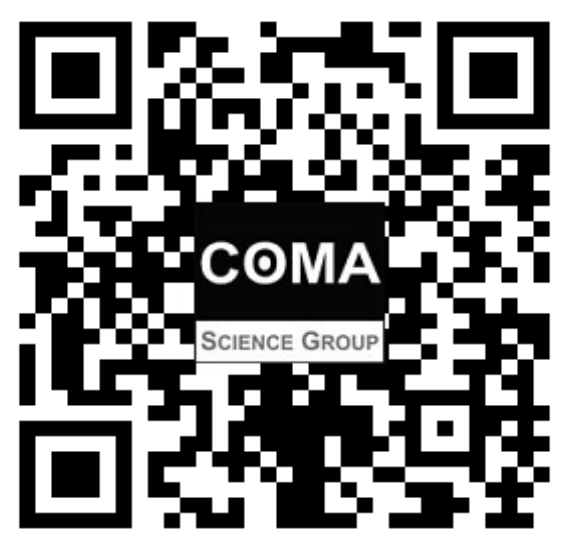


NEAR-DEATH EXPERIENCES IN PATIENTS WITH LOCKED-IN SYNDROME



Vanessa Charland-Verville¹, Zulay Lugo¹, Jean-Pierre Jourdan² and Steven Laureys¹

1Coma Science Group, Cyclotron Research Center, University and University Hospital of Liège, Liège, Belgium
2International Association For Near Death Studies



Objectives:

Near-Death Experiences (NDEs) are classically associated with positive emotions like peacefulness, happiness and joy [1-3]. To date, few negative NDEs reports have been documented [4]. Although NDEs classically arise in the context of an acute severe brain damage, their associated memories are reported as being phenomenologically very rich and detailed [5]. To date, no satisfactory explanatory model exists to fully account for the rich phenomenology of NDEs following a severe acute brain injury [6]. Neurobiological hypotheses include cerebral hypoxia [7, 8] and temporal lobe dysfunctions [9] to account for some of the features occurring during NDEs. However, it has been recently shown that anoxic/hypoxic, traumatic and other supratentorial brain lesions do not seem to influence the content of a NDE when assessed with a standardized tool (i.e., Greyson NDE scale; [1]). Due to their particular brain lesion (i.e., pontine brainstem), locked-in syndrome (LIS) patients provide a unique opportunity to further investigate the neural correlates of NDEs.

We here aimed at retrospectively characterizing the content of NDEs in patients with LIS having suffered from an acute brainstem lesion (cerebrovascular accident (CVA) or trauma; i.e., "LIS NDEs") and to compare these experiences to those collected in a cohort of matched NDE experiencers after coma with supratentorial lesions (CVA or trauma; i.e., "classical NDEs").

Methods:

In collaboration with the French Association for Locked-In Syndrome (LIS) (<http://alis-asso.fr>), patients with LIS who retrospectively recalled memories from their coma period were referred to our research team and invited to fill in a structured questionnaire, aided by a proxy. The questionnaire included demographic and clinical information (age, gender, duration and etiology of LIS) and the Greyson NDE scale [10]. The scale consists of a validated 16-item multiple-choice tool (i.e., scores ranging from 0 to 32) used to characterize the experience's content (items' associated 16 NDE core features) [10]. For each item, the scores are arranged on an ordinal scale ranging from 0 to 2 (i.e., 0 = "not present", 1 = "mildly or ambiguously present" and 2 = "definitively present"; [10]). For statistical analyses, a feature was considered present when participants scored an item as 1 or 2. Patients with LIS whose experience did not meet the accepted criteria of NDE (i.e., Greyson total score ≥ 7 ; [10]) were excluded from further analyses.

Differences between "LIS NDEs" and "classical NDEs" groups were assessed using Student's t-test (age and time since insult) and a Pearson's chi square test (gender, etiology and Greyson NDE scale items) using SPSS (Statistical Package for the Social Sciences, version 22.0, SPSS Inc., Chicago, IL, USA). Results were considered to be significant at the 5% critical level ($p < 0.05$) and were expressed as mean \pm standard deviation (SD) for quantitative variables and as counts and proportions (%) for categorical variables.

Differences between "LIS NDEs" and "classical NDEs" groups were assessed using Student's t-test (age and time since insult) and a Pearson's chi square test (gender, etiology and Greyson NDE scale items) using SPSS (Statistical Package for the Social Sciences, version 22.0, SPSS Inc., Chicago, IL, USA). Results were considered to be significant at the 5% critical level ($p < 0.05$) and were expressed as mean \pm standard deviation (SD) for quantitative variables and as counts and proportions (%) for categorical variables.

Results:

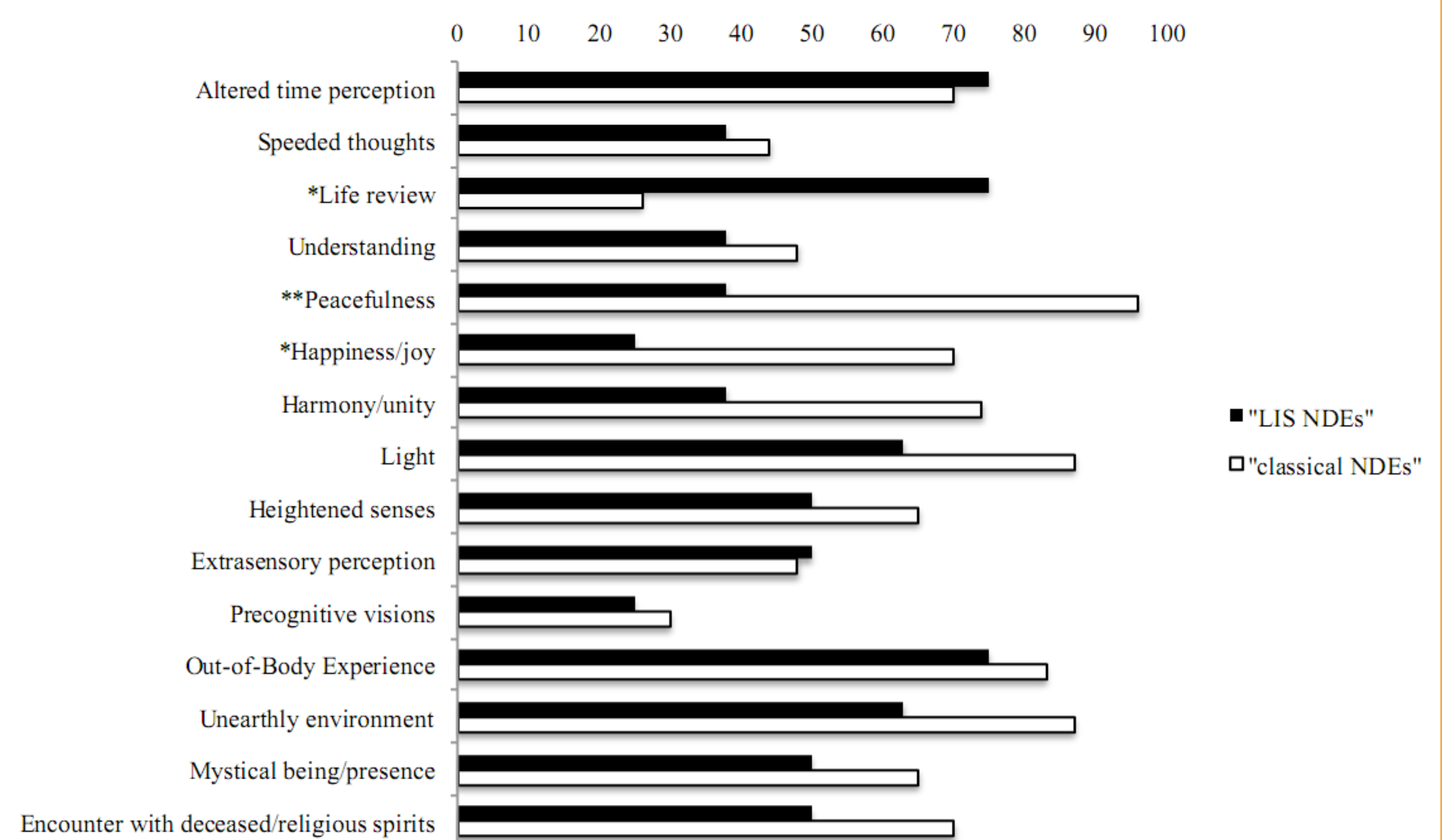
14 patients with LIS recalled having had memories of their coma period. 8 (57%) qualified as a NDE according to the Greyson NDE scale criteria (i.e., total score ≥ 7) [10]. Table 1 reports the demographic information of the "LIS NDEs" and "classical NDEs".

There were no significant differences in gender and aetiology ratios, as well as for age and interval since NDE. The content (i.e., NDE scale features) of reported NDEs differed between both groups. As compared to the matched "classical NDEs" group, "LIS NDEs" reported less frequently feelings of peacefulness (96% vs. 38%, respectively, $p < 0.001$) and joy (70% vs. 25%; $p = 0.028$) and more frequently experienced life review during the NDE (26% vs. 75%; $p = 0.032$; see figure 1).

Demographical information of patients with NDE in LIS versus patients with "classical" NDEs.

	"LIS NDEs" n=8 (%)	"classical NDEs" n=23 (%)	p value
Gender - female	5 (63)	12 (52)	0.890
Etiology	7 brainstem CVA (88) 1 brainstem trauma (12)	20 supratentorial CVA (87) 3 supratentorial trauma (13)	0.968
Age at NDE (Mean in years \pm SD)	31 \pm 6	31 \pm 14	0.959
Time since NDE (Mean in years \pm SD)	19 \pm 9	19 \pm 9	0.732

Frequency of reported Greyson NDE scale items in patients with locked-in syndrome (LIS; n=8) and matched "classical" NDEs after coma (n=23); * $p < 0.05$; ** $p < 0.001$.



Conclusion & discussion:

We here report that patients with NDEs following an acute brainstem lesion and subsequent LIS, less frequently recount positive emotions and more frequently experience autobiographical memory flashbacks. The lower proportion of patients with LIS experiencing peacefulness and joy and the increased frequency of autobiographical life review could be related to an altered connectivity in (para)limbic systems secondary to the acute pontine brainstem dysfunction [12], similar to what can be observed in REM sleep intrusions and nightmares [3, 13]. Some authors have indeed postulated that positive emotions and autobiographical memory flashbacks in NDEs could be linked to mesiotemporal dysfunction (involving amygdala and hippocampi) [6]. The presence of "life review", usually one of the least reported features by NDE experiencers [1-3], was here reported in 6/8 patients with LIS. It could be hypothesized that the specific ventral pontine brainstem lesions causing the LIS and their potential repercussion on afferent and efferent pathways with (para)limbic/midbrain structures and neurotransmitters systems [3, 14] could account for the observed differences in NDEs content. Thus, when brain lesions occur at the infratentorial level, individuals might experience more negative emotions and memory flashbacks. Alternatively, it could be argued that finding oneself in a paralyzed body might account for the potential negative and possibly frightening emotions associated with the experience. A parallel could be made with the pharmacologically induced LIS that can exceptionally be encountered in general anesthesia when patients receive muscle relaxants together with inadequate amounts of anaesthetic drugs. Further studies should disentangle whether negative NDEs have a specific neuroanatomical substrate (i.e., could be related to an altered limbic/pontine connectivity) or should be seen in light of the specific emotional distress caused by motor paralysis and residual conscious awareness.

- Charland-Verville, V., Jourdan, J., Thonnard, M., Ledoux, D., Donneau, A. F., Quertemont, E. & Laureys, S. (2014). Near-death experiences in non-life-threatening events and coma of different etiologies. *Frontiers in Human Neuroscience*, 8:203.
- Greyson, B. (2003). Incidence and correlates of near-death experiences in a cardiac care unit. *General hospital psychiatry*, 25(4), 269-276.
- Nelson, K. R., Mattingly, M., Lee, S. A. & Schmitt, F. A. (2006). Does the arousal system contribute to near death experience? *Neurology*, 66(7), 1003-1009.
- Greyson, B. & Bush, N. E. (1992). Distressing Near-Death Experiences. *Psychiatry*, 55, 95-110.
- Thonnard, M., Charland-Verville, V., Bredart, S., Dehon, H., Ledoux, D., Laureys, S. & Vanhaudenhuyse, A. (2013). Characteristics of near-death experiences memories as compared to real and imagined events memories. *PLoS ONE*, 8(3), e57620.
- Mobbs, D. & Watt, C. (2011). There is nothing paranormal about near-death experiences: how neuroscience can explain seeing bright lights, meeting the dead, or being convinced you are one of them. *Trends in cognitive sciences*, 15(10), 447-449.
- Lempert, T., Bauer, M. & Schmidt, D. (1994). Syncope and near-death experience. *Lancet*, 344(8925), 829-830.
- Blackmore, S. J. (1996). Near-death experiences. *Journal of the Royal Society of Medicine*, 89(2), 73-76.
- Blanck, O., Landis, T., Spinelli, L. & Seeck, M. Out-of-body experience and autopsy of neurological origin. *Brain*, 127(Pt 2), 243-58.
- Lange, R., Greyson, B. & Houran, J. (2004). A Rasch scaling validation of a "core" near-death experience. *British journal of psychology*, 95(Pt 2), 161-177.
- Greyson, B. (2003). Near-death experiences in a psychiatric outpatient clinic population. *Psychiatric services*, 54(12):1649-1651.
- Baxter, M. G., Murray, E. A. (2002). The amygdala and reward. *Nature Review Neuroscience*, 3(7), 563-73.
- Hobson, J. A., Stickgold, R. & Pace-Schott, E. F. (1998). The neuropsychology of REM sleep dreaming. *Neuroreport*, 9(3), R1-14.
- Blackmore, S. & Troscianko, T. (1988). The physiology of the tunnel. *J Near Death Stud* 1988, 8, 15-28.

ACKNOWLEDGEMENTS & SPONSORS

The authors thank the patients, their families and the Association for Locked-in Syndrome (ALIS; France) and particularly V. Blandin and F. Pellas who helped with patient recruitment. This research was supported by the European Commission (European ICT Programme Projects FP7-247919 DECODER), the Belgian National Funds for Scientific Research (FNRS), the Tinnitus Prize 2011 (FNRS 9.4501.12), FEDER structural fund RADIOMED-930549, Fonds Léon Fredericq, the James McDonnell Foundation, the French Speaking Community Concerted Research Action and the University and University Hospital of Liège.