Characterization of "Near-Death Experiences" through the comparison of experiencers and non-experiencers' particularities: Inter-individual differences in cognitive characteristics and susceptibility to false memories

ABSTRACT:

Background
Near-Death Experiences (NDEs) refer to mental events with highly emotional and mystical aspects classically occurring in altered states of consciousness following a real or perceived life-threatening situation.

Aim
The aim of this project was to better characterize the NDE phenomenon and their experiencers though the integration of both a psychological and a neuropsychological approach. We conducted 7 studies aiming to investigate the NDE memory, 2 studies aiming to study the NDE experiencers' personality and cognitive characteristics, and 3 studies aiming to investigate the neurobiological basis of the NDE phenomenon.

Method
Using qualitative (e.g. thematic analysis) and quantitative (e.g. natural language processing tool) analyses of hundreds of written narratives, we extracted common features, identified their order of appearance, and we compared them with experiences elicited by different types of psychoactive drugs. We also retrospectively assessed experiencers' cognitive and personality variables, the phenomenological characteristics of the memory and assessed to what extent they are considered self-defining using validated questionnaires. Finally, we reproduced NDE-like features in controlled laboratory settings in 'naïve' healthy subjects and NDE experiencers by administrating DMT, medically-controlled vaso-vagal syncopes and using hypnosis, while performing high-density EEG monitoring to measure cerebral electrical changes.

Results and Conclusions
NDE memories comprise recurrent time-bounded and transversal features with no prototypical sequences, and are associated with an important amount of phenomenological characteristics – correlated with the richness of the experience itself. Besides, they are self-defining, meaning that they are central to experiencers' identities. A natural language processing tool enabled to identify, via semantic similarity, the long-standing link between certain drugs and NDEs. Indeed, the NMDA receptor antagonist ketamine consistently resulted in reports most similar to those associated with NDEs. Ketamine was followed by a series of serotonergic psychedelics (e.g. DMT) and could be used as a reversible experimental model for NDE phenomenology. In addition, our findings support the view that a particularly strong engagement in fantasy and a high illusory recollection susceptibility might make people more likely to report such experiences when exposed to suitable physiological and psychological conditions. Finally, we

observed significant overlaps in nearly all of the NDE-like phenomenological features induced in controlled laboratory settings, compared with reports of 'actual' NDEs. These studies suggest that NDE features are brain-mediated events resulting from dynamic changes in the brain's activity and connectivity.

Keywords

Near-death experiences, Consciousness, Memory, Personality

Published Work:

Barra, A., Carrière, M., Laureys, S., Martial, C. (in press). From unconscious to conscious: a spectrum of states. In M. Overgaard, J. Mogensen & A. Kirkeby-Hinrup (Eds.), *Beyond the Neural Correlates of Consciousness*. Taylor & Francis.

Cassol, H., D'argembeau, A., Charland-Verville, V., Laureys, S., & Martial, C. (2019). Memories of near-death experiences: Are they self-defining? *Neuroscience of Consciousness, 5*(1): niz002. doi: 10.1093/nc/niz002

Demertzi., A., Tagliazucchi, E., Dehaene, S., Deco, G., Barttfeld, P., Raimondo, F., Martial, C., Fernandez-Espejo, D., Rohaut, B., Voss, H.U., Schiff, N. D., Owen, A. M., Laureys, S., Naccache, L., & Sitt, J.D. (2019). Human consciousness is supported by dynamic complex patterns of brain signal coordination. *Science Advances. 5*(2): eaat7603. doi: 10.1126/sciadv.aat7603

Martial, C., Cassol, H., Charland-Verville, V., Pallavicini, C., Sanz, C., Zamberlan, F., Vivot, R. M., Erowid, F., Erowid, E., Laureys, S., Greyson, B., & Tagliazucchi, E. (2019). Neurochemical models of near-death experiences: a large-scale study based on the semantic similarity of written reports. *Consciousness and Cognition, 69*, 52-69. doi: 10.1016/j.concog.2019.01.011

Annen, J., Blandiaux, S., Lejeune, N., Bahri, M. A., Thibaut, A., Cho, W., Guger, C., Chatelle, C., & Laureys, S. (2018). BCI performance and brain metabolism profile in severely brain-injured patients 2 without response to command at bedside. *Frontiers in Neuroscience, 12*, 370. doi: 10.3389/fnins.2018.00370

Annen, J., Frasso, G., Heine, L., Di Perri, C., Martial, C., Antonopoulous, G., Aubinet, C., Cassol, H., Laureys, S. (2018). Regional brain volumetry and brain function in severely brain-injured patients. *Annals of Neurology, 83*(4), 842–853.

Aubinet, A., Larroque, S., Heine, L., Martial, C., Majerus, S., Laureys, S. & Di Perri, C. (2018). Clinical subcategorization of minimally conscious state according to resting functional connectivity. *Human Brain Mapping, 39*(11), 4519-4532. doi: 10.1002/hbm.243

Aubinet, C., Murphy, L., Ali Bahri, M., Larroque, S. K., Cassol, H., Annen, A., Carrière, M., Wannez, S., Thibaut, A., Laureys, S., & Gosseries, O. (2018). Brain, behavior and cognitive

interplay in disorders of consciousness: A multiple case study. *Frontiers in Neurology, 9*: 665. doi: 10.3389/fneur.2018.00665.

Bodart, O., Fecchio, M., Massimini, M., Wannez, S., Virgillito, A, Casarotto, S., Rosanova, M., Lutz, A., Ricard, M., Laureys, S., & Gosseries, O. (2018) Meditation-induced modulation of brain response to transcranial magnetic stimulation. *Brain Stimulation, 11*(6), 1397-1400. doi: 10.1016/j.brs.2018.08.018

Cassol, H., Aubinet, C., Thibaut, A., Wannez, S., Martial, C., Martens, G. & Laureys, S. (2018). Diagnostic, pronostic et traitements des troubles de la conscience. *Neurologie - Psychiatrie – Gériatrie, 8,* 47–49.

Cassol, H., Pétré, B., Degrange, S., Martial, C., Charland-Verville, V., Lallier, F., Bragard, I., Guillaume, M., & Laureys, S. (2018). Qualitative thematic analysis of the phenomenology of near-death experiences. *PLoS One, 13*(2):e0193001. doi: 10.1371/journal.pone.0193001

Cassol, H., Wolff, A., Chatelle, C., Gosseries, O., Laureys, S., & Chatelle, C. (2018). Conscience et états de conscience altérée. In C. Jourdan, F. Pellas, J. Luauté, B. Chevalier, & X., de Boissezon (Eds.), *Etats de Conscience Altérée - Actualités Diagnostiques, Pronostiques et Thérapeutiques* (pp. 9-24). Montpellier, France: Sauramps Médical.

Charland-Verville, V., Martial, C., Cassol, H. & Laureys, S. (2018). Near-death experiences: actual considerations. In C. Schnakers, & S., Laureys (Eds.) *Coma and Disorders of Consciousness* (pp. 235-263, 2nd edition). Cham, Switzerland: Springer.

Martial, C., Cassol, H., Charland-Verville, V., Merckelbach, H., & Laureys, S. (2018). Fantasy proneness correlates with the intensity of near-death experience. *Frontiers in Psychiatry, 9*: 190. doi:10.3389/fpsyt.2018.00190.

Martial, C., Charland-Verville, V., Dehon, H., & Laureys, S. (2018). False memory susceptibility in coma survivors with and without a near-death experience. *Psychological Research, 82*(4), 806-818. doi:10.1007/s00426-017-0855-9.

Mélotte, E., Maudoux, A., Delhalle, S., Martial, C., Antonopoulos, G., Larroque S., Wannez, S., Faymonville, M-E., Kaux, J-F., Laureys, S., Gosserie, O., & Vanhaudenhuyse, A. (2018). Is oral feeding compatible with an unresponsive wakefulness syndrome? *Journal of Neurology, 265*(4), 954-961. doi: 10.1007/s00415-018-8794-y.

Riganello, F., Larroque, S., Ali Bahri, M., Heine, L., Martial, C., Charland-Verville, V., Aubinet, C., Vanhaudenhuyse, A., Chatelle, C., Laureys, S., Di Perri, C. (2018). A heartbeat away from consciousness: Heart rate variability entropy can discriminate disorders of consciousness and is correlated with resting-state fMRI brain connectivity of the central autonomic network. *Frontiers in Neurology, 9,* 769.

Os textos são da exclusiva responsabilidade dos autores
All texts are of the exclusive responsibility of the authors

Thibaut, A., Chatelle, C., Vanhaudenhyse, A., Martens, G., Cassol, H., Barra, A., Martial, C., Carrière, M., & Laureys, S. (2018). Transcranial direct current stimulation unveils covert consciousness. *Brain Stimulation, 11*(3), 642–4.

Thibaut, A., Chennu, S., Chatelle, C., Martens, G., Annen, J., Cassol, H., Laureys, S. (2018). Theta network centrality correlates with tDCS responders in disorders of consciousness. *Brain Stimulation, 11*(6), 1407-1409.

Timmermann, C., Roseman, L., Williams, L., Erritzoe, D., Martial, C., Cassol, H., Laureys, S., Nutt, D., & Carhart-Harris, R. (2018). DMT Models the Near-Death Experience. *Frontiers in Psychology, 9*: 1424. doi:10.3389/fpsyg.2018.01424.

van Ommen, J. H., Thibaut, T., Vanhaudenhuyse, A., Heine, L., Charland-Verville, V., Wannez, S., Bodart, O., Laureys, S., & Gosseries, O. (2018). Resistance to eye opening in patients with disorders of consciousness. *Journal of Neurology, 265:*1376-1380.

Wannez, S., Gosseries, O., Azzolini, D., Martial, C., Cassol, H., Aubinet, C., Annen, J., Martens, G., Bodart, O., Heine, L., Charland-Verville, V., Thibaut, A., Chatelle, C., Vanhaudenhuyse, A., Demertzi, A., Schnakers, C., Donneau, A.-F. & Laureys, S. (2018). Prevalence of Coma-Recovery Scale-Revised signs of consciousness in patients in a minimally conscious state. *Neuropsychological Rehabilitation, 28*(8), 1350-1359. doi: 10.1080/09602011.2017.1310656

Wolff, A., Blandiaux, S., Cassol, H., Chatelle, C., Laureys, S., & Gosseries, O. (2018). Evaluations comportementales chez les patients en état de conscience altérée. In C. Jourdan, F. Pellas, J. Luauté, B. Chevalier, & X., de Boissezon (Eds.), *Etats de Conscience Altérée - Actualités Diagnostiques, Pronostiques et Thérapeutiques* (pp. 43-57). Montpellier, France: Sauramps Médical.

Di Perri, C., Amico, E., Heine, L., Annen, J., Martial, C., Larroque, S., Soddu, A., Marinazzo, D. & Laureys, S. (2017). Multifaceted brain networks reconfiguration in disorders of consciousness uncovered by co-activation patterns. *Human Brain Mapping, 39*, 89–103.

Martens, G., Laureys, S., & Thibaut, A. (2017). Spasticity Management in Disorders of Consciousness. *Brain Sciences, 7*, 162; doi:10.3390/brainsci7120162

Martial, C., Cassol, H., Antonopoulos, G., Charlier, T., Heros, J., Donneau, A. F., Charland-Verville, V., Laureys, S. (2017). Temporality of features in near-death experience narratives. *Frontiers in Human Neurosciences, 11*: 311. doi: 10.3389/fnhum.2017.00311.

Martial, C., Charland-Verville, V., Cassol, H., Didone, V., Van Der Linden, M., & Laureys, S. (2017). Intensity and memory characteristics of near-death experiences. *Consciousness and Cognition, 56*, 120-127. doi: 10.1016/j.concog.2017.06.018.

Wannez, S., Heine, L., Thonnard, M., Gosseries, O., Laureys, S., & Coma Science Group collaborators (2017). The repetition of behavioral assessments in disorders of consciousness. *Annals of Neurology, 81*(6), 883-889.

Wannez, S., Hoyoux, T., Langohr, T., Bodart, O., Martial, C., Wertz, J., Chatelle, C., Verly, J.G., & Laureys, S. (2017). Objective assessment of visual pursuit in patients with disorders of consciousness: an exploratory study. *Journal of Neurology, 264*(5), 928–937.

Researcher's Contacts:

Pr Steven Laureys Coma Science Group
GIGA-Consciousness and Neurology Department University
and University Hospital of Liège,
Belgium Avenue de l'hôpital, 11 4000 Liège
Belgium

Tel: +32 4 366 34 92
Fax: +32 4 366 84 49