



## Pioneers in neurology: Michel Jouvét (1925–2017)

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Michel Jouvét was born on November 16th, 1925 in Lons-le-Saunier in Jura, France, where he attended Rouget de l'Isle secondary school (Fig. 1). While his father was a medical doctor, Jouvét wished to become a naval officer but reconsidered following the fall of the French naval fleet during World War II. During the war, Jouvét fought against German occupation forces in Jura as part of the French resistance. He was incorporated as a sergeant in the French First Army and, after the Allied liberation, was promoted to the level of Alpine sergeant. He received la Croix du combattant volontaire de 1939–1945 and the Légion d'honneur for his military service [1]. Jouvét was finally convinced by his father to pursue medical training, which he completed at the University of Lyon's (now Claude Bernard University) Faculty of Medicine [2]. He supplemented his training with studies in ethnography and anthropology, a curiosity blossoming from interest in traveling abroad [3].

Upon graduating, Jouvét stayed at Lyon and began neurosurgical residency in 1951, during which he conducted neurophysiological research in the department of physiology. Studying paralyzed cats with brain stem lesions, Jouvét's first (first-authored) publication characterized caffeine's effects on cortical electrical activity [4]. In 1954, he traveled to Long Beach, California on a Fulbright fellowship to work in Professor Horace Magoun's lab with the goal of identifying brain structures responsible for arousal states. There, he developed a novel technique to implant chronic electrodes in cats to record evoked potentials and capture the electrophysiological components of classical conditioning. These techniques were also used to study attention and habituation in cochlear-evoked activity, emphasizing the role of functional recordings in correlation with psychic processes [5].

Taking advantage of Pan-American's airline ticketing policies, Jouvét traveled through Hawaii, Australia, Japan, South East Asia, India, Turkey, and Italy, before finally returning to France in late 1955 [3]. Jouvét became a medical doctor in the Faculty of Medicine of Paris in 1956, specializing in neurobiology, neurosurgery, and neuropsychiatry, and, later, became a researcher at the French National Center for Scientific Research in the Lyon Neurological Hospital's physiology laboratory in 1958 [1].

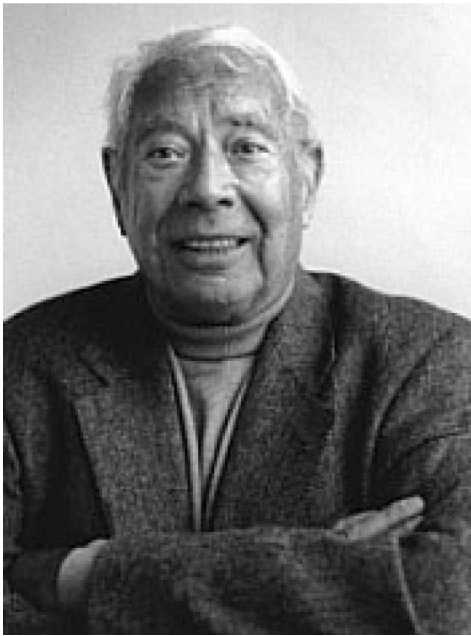
In 1959, using electroencephalographic (EEG) recordings of comatose patients, Jouvét defined a scale of consciousness ranging from fully active to a state of non-responsiveness to stimuli. This classification schema was the first subcortical neurophysiological criterion for brain death in comatose patients which is still used in principle by neurologists today [1]. Concurrently, Jouvét's studies on the sleeping patterns of cats led him to describe a third state of electrophysiological arousal which he called “paradoxical sleep”—a state characterized by inhibited muscle activity during rapid eye movement (REM) sleep [6]. Jouvét went on to detail these findings in his 1959 manuscript, *Sur un stade d'activité électrique cérébrale rapide au cours du sommeil physiologique* [7]. Jouvét classified two distinct sleep states: telencephalic sleep, characterized by slow EEG waves, and rhombencephalic (paradoxical) sleep, characterized by fast EEG waves, muscle atonia, and rapid eye movements associated with intracerebral ponto-geniculo-occipital waves close to the nucleus of CN VI. He also demonstrated the dependence of paradoxical sleep on pontine structures by removing the part of the brain anterior to the pons—a process named pontine cat preparation—as well as electrocoagulation of structures of the dorsal pontine tegmentum [1]. Along with his first wife, Danielle Mounier, Jouvét published results from these experiments in the paper *Effects of lesions of the pontine reticular formation on sleep in the cat* in 1960 [8].

Jouvét was appointed associate professor of experimental medicine at the University of Lyon in 1961. Following the observation that 80% of subjects awakened during paradoxical sleep were able to describe clear and well-constructed memories of their dreams, while subjects awakened during

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**Fig. 1** Michel Jouvét ([https://www.typtotex.hu/en/author/340/jouvet\\_michel#](https://www.typtotex.hu/en/author/340/jouvet_michel#))

slow-wave sleep had poor memories of their dreams, Jouvét set out to further interrogate the link between dreaming and sleep states [1]. He noted that when small lesions in the pontine tegmentum were present, cats began to move during periods of paradoxical sleep without reacting to outside stimuli. Jouvét called these movements, which were often similar to walking, hunting, or grooming, “oneiric behavior”—behavior related to dreams—since it seemed as if the animals were acting out their dreams. This research laid the groundwork for the identification and description of REM sleep behavior disorder, the human equivalent of the uninhibited sleep movements observed in cats, in 1986 [9]. In line with the previous work applying animal model physiology to human disease, Jouvét also conducted the early research on modafinil, a stimulant used to treat narcolepsy, chronic fatigue, and idiopathic hypersomnia in humans, after it was shown to maintain a long-term calm wake state in cats [10].

Jouvét’s accomplishments include being appointed head of the Neurology Department at the Lyon Neurological Hospital in 1962 as well as becoming a research director at the French Institute of Health and Medical Research in 1966 [2]. He was named Professor of Experimental Medicine at the Faculty of Medicine and Head of the Department of Neurophysiology of the Claude Bernard University of Lyon

in 1968 and, later, Professor Emeritus. Jouvét published many books over his academic career including his fiction novel *Le château des songes* (The Castle of Dreams, 1992), which tells the story of Count Hugues la Scève, a scientist in eighteenth century France who records many of his own dreams in addition to his experiences studying the various aspects of dreams. He received numerous awards including the appointment into the Academy of Science in France in 1977, as well as both the Gold Medal of the French National Center for Scientific Research and the Distinguished Scientist Award of The Sleep Research Society of the United States in 1989. He passed away at the age of 91 in Villeurbanne, France, on October 3rd, 2017.

### Compliance with ethical standards

**Conflicts of interest** The authors declare no financial or personal conflicts of interest in the submission of this manuscript.

### References

1. Cespuglio R (2017) In Memoriam: Michel Jouvét (1925–2017). *Sleep Vigilance* 1(2):119–122
2. Slotnik D (2017) Michel Jouvét, who unlocked REM sleep’s secrets, Dies at 91. *The New York Times*. <https://www.nytimes.com/2017/10/11/obituaries/michel-jouvet-who-unlocked-rem-sleeps-secrets-dies-at-91.html>. Accessed 29 Oct 2018
3. Jouvét M (2004) How sleep was dissociated into two states: telencephalic and rhombencephalic sleep? *Arch Ital Biol* 142:317–326
4. Jouvét M, Benoît O, Marsalon A, Courjon J (1957) Action de la caféine sur l’activité électrique cérébrale. *CR Soc Biol* 151:1542–1545
5. Hernandez-Peon R, Scherber H, Jouvét M (1956) Modification of electrical activity in the cochlear nucleus during “attention” in unanesthetized cats. *Science* 123:331–332
6. Jouvét M, Michel F, Courjon J (1959) Sur un stade d’activité électrique cérébrale rapide au cours du sommeil physiologique. *Comptes rendus des séances de l’Académie des Sciences* 6:1024
7. Jouvét M, Michel F, Courjon J (1959) Sur la mise en jeu de deux mécanismes à expression E.E.G. différente au cours du sommeil physiologique chez le chat. *C R Hebd Seances Acad Sci* 248(21):3043–3045
8. Jouvét M, Mournier D (1960) Effects of lesions of the pontine reticular formation on sleep in the cat. *C R Seances Soc Biol Fil* 154:2301–2305
9. Sallanon M, Sakai K, Buda C, Puymartin M, Jouvét M (1986) Augmentation du sommeil paradoxal, induite par l’injection d’acide iboténique dans l’hypothalamus ventrolatéral postérieur, chez le chat. *C R Acad Sci III* 303(5):175–179
10. Lin JS, Roussel B, Akoaka H, Fort P, Debilly G, Jouvét M (1992) Role of catecholamines in the modafinil and amphetamine induced wakefulness, a comparative pharmacological study in the cat. *Brain Res* 591(2):319–326