

## ASPECTS OF THE PERSONALITY OF MAURICE RAVEL

Ravel was a brilliant, intelligent, ironic, self-controlled, shy person, revealing obsessive personality traits – constant striving for order, and perfectionism (Achache) [2] – as confirmed in his letters. From his letters we may also deduce that his intelligence was analytic-speculative, with a tendency to classify and to isolate individual elements for use in methodical intellectual construction. He tended to be ruggedly individualistic, his relationships with others were social but distant, and his choice of friends was based on affinity but did not imply emotional reciprocity. He was childish, a dandy, loved beauty, and he was keen on fashion (Mahler) [3] and on the inventions of the Twentieth century (Mercier) [4]. He was an intellectual dandy too – unusual artistic contexts excited him, such as Japanese art or jazz, (Léon) [5]. Ravel's life and artistic production were deeply linked to his childhood memories: little wooden horses, little mechanical robot dolls – many of the ornaments in Montfort L'Amaury are reminiscent of childhood memories. Infancy had a great influence on his musical processes, as demonstrated by some of his works: *Ma Mère l'Oye*, *la Ballade de la Reine morte d'aimer*, and *l'Enfant et les Sortilèges* (Mercier) [4].

Ravel's personality was greatly influenced by his mother. She was of Basque origin, and infused Maurice with Basque (and Spanish) traditions (Léon) [5]. She died in 1917 at the age of 77; her death plunged him into a crisis that lasted many years (Colette et al., 1938) [6], and may have had consequences for Ravel's depressive moods. The composer's attachment to his mother was so deep that he concealed his military enrolment from her in 1916. Her death came during the First World War, when Ravel was experiencing health problems: he was physically weak, suffered from heart hypertrophy and insomnia, and experienced constant sensations of anxiety, anguish, sadness and apathy, and was operated on, probably due to peritonitis. He did not want to return to the family apartment after her death; it took him

three years to return to work, and a number of letters written after her passing reveal his sadness and despair.

His mother was the only great love of his life: Ravel never married, and no official mistress is known (Long) [7]. He was assumed, but never proven, to be homosexual; he never had room to love a woman (Long) [7]. He had many female friends (Mercier) [4] but never had a relationship with a woman. The musician wrote in 1919: "We are not made for marriage, we artists. We are rarely normal and our life is even less normal" (Mercier) [4]. However, some poems that Ravel set to music betray strong sensuality: the sensual words and sounds in *Songs Madécasses*, in *The Magic Flute (Shéhérazade)*, and some of the *Cinq chansons grecques* (Mercier) [4].

One might suppose that music was sublimation for him, or that he inhibited his sexual drives, turning his impulses into precise and obsessive musical activity. The lack of a nurturing figure weighed on him. His housekeeper, Madame Revelot, was like a second mother, and during Ravel's final illness she was devotedly at his side (Mercier) [4]. Ravel said little about his father, Joseph, although his influence on the composer's personality was important; he was an engineer of Swiss origin – it should be noted that Stravinsky described the musician as a "Swiss clockmaker" because of the precise complexity of his music. His father was a man with many interests, and Maurice inherited his taste for mathematics and new technologies (Mercier) [4]. Ravel's brother, Édouard – an engineer – was three years younger; the two were very attached, and lived together in the family home until the death of their mother. When Édouard married, Maurice had great affection and love for his sister-in-law. During Ravel's illness, Édouard gave Maurice his total dedication and support (Achache) [2].

## MATERIAL: NEUROPSYCHOLOGICAL LITERATURE ON THE FINAL ILLNESS OF MAURICE RAVEL

Many articles have been published in recent decades about Ravel's final illness. The most important is Alajouanine's famous study published in *Brain* in 1948. Researchers have attempted to build diagnostic hypotheses, the subject of this overview. In this paper we analyze the neuropsychological literature on Ravel's final illness, report the main scientific studies and discuss the sources.

The article by Alajouanine [8] is the main historic landmark in the study of the case and in research into aphasia and artistic creation. Alajouanine investigated three areas: writing, music and painting. The writer uses everyday language, which may be destroyed by aphasia, as Alajouanine reports in the case of Larbaud, afflicted with Broca aphasia, who experienced a rehabilitation: written language followed partial restoration, reading became possible again, but literary production was impossible. Alajouanine also reports on the case of Maurice Ravel, struck by Wernicke's aphasia of moderate intensity with apractic components: oral and written language were impaired, recognition of tunes was good, musical dictation defective, piano playing difficult. The third famous case concerns the painter Gernez (1888–1948), affected by Wernicke's aphasia: he became sad and irritable, but his art remained excellent, even more intense, but less poetic, more concrete and realistic (Boller

et al., 2005) [9]. The consequences of the illness on artistic creation were different in each of the three artists, depending on the different nature and technical means of expression in their domains of creativity, and concerning different psychophysiological processes and “technical” brain localizations (Alajouanine) [9]. Shortly before his death, Alajouanine put forward the hypothesis of Pick’s disease (Cytowic) [10].

The first study after Alajouanine is by Kerner [11], who affirmed that Ravel’s symptoms of Pick’s disease and pre-senile dementia could be dated from 1918, and could be the origin of the obsessive structure of *Boléro*. The article reveals biographic mistakes – no sources date symptoms of pre-senile dementia from 1918, and it seems excessive to suggest that *Boléro* displays obsessive symptoms of Pick’s disease – once these symptoms are observed, Pick’s disease can be clearly diagnosed, but Ravel continued to produce until 1933.

The tragedy of Ravel’s final years was “conception without creation” – imprisoned in aphasia, he could no longer translate music from his mind into musical symbols (Cytowic) [10]. The role of aphasia on artistic creation can be studied with reference to interactions between a spared musical system (which we know to depend on the right hemisphere) and an injured linguistic system (usually lateralized in the left hemisphere) (Cytowic) [10]. Cytowic reports details of the psychopathological situation of Ravel’s health, which was unstable throughout his life, and mentions research by Brown-Séquard, who was one of the first neurologists to explore the duality of the cerebral hemispheres.

The decade of the 1980s saw a significant amount of correspondence between Dalessio, Christy, and Wainapel. Dalessio wrote in 1984 [12] that from 1931–1932 onwards the composer demonstrated insomnia, fatigue and decreased creative impulse (symptoms of insomnia and fatigue actually date back as far as 1914) and that he never experienced symptoms of cerebrovascular disease – in fact the role of the taxi accident might demonstrate the opposite. Moreover, Dalessio suggested in 1985 [13] the hypothesis that at the beginning of his presenile dementia the composer’s musical problems were expressive, and that he later became unable to produce and to comprehend music – which is not correct, for music comprehension was preserved until his last year, as Alajouanine noted in 1936. A tendency toward disorder appeared in the composer’s behaviour in his later years, something peculiar in a man whose personal and artistic life had been characterized by precision and lucidity. Deterioration of the mental faculties must have been particularly distressing to such a person (Christy) [14]. Moreover, Ravel’s amusia was not as global as Dalessio suggested, but it should be labelled as expressive amusia, or even better, dysmusia, since his receptive musical abilities were largely intact (Wainapel) [15]. Syphilis was excluded (Dalessio) [12].

During the same period, Shafer [16] published an article in the field of legal medicine concerning dementia and brain injuries, also citing the Ravel case. The article was criticized by Mercier for a number of issues [4]: Shafer wrote that Alzheimer’s disease showed in Ravel through the symptoms of insomnia, hypochondria and fatigue – which, on the contrary, had characterized Ravel’s health since the years of the First World War. Shafer also reported that: 1) the taxi

accident might have damaged his intellectual functions – whereas Alajouanine claimed on the contrary that memory, judgment, aesthetic taste and musical thought were preserved; 2) after the taxi accident Ravel composed only two short melodies – *Don Quichotte à Dulcinée*, (three – not two – songs) were written before the taxi accident; and 3) Shafer affirms that agnostic components were also present, while in fact they were not. Of great interest is the hypothesis concerning progressive aphasia without generalized dementia, mentioned by Henson [17], with specific reference to studies by Mesulam [18], who described six patients suffering from slowly progressive aphasia, but without generalized dementia. The Ravel case might fall into this group – the same pathology has been described in two patients who were autopsied without showing any features of Alzheimer’s or Pick’s disease. It is common knowledge that minor head injury can be linked with deterioration of already present brain disease (Henson) [17]. With modern methods Vincent would not have operated (Henson) [17]. A relevant part of the article deals with aphasic, apraxic, agraphic and amusic components of Ravel’s health.

The reference to Mesulam is also reported by Signoret [19], who proposed a diagnosis of localized atrophy due to cerebral degeneration with subcortical gliosis without dementia, which is among the most original diagnostic hypotheses. The article presents some biographical mistakes. Signoret writes that in 1932 Ravel was unable to sign his autograph, when in fact his letters dated 1932 do not show any writing deficiencies, and claims symptoms of writing deficiency in music dated 1931–1932, when the writing of the *Piano Concerto in G major* (1931) is normal. Signoret, along with Mahieux and Laurent [20], were the first researchers to suggest subdural hematoma caused by the taxi accident. Mahieux and Laurent [20] criticized the thesis by Alajouanine concerning brain atrophy, citing its incompatibility with lack of disorientation and memory loss, which did not characterize the composer’s pathology.

The two major works about the Ravel case are the theses by Achache [2], and by Mercier [4]. In his thesis, Achache gives details of Ravel’s personality and exhaustively reports on details of his health in his final years. It is the only study to report the full text of the three sessions of Alajouanine’s examination of Ravel in 1936. The author mentions that the content of Alajouanine’s 1948 article was published by Gallimard in *Les Cahiers de la Pléiade* in 1949, and in *L’Aphasie et le langage pathologique*, published by Baillièere-Paris in 1968, in which he mentions the 1936 psychometric assessment and the report by Signoret [19] and Alajouanine [8] concerning language, reading abilities, playing, agraphic and aphasic components. In the discussion – the most interesting part of Achache’s work – the author mentions that aphasia is not necessarily present in apraxic patients, and approaches different aspects of amusia and its methodology of investigation. The angular gyrus should have been affected, suggesting brain degeneration associated with agraphic, apraxic, and aphasic components (Achache) [2].

The most important contribution to the Ravel case is Mercier’s thesis [4]. In the first section Mercier deals with details concerning Ravel’s mother, father and brother. His relationship with his mother was the most important of Ravel’s life. His father, an engineer, contributed to the composer’s interest in

technology and 'modernity', and his brother, who was very attached to him, took care of him during his illness. Mercier reports on Ravel's fragile health since his youth, and mentions that the years following his mother's death were characterized by depression, insomnia and inability to compose. In 1921 he was permanently exempted from national service due to inadequate physical conditions and for health reasons. In the second section, concerning his final illness, Mercier thoroughly describes events between 1933 and 1937, and the diagnostic investigation by Alajouanine. Mercier's diagnostic conclusions were bilateral atrophy with apraxic components, Wernicke's aphasia, and apraxia without agnostic components. Latent degeneration previous to the taxi accident can be supposed, and Ravel's obsessive, depressive, anxious personality traits might have worsened the situation. The third section concerns the composer's psychological world – family, relationships with women, infancy, interest in mechanical toys and fairytales, and his suspected homosexuality. The thesis reports on important documents, including military documents about the young Ravel's health, excerpts from Alajouanine's reports, Vincent's surgical protocol, and Dr. Desjardins's medical report following the taxi accident.

The author who perhaps contributed the most to study of the neuropsychological aspects of the Ravel case is Erik Baeck. The hypothesis presented by Baeck in his early articles concerns corticobasal degeneration. This hypothesis was excluded by Amaducci, Grassi, and Boller [21], who had observed that during his 1935 trip to Morocco, Ravel performed movements with precise manual coordination, hardly compatible with corticobasal degeneration, even if the composer exhibited a lack of energy and decreased vitality during this trip (Otte et al., 2003) [22]. In 1996, Baeck [1] mentioned the opinion of the neurologist Van Bogaert, who supposed that Ravel suffered from left temporo-parietal meningioma, reported that the taxi accident might evoke normal pressure hydrocephalus, and mentioned the hypothesis based on the basis of Mesulam's research on progressive aphasia without dementia. De Martel, the neurosurgeon who carried out the same radiological examinations as Vincent did, suggested that Ravel was born with a deficiency in one of the cerebral hemispheres, while the other one functioned perfectly until the moment when other accidents occurred. The best specific report about Ravel's death was written in 1997 by Baeck, in which he once again suggested the hypothesis of corticobasal degeneration. One of the most important questions raised by Baeck (1997) [23] is why was Ravel operated on. Demuth [24] wrote that a brain tumor was diagnosed, Long [7] reported that Vincent intended to verify if there was a brain tumor, and Roland-Manuel [25] wrote that some of the medical doctors consulted excluded the diagnosis of tumor. It is interesting to observe that while Orenstein (1989) [26] had stated that Vincent succeeded in equalizing the level of the cerebral hemispheres, Baeck [23] firmly stated that the surgery report (see Note 1) vouches that the surgeon had not succeeded in doing so. The date of the surgery is also the subject of dispute – December 17<sup>th</sup> or 19<sup>th</sup> of 1937? The diagnostic hypothesis of corticobasal degeneration without dementia was advanced by Baeck in 1998 [27], when he wrote that loss of movement control, defective oculomotricity, and an episode of motor difficulty (see Note 2) might confirm extrapyramidal syndrome – even if other diagnostic hypotheses should be taken into consideration, such as

tumor, congenital hydrocephalus worsened by age, hydrocephalus caused by the taxi accident, subdural hematoma, progressive aphasia, and Alzheimer's and Pick's diseases.

In 2002 a dispute of great relevance occurred between Baeck, Marins, Grassi, and Boller, also with reference to some hypotheses presented by Amaducci et al. [21]. Suggesting a diagnosis of progressive degenerative disease with ideomotor apraxic components, Amaducci et al. [21] had observed that *Piano Concerto for the Left Hand* and *Boléro* show right hemisphere functional characteristics and demonstrate the influences of Ravel's illness on his creativity in his later years – his themes are shorter and less elaborate, while his orchestration uses a great variety of timbre. This might suggest that, while avoiding the difficulties of elaborating complex structures, Ravel adopted alternative uses of timbre and effects, and that the *Concerto for the Left Hand* is music predominantly originating in the right hemisphere. Amaducci and Marini [28] had already affirmed that the different musical structures of the two piano concertos might demonstrate the worsening condition of the left hemisphere, demonstrating right hemisphere activation. These hypotheses, however, do not match with the dates of the concertos, which are almost contemporary. The hypothesis of right hemisphere activation is also mentioned by Tudor et al. (2010) [29], who wrote that Ravel's illness might demonstrate the role of the right hemisphere in music composition – Ravel's left hemisphere was damaged, and in his later production one can feel the predominance of changes in timbre (right hemisphere) in comparison with few changes of melody (left hemisphere). In their correspondence, Marins, Baeck, Grassi and Boller commented negatively on the suggested relationship between Ravel's illness and production in his final years. In reply to Amaducci et al. [21], Marins [30] stated that it is wrong to consider *Boléro* musically poor – its melodic richness is mesmerizing, and is built on highly innovative elements. Even Baeck [31] criticized Amaducci et al. [21], saying that the *Piano Concerto for the left hand* was completed only one year earlier than the *Piano Concerto in G major*, and that Ravel's late composition *Don Quichotte à Dulcinée* ought to reveal similar features of latent left hemisphere disease, which is not the case. Moreover, the final pages of the *Piano Concerto for the Left Hand* are as calligraphic as those of the *Piano Concerto in G major*. With reference to the hypothesis of Amaducci et al. [21] that the right hemisphere is activated in timbre processing and rhythm is associated with the left hemisphere, Baeck [31] argues that they forget that this hemispheric specialization is based on experimental data concerning perception of music, but not its creation. With specific reference to *Boléro*, Cybulska [32] wrote that the throbbing rhythms of obsessive hallucinatory insistence are a confession of the nightmares and anguish that tormented the composer, and might be interpreted as a musical perseveration, as a consequence of frontotemporal atrophy. Perseveration is symptom of fronto-temporal atrophy, and *Boléro* could be related to it after the emergence of the first signs. On the contrary, Baeck stated [33] that perseveration appears late in these diseases, whereas Ravel lived for another nine years after *Boléro*; moreover, patients with frontotemporal dementia are not aware of their perseveration, while Ravel described this work as a monotone repetition imposed to the point of discomfort. With reference to the correspondence between Marins, Baeck, Grassi and Boller, in 2002 Grassi and Boller [34] replied to Marins [30] and to Baeck [31]. They



agreed with Marin's comments, and reported that degenerative brain disease can be present years before symptoms become obvious; moreover, researchers report cases of patients with improved artistic production despite cognitive impairment (Miller et al., 1996) [35].

Warren [36] and Otte et al. [22] also denied the hypothesis of the influence of the illness on *Boléro* and on the two Piano Concertos – *Boléro* demonstrates Ravel's interest in technical 'new models' of making music, as do the jazz elements of the *Piano Concerto for the Left Hand*, the sketches for which were written before the brain impairment.

In 2005 Baeck [37] hypothesized that Ravel's illness might be Pick's complex, which includes fronto-temporal dementia, primary progressive aphasia and corticobasal degeneration, a hypothesis also considered by Cardoso [38]. For a complete understanding of Ravel's final illness, one should not, however, forget the frequent ups and downs of his last years. Tiredness, cerebral anemia, amnesia symptoms in 1927, and, on the other hand, the improvements in his health which allowed him to compose his final masterpieces and to take the trip to Morocco and Spain, and the final decline around 1936, when his behavior was apathetic and he had a frightened blank expression, giving the impression of being at risk of disintegration (Baeck) [31]. In 2010, Deborah Mawer edited "Ravel Studies" with a further and exhaustive tribute by Baeck. Baeck reported in a great degree of detail on Ravel's health, certificates and examinations by physicians, and the craniotomy. Of peculiar biographical interest is the mention that the famous episode of the pebble (see Note 2) might not have taken place at Saint-Jean-de-Luz, since Ravel wrote to Gaudin on 2<sup>nd</sup> August 1933 from Le Touquet on the Channel, where he was the guest of friends: "You won't see me this year at Saint-Jean, alas!" Ravel did not complain of stiff neck, dizziness or headache, nor did he lose consciousness, as would be the case with whiplash, and did not suffer either gait disturbance or incontinence, as would occur in normal pressure hydrocephalus or subdural hematoma (Baeck) [33]. Recent developments in molecular neuropathology have led to a protein-based system of neurodegenerative disorders; biochemical examinations of brain tissues have revealed accumulation of abnormal filaments of tau-proteins characterizing the so-called "tauopathies" (Baeck) [33]. The Ravel case might be considered a case of non-Alzheimer tauopathy. Baeck takes his cue from the Ravel case to explore present-day knowledge about brain hemispheres and music perception and hemisphere activation in musical abilities, and exhaustively discusses the main diagnostic hypotheses.

Of neuropsychological relevance is the citation by Boucher [39] about the funeral of Dukas (1935), where Ravel said "...I have noted a melody in my head, I can perhaps still write music" – which is of great interest, since two years before he had declared that he could no longer compose. Boucher confirms that the Ravel case is of great interest for the exploration of different areas of neuropsychology of music, citing Mesulam's theory of progressive aphasia without dementia as a possible diagnosis, and rejecting the diagnosis of Alzheimer's disease since the composer never suffered from dementia, and only a part of his cognitive functions were impaired until the very last years, as Alajouanine showed in 1948. Of biographical interest is Ravel's inheritance,

mentioned by Boucher [39] and investigated by Restagno [40], but rarely reported by sources – the composer's inheritance went to a family who took care of Ravel's father, after a legal case involving some of the composer's cousins in the fifth degree of kinship.

The major works concerning the Ravel case also include two articles by Justine Sergent (1993) [41,42]. The author is unfortunately known for the sad events which led her to commit suicide. A professor at McGill University, in 1992 a complaint was made against her for having failed to obtain ethics committee approval for some of her research, and in 1993 Principal Johnston gave her an official reprimand. An anonymous letter was sent to the Montreal Gazette, saying that Professor Sergent was a scientific fraud and undisciplined because she broke the rules. Because of the total discredit to the career, Justine and her husband committed suicide on April 1994, and were found dead after having run a hose from the exhaust pipe into their car. The two studies by Sergent take their cue from the Ravel case to explore musical processes under neuroscientific perspectives highly relevant today: brain-damaged composers (Shebalin, Shostakovich, Langlais, Britten, Gershwin), musical creativity and neuronal networks encompassing cerebral lobes, emotional, auditory, motor, production processes and the relationship between music and the brain, studied in normal subjects and in cases of brain impairment. Neuroimaging studies are cited, as well as an experimental protocol concerning PET parameters in professional pianists (Sergent) [42]. Cerebral structures can, when destroyed, produce aphasia or alexia, but are not indispensable to the processes of musical composition, and researchers have pointed out cases of aphasic but not amusic patients, and vice versa. Ravel's illness concerned transposition of information from the auditory and subjective domains into motor perspectives, whereas none of these modalities, considered separately, was impaired (Sergent) [41]. The author cites studies by Mesulam which help us to understand the etiology of Ravel's illness (Sergent) [41], reporting that the first signs of the illness might date back to 1933, and were agraphia, alexia, apraxic signs, and aphasic – when in actual fact, symptoms may be dated back to some years earlier. *Don Quichotte à Dulcinée* might have been written by "a friendly hand", since differences in writing may be noted between the score of *Don Quichotte à Dulcinée* and Ravel's previous works (Chalupt and Gerar, 1956) [43]. This opinion was, however, rejected by Rosenthal, who, in a personal letter written in 1992, wrote that this song cycle was written by the composer without any help (Sergent) [42] at a time when his musical creativity was preserved. Even Henson [17] reported that orchestral holographs are in Ravel's hand, but Lucien Garban and Manuel Rosenthal assisted in transcription, and wrote down the orchestration of *Ronsard à son âme* following Ravel's "laborious dictation" in February 1933. *Don Quichotte à Dulcinée* was part of a competition dated 1932, involving De Falla, Ravel, Milhaud, Delannoy and Ibert, concerning performance in Pabst's film "Don Quixote" with Chaliapin. As he was unable to deliver the work in time because of the European tour of his Piano Concerto in G, Ravel's composition was passed up and Ibert's work was chosen instead. Despite Pabst's rejection, Ravel's work was performed on December 1934.

No particular new perspectives come from Alonso and Pascuzzi [44], or from Dubb [45]. Alonso and Pascuzzi

reported the core of the article by Alajouanine [8] and the surgical notes by Vincent, and recalled that on the weekend preceding the craniotomy, Ravel listened to a broadcast of a Ravel festival, but after *Boléro* he burst out laughing, saying: "What a good joke I have played on the musical world!" The article mentions the effect of the illness of Ravel's father, and says that Alajouanine abandoned his early diagnosis in favor of Pick's disease before his death. The short contribution by Dubb, based on a scant bibliography, mentions the decoration from the King of Belgium and the honorary Doctorate from Oxford University received by Ravel (details scarcely reported in the sources)- and Ravel's supposed Jewish origins. With reference to this last point, Ravel wrote to Hans Brückner in 1937 that he was astonished to find his name among Jewish composers cited in his book "Judentum und Musik", stating that he was a Catholic and asking Brückner to remove his name from the book. Brückner answered that he had already stopped the third edition of the book, and would correct supplements to previous editions (Orenstein) [26].

During the following years innovative hypotheses were presented by Otte et al. [22], Otte et al. [46], Cardoso [38], Seeley et al. [47], and by Warren and Rohrer [48].

A complete diagnosis should consider superimposed elements. It might be hypothesized that several pathologies affecting the composer's brain were 'superimposed', a perspective that takes into consideration diagnostic hypotheses proposed over the years and provides a wider understanding of the case (Otte et al.) [22]. Among the diagnostic hypotheses, chronic endocrine disease has been suggested (Otte et al.) [22] – Ravel's infantilism and abstinence from sexual contact with women might indicate chronic endocrine dysfunction. In any case, the taxi accident played a key role, and may have triggered pre-existing symptoms. A mild concussion did occur during the taxi accident, and concentration and attention deficits and loss of ability to complete compositions are also symptoms of mild to moderate brain injury (Otte et al.) [22]. Symptoms from the accident might also include whiplash syndrome with headache, vertigo and disturbances in concentration and attention, as affirmed by Otte et al. in a brief but relevant communication, published in *Medical Science Monitor* in 2003 [46].

The hypothesis of tauopathy characterized by deposition of doublet paired helical filaments – the term for "Pick's complex" – has also been raised (Cardoso) [38]. Tauopathies are neurodegenerative diseases involving pathological aggregation of tau protein in the human brain. Most patients with this condition develop overlapping disease features, leading to suggestion of the above-mentioned term of Pick's complex. Ravel presented features of corticobasal degeneration, progressive aphasia and frontotemporal dementia, but failed to meet the exact diagnostic criteria for any of these conditions. Pick's complex should include overlapping syndromes of fronto-temporal dementia, primary progressive aphasia, corticobasal degeneration, progressive palsy, and the neuropathological and genetic spectrum may be observed with reference to commonalities rather than differences (Kertesz) [49].

Seeley et al. [47] mention cases of gains in artistic creativity associated with hemisphere degeneration, raising the issue of enhanced artistic creativity in Ravel's late production. They

cite Mesulam to remind us that research criteria for primary progressive aphasia allow for ideomotor apraxia within the first 2 years of symptoms. The case of Anne Adams, who developed an intense drive to produce visual art, suggests that dominant hemisphere degeneration may be associated with gains in artistic creativity. Neuroimaging analyses revealed that, despite degeneration of the left frontal-insular and temporal regions, Anna showed increased grey matter and functional enhancements in the posterior neocortex, which may have given rise to improved creativity. Grassi and Boller [34], writing in reply to Marins [30] and Baeck [31], had already reported cases of patients with improved artistic production despite cognitive impairment (Miller et al., 1996) [35], and had observed that degenerative brain disease can be present years before symptoms become obvious. In the same year and in reply to Seeley et al. [47], Sellal [50] suggested that the first symptoms of Ravel's illness were not aphasic but apraxic, and aphasic symptoms appeared when Ravel began to demonstrate difficulty finding words (1935–1936). A diagnosis of late 'anomic aphasia' and focal parietal atrophy might be more accurate (Sellal) [50].

A fascinating new hypothesis offering new perspectives concerns features of progranulinopathy (Warren and Rohrer) [48]. Progresses in the molecular basis of progressive aphasia and corticobasal syndrome might suggest a unifying hypothesis. Mutations in the progranulin (GNR) gene produce phenotypes including elements of progressive aphasia and of corticobasal syndrome and primary progressive aphasia (Gijssels et al., 2008) [51], and Ravel might have suffered cerebral TDP43opathy on the basis of a GNR mutation. Features of progranulinopathy might fit the composer's clinical spectrum – apraxia, aphasia, anomia. The onset of the disease is usually in late middle life, and the mean disease duration is 5 years with a positive family history. Patients also reveal apathic behaviors.

As far as we know, the most recent contribution is by Kanat et al. [52]. The use of timbres, careful notation and instructions to performers in *Boléro* could be consistent with the diagnosis of fronto-temporal syndrome. However, *Boléro* was composed before the onset of any symptoms of the illness, while frontotemporal dementia patients can develop visual artistic skills after its onset. The traumatic injury of the taxi accident did not precipitate the development of Pick's disease, but may be a second major factor that exacerbated an already existing brain disease, hypothesizing a situation of superimposed elements, as suggested by Otte et al. [22]. Moreover, when considering diagnosis of normal-pressure hydrocephalus and chronic subdural hematoma, it must be taken into consideration that cerebrovascular insults can lead to acute neurological signs and acute mental impairment, whereas in patients with chronic subdural hematomas, neurological signs develop over weeks. In Vincent's surgery protocol, right hemispheric subdural hematoma was not mentioned; hence the chance that the taxi accident caused a minimal left hemisphere subdural hematoma, not observed, since the surgery was a right-sided craniotomy (Kanat et al.) [52].

## DISCUSSION

In 1948 a major article was published by Alajouanine about aphasia and artistic creation, which gave rise to subsequent

research into Ravel's final illness. Researchers have attempted to build diagnoses, as discussed in this overview, but the musician's illness remains an enigma. Among the most frequently discussed questions is when symptoms of Ravel's final illness became evident. Researchers suggest different dates, as early as the composer's youth, when his fragile psychological structure might have had future consequences.

One of the most important perspectives is Alajouanine's hypothesis of Wernicke's aphasia of moderate intensity with bilateral ventricular enlargement – memory, judgment, affectivity, aesthetic taste and musical thought were preserved. At the end of his life Alajouanine suggested Pick's disease, previously excluded. The taxi accident might have played a key role in worsening a degenerative situation; however, subdural hematoma caused by the accident should be excluded, since Ravel never experienced acute symptoms characteristic of cerebrovascular disease. Moreover, concentration and attention deficits and loss of ability to complete compositions are symptoms of mild brain injury, which may be found in whiplash conditions. One of the most relevant hypotheses is corticobasal degeneration. Ravel was born with a slight deficiency in one of the cerebral hemispheres; lack of movement control and the episode of the pebble (see Note 2) might suggest extrapyramidal syndrome. Recent progress in the study of the molecular basis of progressive aphasia and corticobasal syndrome might suggest that mutations in the progranulin (GNR) gene produce phenotypes with components of progressive aphasia and corticobasal degeneration. Ravel may have suffered a cerebral TDP43opathy based on GNR mutation – the wider term of "Pick's complex" may be used, even if no precise diagnostic picture can exactly meet the diagnostic criteria for any of the conditions listed above.

Researchers have also pointed out 'expressive' amusia or dysmusia, since receptive musical skills and comprehension of musical taste were preserved. Moreover, heredity of the composer's illness (with reference to Maurice's father), atrophy caused by brain degeneration, and dysorthographic components have been considered. Vincent operated to verify if there was a brain tumor, but he did not find it, and even the hypothesis of hydrocephalus should be abandoned on the basis of the surgery protocol found in 1987 (see Note 1).

Among the components of greatest relevance, Ravel had health problems since his youth. This perspective is among the most interesting, when considering superimposed elements or comorbidity, and deserves to be explored more thoroughly.

There has been some dispute as to whether Ravel's illness influenced his creativity. The *Piano Concerto for the Left Hand* seems to reveal right hemisphere functional characteristics, while *Boléro* might be a case of musical perseveration, symptomatic of patients with fronto-temporal atrophy. The two hypotheses have been rejected by the majority of researchers. There are, however, cases of improved artistic ability despite cognitive decline, and neuroimaging analyses in the field of visual art have revealed increased grey matter in brain areas, suggesting functional enhancements, giving rise to improved creativity.

The many attempts at building a likely diagnostic hypothesis on the basis of reported symptoms witnessed by Ravel

himself, friends and specialists on one hand, and Ravel's artistic production and life on the other, end up creating a puzzle. This puzzle demonstrates just how baffling human behaviour can be in the absence of objective measures of brain structure and function. The neuroscience of music has benefitted enormously from imaging techniques used in recent decades, showing how plastic the brain of musicians can be (Munte et al., 2002) [53], and this goes hand in hand with advances in the neuroscientific study of creativity (Heilman et al., 2003) [54]. Neuropsychological examinations of the Ravel case, besides their undeniable historical interest, should serve as triggers for better comprehension of musical creation and offer important perspectives for future studies in the neuroscience of artistic creativity. The role of aphasia in Ravel's artistic output could depend on interactions between an undamaged musical system (right-sided) and an injured verbal and linguistic system (left-sided), and developments in this direction are strongly suggested. The case therefore focuses on important neuroscientific topics, which also need to be better understood from a clinical point of view – musical creativity requires the functioning of the two brain hemispheres and the exchange of information between them. Ravel's illness might have involved transposition of information from auditory, subjective perspectives into motor perspectives.

## CONCLUSIONS

Advances in understanding of the Ravel case have been made in recent years. The most intriguing and relevant conclusion might be co-morbidity of 'superimposed' components, leading to the complete worsening of his conditions. His final illness led the brilliant, bubbly Maurice to the shadows and darkness of his obscure final years, when his deepest need was Music, but Music was desperately imprisoned in his mind. Maurice abandoned life smoothly and in silence, just as smoothly and silently as the words of the French poet De Ronsard (1524–1585), set to music by Ravel in his last musical composition – his attempted orchestration of "Ronsard à son âme":

*"Amelette Ronsardelette... Tu descends là bas foiblelette pasle, maigrelette, seulette, dans le froid Royaume des Mors. Passant, j'ay dit, suy ta fortune ne trouble mon repos, je dors"* ("Sweet little soul of Ronsard...you start to descend down weak, pale, thin, alone in the cold Realm of the Dead. Follow your destiny, do not disturb my rest, I sleep").

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## NOTE

<sup>1</sup> Clovis Vicent's report of the surgery (17<sup>th</sup> December 1937): "Pre-operative diagnostic: ventricular dilatation. Right front cover, fronto-temporal based. Scalp. Complete separation of the bone. Vertical saw. Dura glued, floating. Suspension of the Dura immediately by the vessels. Opening section of the Dura. Brain collapsed, without softening aspects of the area viewed. Circumvolutions separated by edema, not atrophied. Puncture of the ventricular horn: liquid goes up if pressed. Injection of 20cc of



*water, deflates immediately. Several attempts. Finally we close the injection hole to coagulation, Dura mater is left open”.*

<sup>2</sup> Ravel while on holiday at Saint-Jean-de-Luz in June 1933 wanted to demonstrate to Marie Gaudin, a close friend, how to skim a pebble on the sea, but he struck her on the mouth instead.

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