

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/345328714>

The Near-Death Experience Content (NDE-C) scale: Development and psychometric validation

Article in *Consciousness and Cognition* · December 2020

DOI: 10.1016/j.concog.2020.103049

CITATIONS

0

READS

258

9 authors, including:



Charlotte Martial

University of Liège

77 PUBLICATIONS 672 CITATIONS

SEE PROFILE



Jessica Simon

University of Liège

22 PUBLICATIONS 155 CITATIONS

SEE PROFILE



Ninon Puttaert

University of Liège

5 PUBLICATIONS 1 CITATION

SEE PROFILE



Olivia Gosseries

University of Liège

261 PUBLICATIONS 6,661 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



Hypnosis [View project](#)



Descending regulation of pain [View project](#)

The Near-Death Experience Content (NDE-C) scale: Development and psychometric validation

Charlotte Martial^{a,b*}, Jessica Simon^c, Ninon Puttaert^c, Olivia Gosseries^{a,b}, Vanessa Charland-Verville^{a,b}, Anne-Sophie Nyssen^d, Bruce Greyson^e, Steven Laureys^{a,b}, H el ena Cassol^{a,b}

^a GIGA-Consciousness, Coma Science Group, University of Li ege, Li ege, Belgium
Avenue de l'h opital, 11
4000 Li ege, Belgium
Tel: +32 4 366 24 44
Fax: +32 4 366 84 49

^b Centre du Cerveau², University Hospital of Li ege, Li ege, Belgium
Avenue de l'h opital, 11
4000 Li ege, Belgium
Tel: +32 4 366 24 44
Fax: +32 4 366 84 49

^c Psychology and Neuroscience of Cognition, University of Li ege, Li ege, Belgium
B at. B32 Quartier Agora
Place des Orateurs 2
4000 Li ege 1, Belgium
Tel: +32 4 366 21 55

^d Department of Work Psychology, University of Li ege, Belgium
B at. B32 Quartier Agora
Place des Orateurs 2
4000 Li ege 1, Belgium
Tel: +32 4 366 21 55

^e Department of Psychiatry and Neurobehavioral Sciences, University of Virginia Health System, Virginia, USA
210 10th Street NE
Charlottesville, VA 22902-4754
Tel: 434-924-2281
Fax: 434-924-1712

*Correspondence: cmartial@uliege.be (C. Martial).

Abstract

As interest grows in near-death experiences (NDEs), it is increasingly important to accurately identify them to facilitate empirical research and reproducibility among assessors. We aimed (1) to reassess the psychometric properties of the NDE scale developed by Greyson (1983) and (2) to validate the Near-Death Experience Content (NDE-C) scale that quantifies NDEs in a more complete way. Internal consistency, construct and concurrent validity analyses were performed on the NDE scale. Based on those results and the most recent empirical evidence, we then developed a new 20-item scale. Internal consistency, explanatory and confirmatory factor, concurrent and discriminant validity analyses were conducted. Results revealed (1) a series of weaknesses in the NDE scale, (2) a 5-factor structure covering relevant dimensions and the very good psychometric properties of the NDE-C scale, including very good internal consistency (Cronbach $\alpha=0.85$) and concurrent validity (correlations above 0.76). This new reliable scale should facilitate future research.

Keywords: near-death experience, scale, phenomenology, life-threatening situation, experiencer

1. Introduction

Since the introduction of the term “*near-death experience*” (NDE) into the English language by Raymond Moody (1975), interest in NDEs has considerably grown and reports of NDEs have been collected around the world. Historical descriptions of NDEs from diverse sources reveal sufficient common features, thereby suggesting a prototypical core experience that is independent from cultures, societies and religions (Belanti et al., 2008; Blackmore, 1993; Greyson, 2006). National-sample surveys among the general public revealed that approximately 4 to 8% of people endorse having had a NDE (Knoblauch et al., 2001; Perera et al., 2005). Considering only cardiac arrest survivors, it appears that 10 to 23% of survivors report a NDE (Greyson, 2003; Schwaninger et al., 2002; van Lommel et al., 2001). It is worth noting that those divergent surveys used different tools to identify NDEs.

NDEs are typically experienced in life-threatening conditions involving a disconnection from the environment, thereby corresponding to a state of disconnected consciousness (Martial et al., 2020). Despite the critical context in which brain physiology is impaired, “experiencers” report mental perceptions associated with an apparently clear sensorium (Charland-Verville et al., 2017). The NDE phenomenology is a set of distinguishable and identifiable mental events – referred to as “features” – with self-related, highly emotional, mystical and/or spiritual aspects (Charland-Verville et al., 2014). Clearly, there is a shared common core experience with prototypical features such as the feeling of peace and well-being, out-of-body experiences, and altered time perception (Charland-Verville et al., 2014; Greyson, 2003; Lai et al., 2007; Schwaninger et al., 2002). Other frequently reported features are seeing a bright light, seeing a tunnel, encountering people or spirits, a sense of harmony/unity, and experiencing heightened senses (i.e., more vivid sensations than usual) (Charland-Verville et al., 2014; Greyson, 2003; Parnia et al., 2001; Schwaninger et al., 2002; Zhi-ying & Jian-xun, 1992). The precognitive visions (i.e., seeing events occurring in the future), extrasensory perception (i.e., acquisition of information without the use of the five physical senses), and life review are also prototypical NDE features but are less often encountered (Charland-Verville et al., 2014; Greyson, 2003; Zhi-ying & Jian-xun, 1992). Interestingly, all these features are subsequently recalled with vividness and details, even decades later (Cassol et al., 2019a, 2020; Martial et al., 2017a; Moore & Greyson, 2017; Thonnard et al., 2013).

Memories of NDE phenomenology are associated with multiple contexts. A NDE phenomenology typically emerges in a life-threatening context, but it can also be present in situations where there is an absence of severe physiological insults to brain functioning (referred to as “NDEs-like”), such as during syncope (Lempert et al., 1994), hypnagogic or hypnopompic states (Nelson et al., 2006; Kondziella et al., 2019), meditation (Beauregard et al., 2009) or after consumption of recreational drugs, particularly N,N-Dimethyltryptamine (DMT; Timmermann et al., 2018) and ketamine (Martial & Cassol, et al., 2019). At present, we cannot distinguish “classical” NDEs (i.e., in a life-threatening situation) from NDEs-like solely based on their content (Charland-Verville et al., 2014).

So far, as there is an absence of consensus regarding the definition of the phenomenon itself, various scales have been developed to identify NDE experiencers in research. In 1980, Ring created the *Weighted Core Experience Index* (WCEI), a 10-item self-report questionnaire with weighted scores assigned to elements of the content of the experience. A total score is then obtained by summing the different weighted scores. This scale has rarely been used in research because the *NDE scale* was developed shortly after by Greyson (1983) and is currently the most used tool allowing a standardized identification of NDE experiencers. The NDE scale is a 16-item self-report questionnaire with a cut-off score of 7/32 for a NDE (Greyson, 1990). The scale was found to have

a good internal consistency, a good split-half reliability (Greyson, 1983), and a good test-retest reliability (Greyson, 2007). Lange and colleagues (2015) showed that its concurrent validity was partly supported by a latent semantic analysis quantitative paradigm, and they revealed seven major clusters of descriptors (related to transcendent, paranormal, physiological or environmental themes) in NDE narratives. Later, the same authors categorized those linguistic factors into three types: *unconventional* (esoteric/transpersonal type content recurrent in the NDE literature), *conventional* (environmental or mundane content) and *ambiguous* (words that are emotive or tied to perceptions that might be interpreted in different ways due to context) words (Houran et al., 2017). Initially, the NDE scale was used in a clinical setting to distinguish individuals who had experienced a NDE from those who had experienced something else (Greyson, 1983). Some years later, a Rasch rating-scale analysis (Lange et al., 2004) established that the NDE scale total score (representing the richness of the NDE) fit a Rasch model (1960/1980). This work suggests that NDE is a unidimensional phenomenon with interval-scaling properties allowing to qualitatively and quantitatively differentiate NDEs from other responses to life-threatening situations (Lange et al., 2004). This finding challenged previous research suggesting, rather, the multidimensionality of NDEs (Lester, 2000; Sabom, 1982). Lester (2000) stated that NDE is not a unitary phenomenon and further identified four factors covering four NDE dimensions.

Although the self-report NDE scale has allowed for increased scientific rigor, this measure presents several significant limitations. First, its psychometric characteristics are relatively weak (e.g., non-comparable response formats for the multiple-choice items, a small number of Likert scale responses). Second, its ability to discriminate between different cohorts including other related subjective experiences has not been tested. Third, the scientific investigation of NDEs has accelerated over the last thirty years (10 publications before 1983 vs. 332 currently indexed in PubMed) and its content is no longer up-to-date. As an example, Greyson and Bush provided in 1992 the first scientific evidence that not all NDEs are pleasant. Importantly, these experiences are described as ‘nightmarish’ or ‘hellish’ in about 14% of cases (Cassol et al., 2019b). However, none of the items of the NDE scale relates to negative emotions. Thus, several observations prompted us to reexamine the compositional structure of the NDE scale and to develop a new scale. More recently, Prosnick and Evans (2003) have developed a 6-item version of the NDE scale called the *NDE-6 scale*; however, it has not been used in research.

In parallel, psychometrically-sound self-report scales have been developed in neuroscience to collect data on many (non-observable) subjective states and contents of consciousness. Notably, the 30-item *Mystical Experience Questionnaire* (MEQ30; Barrett et al., 2015; MacLean et al., 2012) was developed to assess the occurrence and character of mystical experiences elicited by classic hallucinogens (Griffiths et al., 2006; MacLean et al., 2012; Pahnke, 1963). However, while a growing number of such scales have been recently created to identify different phenomena and hallucinatory experiences, there is no recent comparable scale allowing for the quantification of NDEs.

The present article focuses on validating a new self-report scale that screens for a NDE phenomenology. In light of this, we designed three studies. The first study examined the internal consistency, the reliability, the concurrent validity, and the factor structure of the NDE scale in a large sample of individuals who had faced life-threatening situations and claimed to have had a NDE. We view this aim as an intermediate step in furthering the development of a new scale as a psychometrically robust and research-useful assessment tool to quantify NDEs. The second study evaluated the psychometric properties of the French version of the *Near-Death Experience Content (NDE-C) scale* with a large sample of participants who experienced a NDE in life-threatening contexts. To that end, this study provides evidence of reliability and validity based on

the internal structure of the scale (through explanatory and confirmatory factor analyses). We used the classical test theory approach (Nunnally & Bernstein, 1994) to evaluate the ability of the NDE-C scale to identify NDEs. The third study aimed to assess the discriminant validity by administering the NDE-C scale to other interest groups relevant to the validation.

2. Study 1: Psychometric evaluation of the NDE scale

2.1. Material and methods

2.1.1. Participants

French-speaking participants were recruited via websites, appearances in local media, and publications from our team. Participants who claimed to have experienced a NDE were mailed questionnaires including questions related to demographic (gender, age at interview, age at NDE) and clinical (precipitating factors, etiology) characteristics. Participants were also invited to freely write down a detailed description of their NDE on a blank sheet of paper. Lastly, they were asked to complete a French version (back-translation method) of the NDE scale and the WCEI. The NDE scale is a 16-item self-report questionnaire with a cut-off score of 7/32 that can be subdivided into four factors (see Supplementary Material A for details about the NDE scale). This group of participants will be referred to as the “NDE group”. All participants involved in the three studies (see Figure 1) completed a written informed consent form. All studies were approved by our local ethics committee (Faculty of Medicine).

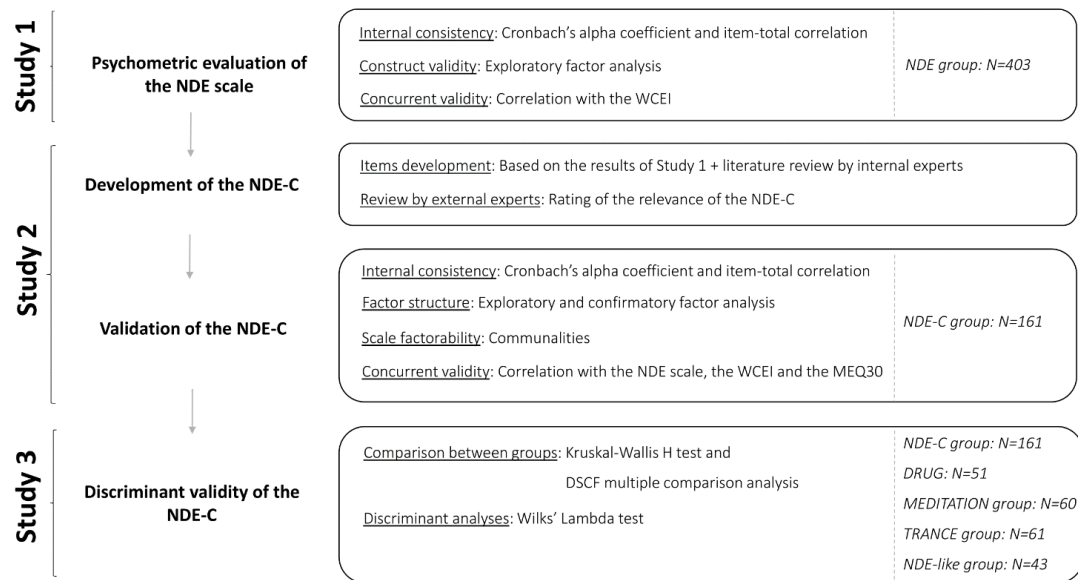


Figure 1. Flowchart.

2.1.2. Statistics

The internal consistency of the NDE scale was assessed using Cronbach's α coefficient. The minimum acceptable value for Cronbach's α is .70 and the maximum value is .90 (Bartko & Carpenter, 1976; Hair et al., 1998). Below .70, the internal consistency of the common range is considered low, while a value greater than .90 is the sign of redundancy or duplication of items within the scale. Pearson inter-item correlations were also performed to identify any potential redundancy in items. We also conducted item-to-total correlations and an exploratory factor analysis with varimax rotation based on a polychoric correlation matrix (an appropriate measure of association for categorical variables) to test the construct validity. Finally, the concurrent validity of the NDE scale was tested by correlating its dimensions to the WCEI.

2.2. Results

2.2.1. Participant characteristics

The sample consisted of 403 participants who claimed to have experienced a NDE (183 males; mean age at NDE=33±17 years; mean age at interview=57±13 years; NDE group). The sample included different near-death events: 91 anoxia (e.g., cardiac arrest), 105 traumas (e.g., car accident, falls), 63 complications of surgery or childbirth, and 144 others (non-traumatic events such as hemorrhage or septic shock).

2.2.2. Item statistics of the NDE scale and distributional properties

The NDE scale total score mean was 15±6. Supplementary Material B contains the frequency of each response for all multiple-choice items of the NDE scale.

2.2.3. Internal consistency and item-total correlation

The overall standardized Cronbach's α estimate for the NDE scale was 0.78, which is considered acceptable. The correlation between each item and the total score ranged from 0.19 to 0.53, and the estimation of the overall Cronbach's α (after removing each item from the pool of items to assess the independent contribution of each item to the measurement error in the scale) ranged from 0.76 to 0.79 (see Supplementary Material C for details), and thus achieved the recommended 0.70 (Nunnally & Bernstein, 1994).

2.2.4. Exploratory factor analysis

This analysis found a 4-factor structure. As shown in Table 1, items 1, 2, 3, 5, 6, 7, 10, 12, 14, 15 and 16 loaded on the factors described by Greyson (1983). In contrast, the other 5 items did not match the factors as described by Greyson (1983): items 8, 9, 11 and 13 loaded on two factors (rather than one as suggested by Greyson, 1983) and items 4 and 9 loaded on another factor than the one found by Greyson (1983). Items 5 and 6 had a correlation of .57 (see Supplementary Material D for all Pearson correlations).

| NDE scale item | Factor 1 Cognitive component | Factor 2 Affective component | Factor 3 Paranormal component | Factor 4 Transcendental component |
|-----------------------|--|--|---|---|
| NDE1 | .63 | .14 | -.05 | .02 |
| NDE2 | .72 | .20 | .19 | -.03 |
| NDE3 | .55 | -.17 | .10 | .34 |
| NDE4 | .32 | <u>.51</u> | .25 | .02 |
| NDE5 | -.15 | .77 | -.05 | .07 |
| NDE6 | .06 | .77 | -.07 | .23 |
| NDE7 | .20 | .71 | .22 | .03 |
| NDE8 | .02 | <u>.52</u> | -.05 | <u>.50</u> |
| NDE9 | <u>.37</u> | .46 | .22 | .18 |
| NDE10 | .08 | .05 | .74 | .12 |
| NDE11 | <u>.37</u> | -.11 | <u>.42</u> | .21 |
| NDE12 | -.07 | .12 | .66 | .06 |
| NDE13 | .11 | <u>.44</u> | .07 | <u>.48</u> |
| NDE14 | .05 | .18 | .18 | .62 |
| NDE15 | .03 | -.06 | .08 | .72 |
| NDE16 | .12 | .24 | .08 | .61 |

Table 1. Polychoric correlations (N=403) (Study 1). Factor loadings in bold print loaded on the same respective factor(s) as in Greyson’s (1983) original analysis. Underlined factor loadings loaded on different factors than Greyson’s (1983) analysis, or on more than one single factor.

2.2.5. Concurrent validity

The correlation between the NDE scale and the WCEI was 0.71 ($p < 0.001$).

2.3. Discussion

This Study 1 shows that its items remained relatively consistent since the inception of the NDE scale. However, our in-depth psychometric analysis reveals a series of issues and weaknesses that are worth improving upon –in addition to the theoretical and psychometric issues mentioned in the introduction section. Notably, the present results do not support the distribution of loadings across the four factors originally suggested by Greyson (1983). This discrepancy may be due to different sample sizes; we tested the scale on a much larger sample size (N=403) than the original validation study (N=74).

3. Study 2: Development and validation of the NDE-C scale

3.1. Material and methods

3.1.1. Development of the NDE-C scale

Items of the NDE-C scale were formed in line with the recent literature and based on the results of the psychometric evaluation of the NDE scale. Item 6 (“*Did you have a feeling of joy?*”) of the NDE scale was removed because of its redundancy with item 5 (“*Did you have a feeling of peace or pleasantness?*”). Indeed, item 6 was deemed theoretically redundant and, in addition, had a correlation of .57 with item 5. The contents of the remaining 15 items were retained for the new NDE-C scale but substantial wording modifications were made to the initial items. Indeed, all statements of the NDE-C scale were worded in an affirmative manner. We sought to write clear, unambiguous items in a language that respondents could easily understand and that represent the

construct of interest. We were careful not to use a vocabulary that could be considered too vague or difficult to understand. The sentences were written to take into account the great variety of elements experienced in the NDE and to minimize the risk of misunderstanding or misinterpretation. These modifications were based on our experience in the field and on feedback from experiencers about the NDE scale items.

In addition, NDE experts involved in this study (internal experts: C.M., H.C., N.P. and V.C.V.) reviewed the literature to develop new items relevant to the construct being measured. Five items were added to address features that are now known to be characteristic of the NDE phenomenon: negative emotions (Cassol et al., 2019b; Greyson & Bush, 1992), the experience of a gateway (Charland-Verville et al., 2020; Martial et al., 2017b), the impression of being dead (Cassol et al., 2018; Charland-Verville et al., 2020; Martial et al., 2017b), the decision to come back from the experience (Cassol et al., 2018; Charland-Verville et al., 2020; Martial et al., 2017b), and ineffability (Cassol et al., 2018).

Responses to each item were given on a Likert-type scale ranging from 0 to 4 inspired by the MEQ30 (Barrett et al., 2015; MacLean et al., 2012), with 0 corresponding to “not at all; none”, 1 corresponding to “slightly”, 2 corresponding to “moderately”, 3 corresponding to “strongly; equivalent in degree to any other strong experience”, and 4 corresponding to “extremely; more than any other time in my life and stronger than 3”.

An appraisal of content validity was performed to assess the NDE-C scale for clarity, specificity, representivity and relevance, as outlined by DeVellis (2003). A panel of three internationally known (external) experts from the field of NDEs reviewed and rated the relevance of the complete scale. Each external expert gave his independent assessment. They were invited to rate (1) the degree to which each item is clear (with a Likert scale: from 1=“not clear” to 4=“very clear”); (2) the degree to which each item is specific to the phenomenon (from 1=“not specific” to 4=“very specific”); (3) the degree to which each item is representative of the phenomenon (from 1=“not representative” to 4=“very representative”); and (4) the degree to which each item is relevant to the intended phenomenon (from 1=“not relevant” to 4=“very relevant”). Items were subsequently revised based on external experts’ relevant feedback.

This procedure resulted in a 20-item scale that was considered optimal. For the exact wording of the 20 items, see Table 2 (and see Supplementary Material E and F respectively for the French and English version of the final NDE-C scale including instructions and response modalities). A general instruction emphasized that the ratings should represent what was experienced specifically during the NDE. The scale was validated in French and translated into the English language using a back-translation method. The validity of the translation was checked by two professional translators (one native English and one native French) in both languages to ensure the functional and conceptual equivalences of the scale.

| NDE-C item | | Sentence |
|------------|----------------------------------|---|
| NDE-C1 | <i>Time perception</i> | Vous avez eu l'impression de soudainement tout comprendre sur vous-même, les autres et/ou l'univers <i>You had the feeling of suddenly understanding everything about yourself, the others and/or the universe</i> |
| NDE-C2 | <i>Speeded thoughts</i> | Vos pensées étaient accélérées <i>Your thoughts speeded up</i> |
| NDE-C3 | <i>Voice</i> | Vous avez entendu une ou des voix ne possédant pas d'incarnation matérielle <i>You heard one or several voices which did not have any material incarnation</i> |
| NDE-C4 | <i>Understanding</i> | Vous avez eu un sentiment de paix et/ou de bien-être <i>You had a feeling of peace and/or well-being</i> |
| NDE-C5 | <i>Peacefulness/well-being</i> | Vous avez eu une sensation d'harmonie ou d'unité, comme si vous faisiez partie d'un tout <i>You felt a sense of harmony or unity, as if you belonged to a larger whole</i> |
| NDE-C6 | <i>Harmony/unity</i> | Vous avez vu ou avez été entouré par une lumière brillante sans origine matérielle déterminée <i>You saw or felt surrounded by a bright light without any determined material origin</i> |
| NDE-C7 | <i>Bright light</i> | Vous avez eu des capacités sensorielles inhabituelles (vue, ouïe, odorat, toucher et/ou goût) <i>You experienced unusual sensations (sight, hearing, smell, touch and/or taste)</i> |
| NDE-C8 | <i>Unusual sensation</i> | Vous étiez conscient(e) de choses au-delà de ce que vos sens peuvent habituellement percevoir <i>You were aware of things beyond what your senses can usually perceive</i> |
| NDE-C9 | <i>Extrasensory perception</i> | Vous avez acquis des connaissances sur l'avenir <i>You gained insightful knowledge about the future</i> |
| NDE-C10 | <i>Precognition</i> | Vous avez eu la sensation d'être 'en-dehors' ou séparé de votre corps <i>You had the impression of being outside of, or separated from your own body</i> |
| NDE-C11 | <i>Out-of-body experience</i> | Vous avez eu la sensation de quitter le monde terrestre ou d'intégrer une nouvelle dimension et/ou environnement <i>You had the sensation of leaving the earthly world or of entering a new dimension and/or environment</i> |
| NDE-C12 | <i>Leaving the earthly world</i> | Vous avez revu ou revécu un ou des événement(s) de votre passé <i>You saw or relived events from your past</i> |
| NDE-C13 | <i>Life review</i> | Vous avez fait la rencontre d'une présence et/ou d'une entité (il peut s'agir d'une personne décédée) <i>You encountered a presence and/or an entity (who might be deceased)</i> |
| NDE-C14 | <i>Encounter</i> | Vous avez eu un sentiment de non-existence, de vide absolu et/ou de peur <i>You had a feeling of non-existence, of being in a total void, and/or of fear</i> |
| NDE-C15 | <i>Non-existence/void/fear</i> | Vous avez fait l'expérience d'une frontière et/ou d'un point de non-retour <i>You came close to a border and/or point of no return</i> |
| NDE-C16 | <i>Border/point of no return</i> | Vous avez pris la décision ou avez été contraint(e) de revenir de l'expérience que vous viviez <i>You made the decision, or were forced, to come back from the experience</i> |
| NDE-C17 | <i>Come back</i> | Vous avez eu l'impression de mourir et/ou d'être mort <i>You had the feeling of dying and/or being dead</i> |
| NDE-C18 | <i>Dying</i> | Vous avez vu ou êtes entré(e) dans une zone de passage (par exemple, un tunnel ou une porte) <i>You saw or entered a gateway (for instance a tunnel or a door)</i> |
| NDE-C19 | <i>Gateway</i> | Vous avez l'impression de ne pas disposer des mots adéquats pour décrire votre expérience <i>You sense that the experience cannot be described adequately in words</i> |
| NDE-C20 | <i>Ineffability</i> | |

Table 2. The final French version of the Near-Death Experience Content (NDE-C) scale (English translation in italics).

3.1.2. Validation of the NDE-C scale

To further test its psychometric qualities, the NDE-C scale was administered to a sample of people who claimed to have experienced a NDE in a life-threatening situation.

3.1.2.1. Participants

French-speaking participants who unequivocally claimed to have experienced a NDE in life-threatening conditions were recruited using the same method as described in Study 1 and were mailed the same questionnaires regarding demographic and clinical characteristics, and the description of their experience. This group of participants will be referred to as the “NDE-C group”. Participants also completed the newly developed NDE-C scale, the WCEI, the MEQ30 and the NDE scale, in a random order.

3.1.2.2. Statistics

The internal consistency was assessed using Cronbach’s α coefficient. We then conducted item-to-total correlations. Parallel analysis extraction method in exploratory factor analysis with varimax rotation based on a polychoric correlation matrix (an appropriate measure of association for categorical variables) was performed to test the factor structure of our scale. Communalities were examined to evaluate the scale factorability. This was followed by confirmatory factor analyses to test the fit of the models suggested by the previous exploratory factor analyses. The 20-item instrument was evaluated using criteria fit statistics (root mean squared error of approximation – criterion <0.06 ; standardized root-mean squared residual – criterion <0.08 ; Tucker-Lewis index – criterion >0.95 ; comparative fit index – criterion >0.95) to assess whether the suggested models were consistent with the data. Finally, the concurrent validity of the NDE-C scale was tested against the NDE scale, the WCEI and the MEQ30.

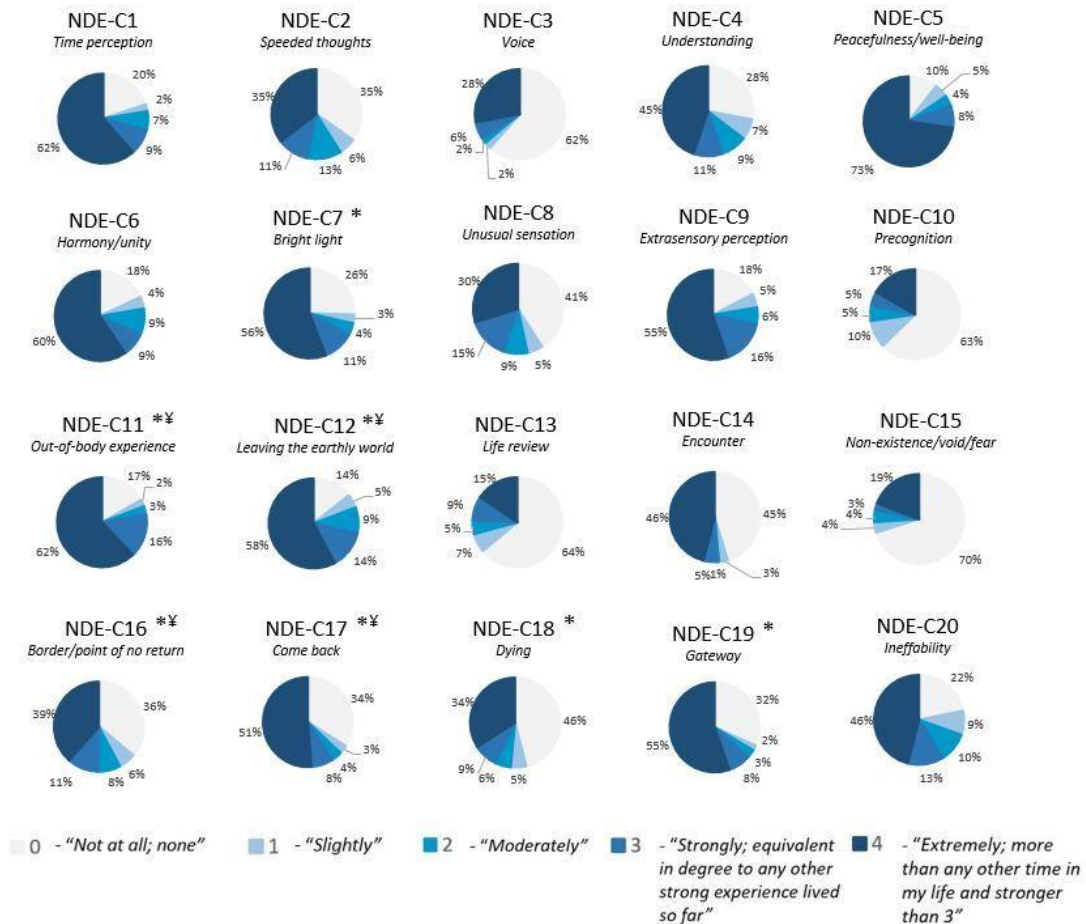
3.2. Results

3.2.1. Participants characteristics

The NDE-C scale was administered to 161 participants who claimed to have experienced a NDE (76 males; mean age at NDE= 30 ± 16 years; mean age at interview= 56 ± 13 years; NDE-C group). The sample included different near-death events: 27 anoxia (e.g., cardiac arrest), 44 traumas (e.g., car accident, falls), 17 complications during surgery or childbirth, and 73 others (non-traumatic events). A part of this sample (77%) was also in the NDE group of Study 1.

3.2.2. Item statistics and distributional properties

The NDE-C total score mean was 44 ± 17 (out of 80). Figure 2 contains the distribution of each response for all Likert scale items of the NDE-C scale (see also Supplementary Material G for the frequency of each response for all Likert scale items). Results showed that no one item was reported with a value of ≥ 1 by all participants. The NDE scale total score mean was 14 ± 7 (out of 32) for the NDE-C group.



* - items that differentiate between NDE and the DRUG, MEDITATION and TRANCE groups

‡ - items that differentiate between NDE-like and the DRUG, MEDITATION and TRANCE groups

Figure 2. Response frequency distributions for each of the 20 NDE-C scale items for the NDE-C group (N=161) (Study 2).

3.2.3. Internal consistency and item-total correlation

The overall standardized Cronbach's α estimate for the NDE-C scale was 0.85, which is deemed very good. The correlation with the NDE-C total score ranged from 0.13 to 0.61, and the estimation of the overall Cronbach's α when removing each item from the scale ranged from 0.84 to 0.86 (see Supplementary Material H for details). All values were much higher than the recommended 0.70 (Nunnally & Bernstein, 1994) for new instruments. This suggests that they are interdependent and homogeneous in terms of the construct they measure (Nunnally & Bernstein, 1994).

3.2.4. Exploratory factor analysis

This analysis revealed a 4- and 5-factor structure. The 4-factor structure was explored (see Table 3).

| NDE-C scale item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Communalities |
|-------------------------|-----------------|-----------------|-----------------|-----------------|----------------------|
| NDE-C9 | .60 | - | - | - | .51 |
| NDE-C2 | .60 | - | - | - | .55 |
| NDE-C20 | .58 | - | 0.32 | - | .55 |
| NDE-C1 | .54 | - | - | - | .68 |
| NDE-C8 | .49 | - | - | - | .68 |
| NDE-C11 | .42 | - | - | - | .75 |
| NDE-C3 | .39 | - | - | 0.34 | .64 |
| NDE-C16 | - | 0.63 | - | - | .52 |
| NDE-C19 | - | 0.61 | - | - | .54 |
| NDE-C18 | - | 0.50 | - | - | .73 |
| NDE-C12 | - | 0.48 | - | - | .65 |
| NDE-C17 | - | 0.48 | - | - | .66 |
| NDE-C7 | - | 0.45 | 0.44 | - | .54 |
| NDE-C15 | - | 0.42 | -0.34 | - | .67 |
| NDE-C5 | - | - | 0.90 | - | .17 |
| NDE-C6 | - | - | 0.74 | - | .35 |
| NDE-C10 | - | - | - | 0.62 | .57 |
| NDE-C4 | 0.47 | - | 0.34 | 0.52 | .39 |
| NDE-C13 | - | - | - | 0.42 | .80 |
| NDE-C14 | - | 0.36 | - | 0.38 | .63 |

Table 3. Factor loadings and estimated communalities from exploratory factor analysis: the 4-factor structure (Study 2).

The 5-factor structure is displayed in Table 4. Estimated communalities were consistently high (the majority was higher than .50; see Table 4), suggesting that all variables are dependent on each other and important in the explanation of the phenomenon. No item was removed following these exploratory factor analyses.

| NDE-C scale item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Communalities |
|------------------|----------|----------|----------|----------|----------|---------------|
| NDE-C2 | .63 | - | - | - | - | .52 |
| NDE-C1 | .63 | - | - | - | - | .57 |
| NDE-C20 | .55 | 0.34 | - | - | - | .55 |
| NDE-C9 | .55 | - | - | - | - | .52 |
| NDE-C8 | .44 | - | - | - | - | .69 |
| NDE-C11 | .36 | - | - | 0.33 | - | .73 |
| NDE-C5 | - | 0.91 | - | - | - | .14 |
| NDE-C6 | - | 0.73 | - | - | - | .36 |
| NDE-C10 | - | - | 0.61 | - | - | .59 |
| NDE-C4 | 0.46 | 0.34 | 0.52 | - | - | .40 |
| NDE-C14 | - | - | 0.47 | - | - | .61 |
| NDE-C13 | - | - | 0.42 | - | - | .80 |
| NDE-C3 | 0.35 | - | 0.41 | - | - | .61 |
| NDE-C18 | - | - | - | 0.62 | - | .61 |
| NDE-C15 | - | - | - | 0.50 | - | .63 |
| NDE-C17 | - | - | 0.39 | 0.50 | - | .57 |
| NDE-C16 | - | - | - | 0.49 | 0.33 | .54 |
| NDE-C12 | - | - | - | 0.37 | - | .68 |
| NDE-C19 | - | - | - | - | 0.94 | .01 |
| NDE-C7 | - | 0.40 | - | - | 0.44 | .53 |

Table 4. Factor loadings and estimated communalities from exploratory factor analysis: the 5-factor structure (Study 2).

3.2.5. Confirmatory factor analysis

The 4-factor model demonstrated acceptable fit statistics ($\chi^2(164)=312.97$, $\chi^2/DF=1.91$, $p<0.001$; root mean squared error of approximation=0.076; standardized root-mean squared residual=0.12; Tucker-Lewis Index=0.953; Comparative Fit Index=0.96).

The 5-factor structure (Figure 3) was found to provide the best conceptual fit. Fit statistics of this 5-factor model was: ($\chi^2(160)=263.61$, $\chi^2/DF=1.65$, $p<0.001$; root mean squared error of approximation=0.064; standardized root-mean squared residual=0.11; Tucker-Lewis Index=0.967; Comparative Fit Index=0.97). Median score of the *Beyond the usual* subscale was 19 (out of 24), median score of the *Harmony* subscale was 8 (out of 8); median score of the *Insight* subscale was 6 (out of 20); median score of the *Border* subscale was 11 (out of 20); and median score of the *Gateway* subscale was 8 (out of 8). Therefore, factor structures ranging from 4 to 5 factors were attempted through exploratory factor analyses, but a 5-factor structure provided the best conceptual fit.

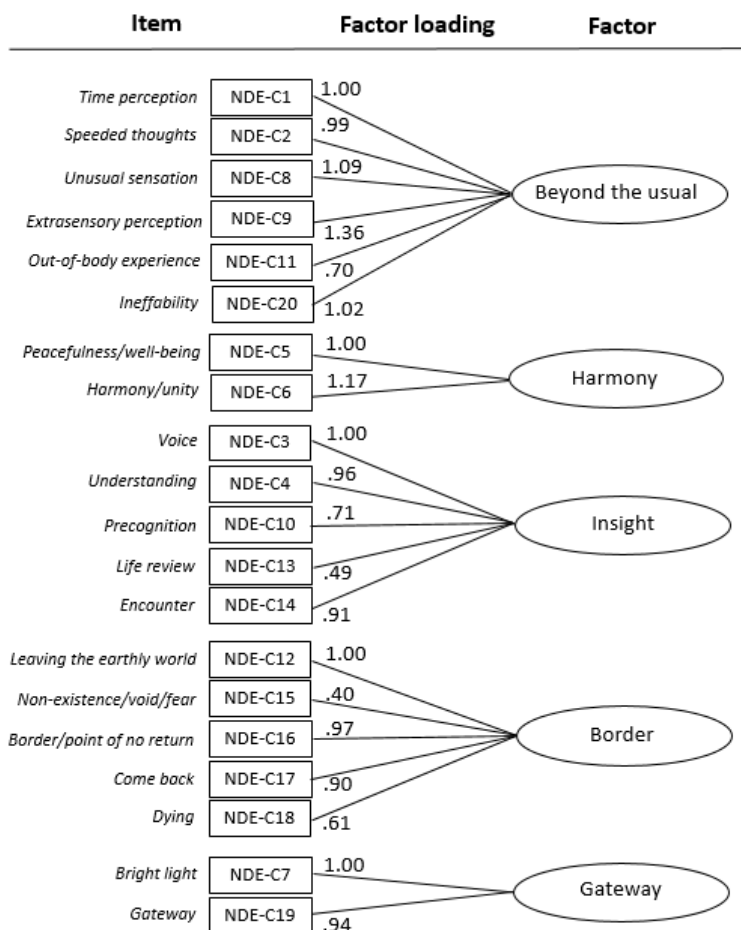


Figure 3. The 5-factor structure of the NDE-C scale: factor loadings (estimates) obtained from the confirmatory factor analysis (Study 2).

3.2.6. Concurrent validity

The correlation was 0.77 ($p < 0.001$) between the NDE-C scale and the NDE scale, 0.76 ($p < 0.001$) between the NDE-C scale and the MEQ-30, and 0.77 ($p < 0.001$) between the NDE-C scale and the WCEI.

3.2.7. Total NDE-C score

A total score can be calculated by summing the scores for each item response, which ranges from 0 to 80, with higher scores reflecting a richer phenomenology.

3.2.8. Cut-off score

We observed that 135 participants (84%) were located at or above the mean of 44 minus the standard deviation of 17, i.e., total score of $\geq 27/80$. Within the sample of 26 participants having a score below $27/80$ (16% of the NDE-C group), 16 participants obtained a total score below the cut-off score at the NDE scale. Thus, 10 participants obtained a total score $\geq 7/32$ at the NDE scale but a score of $< 27/80$ at the NDE-C scale.

3.3. Discussion

The NDE-C scale was shown to have good psychometric properties. Specifically, the scale consistently demonstrated very good internal consistency and a good concurrent validity. The confirmatory factor analysis supports the internal validity of this instrument and demonstrated good fit statistics.

Various modifications have been made in the NDE-C scale, as compared to the original NDE scale. The NDE-C scale differs substantially in item wording and structure. We have opted for affirmative forms for the items while the NDE scale items were expressed in an interrogative form. Interacting repeatedly with the NDE population allowed us to get a finer understanding of the way NDE experiencers interpreted the dimensions. Moreover, we identified redundancy in items (items 5 and 6). Besides, recent research progress in the NDE field has sufficient consistency to justify the development of a new scale to quantify NDE phenomenology. Since the initial development of the NDE scale, important key features have been highlighted as characteristics of the NDE phenomenon by rigorous qualitative and quantitative analyses. Notably, a recent qualitative thematic analysis brought negative emotions to light (Cassol et al., 2019b). As previously mentioned by Greyson and Bush (1992) and Cassol et al. (2019b), the NDE scale places a high value on positive emotions and may therefore be biased and lack sensitivity in the identification of distressing NDEs. Thus, the newly developed NDE-C scale takes into account the diversity of the emotions felt by the experiencers by including an item regarding positive emotions (NDE-C5) as well as an item regarding negative emotions (NDE-C15). Additionally, items recently identified by rigorous qualitative thematic analyses as being key elements of NDEs were added: the experience of a gateway (NDE-C19), the impression of being dead (NDE-C18), the decision to come back from the experience (NDE-C17) and ineffability (NDE-C20) (Cassol et al., 2018; Charland-Verville et al., 2020; Martial et al., 2017b). The gateway item was intentionally formulated so that individuals from different cultures could score if an experience of gateway was experienced, whether it was reported (or interpreted) as a tunnel, a door or something else. Indeed, some authors have questioned whether the tunnel vision was influenced by the western societal models and interpreted that way by western experiencers (Athappilly, Greyson, & Stevenson, 2006; Pasricha & Stevenson, 1986).

The final scale consists of 20 items, grouped into five meaningful clusters. Our examination of structures ranging from 4 to 5 factors revealed that the 5-factor structure provided the best conceptual fit. In this model, items were clustered together in a meaningful way. These factors were retrospectively designated as reflecting (1) the experiences beyond the usual physical senses (or “normal” boundaries) and temporality perception which may include a sense of transcendence and the fact that the experience is felt to be beyond words and impossible to describe accurately; (2) the experience of harmony and/or belonging to a larger whole; (3) experiencing moments or feelings of insight and/or of great understanding (gained at an intuitive, non-rational level or through encounters –whatever their visual appearance) including visions of (past and/or future) events; (4) the experience of leaving the earthly world and of coming close or entering a new dimension/reality; and (5) a gateway that might be accompanied by seeing a bright light (sometimes at the end of this gateway).

4. Study 3: Discriminant validity of the NDE-C scale

4.1. Material and methods

4.1.1. Participants

The NDE-C scale was administered to four other groups of French-speaking participants who had experienced other modified states of consciousness that are theoretically different, but

relevant to compare with classical NDEs: (a) a group of participants having had a hallucination elicited by recreational drugs (DRUG group); (b) a group of long-term meditators (MEDITATION group); (c) a group of experts in cognitive trance (TRANCE group; i.e., volitional and self-induced modified state of consciousness characterized by lucid but narrowed awareness of external surroundings with hyper-focused immersive experience of flow, and expanded inner imagery; Gosseries et al., 2020); and (d) a group of participants who contacted us unequivocally claiming that they had experienced a NDE but the context of the experience was non-life-threatening (NDE-like group). They were recruited using the same method as in Studies 1 and 2. Individuals were mailed questionnaires including questions related to socio-demographic (gender, age at interview, age at experience) and clinical (precipitating factors, etiology) characteristics. They were asked to answer the NDE-C scale considering their most intense experience if they had lived several experiences of the same kind.

4.1.2. Statistics

One-way ANOVAs were performed to compare scores for each factor across the five groups (i.e., the four groups presented in this study as well as the NDE-C group from the Study 2). Violation of the homogeneity of variance was checked using Fisher's test. In case of severe violation, the Welch's approximation was used instead of a F-test for independent groups. Eta squared was used as a measure of effect size. In case of main effect of the group, we performed a post-hoc Tukey's test. Results were considered to be significant at $p < 0.01$ ($\alpha/5$) to take into account the inflation of the alpha error due to the multiplicity of tests. In addition, discriminant analyses were conducted on factor score and the single items to assess the level of discriminatory power of the NDE-C scale to characterize NDEs among other types of modified states of consciousness. A Wilks' Lambda test was performed to test which variables contributed significantly to this discriminant function.

4.2. Results

4.2.1. Participant characteristics

The DRUG group consisted of 51 participants (34 males; mean age at experience= 26 ± 7 years; mean age at interview= 32 ± 17 years) and included drug-induced experiences elicited by lysergic acid diethylamide (LSD; N=13), DMT (N=3), ketamine (N=5), Salvia divinorum (N=1), psilocybin (N=23), and 3,4-methylenedioxymethamphetamine (MDMA; N=6). The MEDITATION group consisted of 60 participants (20 males; mean age at meditative experience= 43 ± 17 years; mean age at interview= 47 ± 11 years) and included meditative experiences elicited by mindfulness (N=47) and Zen techniques (N=13). The TRANCE group consisted of 61 experts in cognitive trance (19 males; mean age at trance experience= 41 ± 12 years; mean age at interview= 42 ± 12 years). The NDE-like group consisted of 43 participants (18 males; mean age at NDE-like= 35 ± 17 years; mean age at interview= 58 ± 14 years) and included NDEs that occurred following non-life-threatening events: syncope (N=13), high anxiety (N=7), falling asleep (N=11) and unknown causes (occurring spontaneously, cause not identified by the participant; N=12). These four groups were compared to the NDE-C group including the 161 NDE experiencers (see section 3.2.1. for demographic characteristics).

4.2.2. Item statistics and distributional properties

The NDE-C total score mean was 30 ± 13 for the DRUG group, 25 ± 14 for the MEDITATION group, 36 ± 17 for the TRANCE group and 43 ± 14 for the NDE-like group (compared to 44 ± 17 for

NDE-C group). Supplementary Material G contains the frequency of each response for all Likert scale items of the NDE-C scale for each group.

4.2.3. Comparison between the five groups

All one-way ANOVAs were significant (*Beyond the usual* (F(4,143)=10.57, $p<0.001$, $\eta^2=0.09$); *Harmony* (F(4,370)=4.09, $p=0.003$, $\eta^2=0.04$); *Insight* (F(4,142)=15.11, $p<0.001$, $\eta^2=0.11$); *Border* (F(4,139)=34.47, $p<0.001$, $\eta^2=0.24$); and *Gateway* (F(4,141)=37.97, $p<0.001$, $\eta^2=0.26$).

Results showed that two factors, *Border* and *Gateway*, distinguished the NDEs from the DRUG, MEDITATION and TRANCE experiences. In this case, all post-hoc comparisons were highly significant ($p<0.001$). *Insight* score distinguished the NDEs from the DRUG and MEDITATION groups ($p<0.001$) (see Supplementary Material I for details). No item was found to distinguish between NDEs and NDEs-like (see Supplementary Material J for details).

4.2.4. Discriminant analyses

Discriminant analysis showed that the NDE-C scale can classify and predict the group membership of experiencers (Wilks' Lambda value=0.560; F(20,12145)=11.25-; $R^2=0.431$; correct classification=0.545; $p<0.0001$). A very low percentage of DRUG (4%), MEDITATION (7%) and TRANCE (16%) experiences were classified into the NDE-C group. In contrast, a relatively higher percentage of NDEs-like (21%) were classified into the NDE-C group (Table 5).

| Number of observations and percent classified into group | | | | | | |
|--|---------------------------|-----------------------|-----------------------------|-------------------------|-------------------------|-------------|
| Group | <i>NDE-like</i> (N=43) | <i>DRUG</i> (N=51) | <i>MEDITATION</i> (N=60) | <i>TRANCE</i> (N=61) | <i>NDE-C</i> (N=161) | Total |
| <i>NDE-like</i> (N=43) | 18 41.86% | 6 13.95% | 6 13.95% | 4 9.30% | 9 20.93% | 43 100% |
| <i>DRUG</i> (N=51) | 7 13.73% | 24 47.06% | 10 19.61% | 8 15.69% | 2 3.92% | 51 100% |
| <i>MEDITATION</i> (N=60) | 5 8.33% | 11 18.33% | 16 58.33% | 22 8.33% | 10 6.67% | 60 100% |
| <i>TRANCE</i> (N=61) | 2 3.28% | 11 18.03% | 16 26.23% | 22 36.07% | 10 16.39% | 61 100% |
| <i>NDE-C</i> (N=161) | 35 21.88% | 19 11.88% | 20 12.50% | 15 9.38% | 71 44.38% | 160 100% |
| Total | 67 17.87% | 71 18.93% | 83 23.20% | 54 14.40% | 96 25.60% | 375 100% |
| Error Count Estimates for Group | | | | | | |
| Rate | 0.5814 | 0.5294 | 0.4167 | 0.6393 | 0.5563 | 0.5446 |
| Priors | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | |

Table 5. Classifications results and error rates between the 5 groups of participants (Study 3).

4.3. Discussion

This Study 3 aimed to examine the differentiation between the content of a NDE and the content of other modified states of consciousness. Our results showed that the NDE-C scale has the ability to discriminate the NDE content among different cohorts in the domain of interest. As compared to experiences elicited by hallucinogenic drugs, meditation and cognitive trance, seven items were specific to NDEs: seeing or feeling surrounded by a bright light (NDE-C7), out-of-body experiences (NDE-C11), leaving the earthly world (NDE-C12), a border/point of no return (NDE-C16), the decision to come back from the experience (NDE-C17), the feeling of dying and/or being dead (NDE-C18) and seeing or entering a gateway (NDE-C19). Four items allowed to distinguish NDEs-like from the experiences elicited by hallucinogenic drugs, meditation and cognitive trance: NDE-C11 (*out-of-body experience*), NDE-C12 (*leaving the earthly world*), NDE-C16 (*border/point of no return*) and NDE-C17 (*come back*). Importantly, those four items are all included in the seven items specific to NDEs. Those features appear to present a shared common core experience. All these features are reported in previous publications discussing a potential “core” experience (Ring, 1980; Lange et al., 2004). It should nonetheless be noted that each of those seven key features taken separately can be experienced in other conditions, such as in DMT-induced psychedelic experiences (consistent with previous studies: e.g., Timmermann et al., 2018) or in a cardiac arrest context in which the individual does not report having experienced a NDE (van Lommel et al., 2001). Further studies are needed to better understand the potential similarities and differences between these experiences. These differences in terms of phenomenology may be due to different underlying neurophysiological mechanisms specific to each of them (Bodart et al., 2018; Gosseries et al., 2020).

5. General discussion

This paper includes three studies describing the reassessment the psychometric properties of the NDE scale developed by Greyson (1983) and the development and validation of the NDE-C, a new scale to quantify NDE phenomenology.

The findings of Study 1 revealed that the NDE scale remained relatively consistent, but a series of weaknesses have been revealed that are worth improving upon. In Study 2, we described the development and the validation of the NDE-C scale. Overall, the NDE-C scale was shown to have good psychometric properties. Specifically, the scale consistently demonstrated a very good internal consistency and a good concurrent validity. The confirmatory factor analysis supported the internal validity of this instrument and demonstrated good fit statistics. Taken together, the newly discovered key features, the redundant item removal, the Likert scale response option, the changes in item wording and structure, and the validation on a larger sample of experiencers present a likely improvement in the identification and quantification of NDEs.

The NDE-C scale consists of 20 items, grouped into five meaningful clusters. This suggests that NDE is a multidimensional experience, as previously reported by Sabom (1982) and Lester (2000). Yet, Lange and co-authors' (2004) Rasch rating-scale analysis rather suggested that NDE is a unitary phenomenon. It is worth noting that those authors used different approaches, so future studies should explore this issue further.

We consider that the usefulness of the NDE-C scale is its ability to characterize and quantify the NDE phenomenology. We here suggest a cut-off score of $\geq 27/80$ if users need to define a cut-off score. We consider this cut-off score as optimal for further studies aiming to include sufficiently rich NDEs. This is relevant for research purposes; however, from a clinical perspective, we would like to stress that each self-reported NDE (including individuals with a score below this cut-off value) should be considered. NDEs probably outline a continuum of

experiences that are more or less rich in terms of content and it should be noted that no specific feature appears in all NDE reports, as found in many other studies (e.g., Charland-Verville et al., 2014; Martial et al., 2017b). As other types of modified states of consciousness (e.g., hypnosis, meditation, trance), there is no one absolute and objective criterion permitting to specify when the individual is actually in such states –and thus leave the “normal” waking baseline state of consciousness. Since NDEs are defined as having a number of distinctive features in which the experience of any one of those features alone does not constitute a “complete” NDE, we suggest the use of a cut-off score using the obtained total score, which may reflect the richness of the NDE content.

Interestingly, in Study 3, no item was found to distinguish between NDEs and NDEs-like. This is consistent with the possibility that NDE neurophysiological mechanisms can be activated spontaneously or in non-life-threatening situations where the threat is only apparent or even absent (Jansen, 1997; Martial & Cassol, et al., 2019). This newly developed NDE-C scale was developed with the aim of identifying “classical” NDEs; however, it was found that the scale also allows for the objective quantification and identification of NDEs-like. The NDE-C scale thus aims to identify the content of a NDE, whatever the context in which it has been experienced. Once the NDE-C scale is filled in, it is the context within which the experience has been precipitated that will allow for the identification of “classical” NDEs (i.e., a prototypical phenomenology emerged in a context of serious threat to the individual’s life and health conditions) vs. NDEs-like (i.e., a similar prototypical phenomenology emerged in a context where there is an absence of a serious threat to the individual’s life and health conditions). Extrapolating from the fact that the NDE-C scale did not discriminate between NDEs and NDEs-like –just like the NDE scale (Charland-Verville et al., 2014)– and that (at least a minimum of) brain functions are required to store and recall the resulting memory, it is plausible to assume that NDEs also arise when cerebral functions are still sufficiently operating. However, that assumption remains untested and would be challenging to reconcile with NDEs demonstrably occurring during cardiac arrest and deep anesthesia. We believe that this valid and reliable scale will help conduct rigorous research and minimize the potential complications caused by scholars adopting different definitions of the phenomenon. Up until now, an important issue is that researchers using different definitions are likely to reach distinct conclusions concerning the phenomenon and its nature, causes and consequences. Therefore, the NDE-C scale may help to identify “reproduced” NDEs-like that are strongly similar in controlled laboratory settings and without causing a safety hazard to volunteers (Martial et al., 2019). It is notable that, although the original NDE scale did not differentiate NDEs from NDEs-like (Charland-Verville, et al., 2014), a Rasch analysis of responses on the original NDE scale revealed significant differences in item hierarchy between NDEs and NDEs-like (Lange et al, 2004). To explore the possibility that the same distinction may be true with the NDE-C scale, we encourage further research involving a Rasch analysis of the NDE-C scale.

The present study has some limitations. First, the population sampled was WEIRD (western, educated, industrialized, rich and democratic), thereby limiting our ability to extrapolate to other parts of the world. More generally, research on NDEs has so far been centered in North America and Western Europe (Sletjes et al., 2014). However, we have here attempted to formulate sufficiently wide (but sensitive enough) items (e.g., the gateway item) allowing the results not to be limited to use in the context of Western interpretation. Future studies should include a more heterogeneous sampling population, notably by recruiting individuals from different cultural and religious backgrounds. A larger number of people could be recruited using online platforms for example. Second, participants enrolled in the study were

self-selected and might not be representative due to a possible selection bias. Third, a part of the NDE group participants (Study 1) was also recruited to form the NDE-C group (included in Studies 2 and 3). Given the relative scarcity of NDEs, we were limited in the recruitment of our participants; however, we think the current sample sizes are sufficiently large to be interesting and relevant for the present study. Another limitation of our study is the lack of objective medical information regarding the presence of a life-threatening event. However, medical information was obtained via the participant self-report using precise/focused questions. It should also be pointed out that the time that has elapsed since the NDEs was relatively long and may have introduced inaccuracies in participants' recall of their experiences. Although the experience was subsequently recalled with vividness and details (Martial et al., 2017a; Moore & Greyson, 2017; Thonnard et al., 2013), several factors may have influenced memory accuracy such as memory performance and personality traits (Martial et al., 2017c; Martial et al., 2018). In addition, no study has assessed the psychometric properties of the French version of the NDE scale used in Study 1. Finally, we should stress that the new scale might not reflect the NDE in all its richness and intensity since the scale is comprised solely of closed questions. Indeed, we necessarily rely on indirect measures of first-person experiences when using standardized scales; only the individuals who experienced the NDEs know "what it feels like" to have such experiences. Nonetheless, this is precisely the aim of the present article: to quantify in a more rigorous way the phenomenology of these experiences to facilitate empirical research.

6. Conclusions

Taken together, these findings suggest that this newly developed NDE-C scale is a psychometrically-sound self-report instrument for assessing NDEs. The NDE-C scale will have a broad relevance as a tool in the empirical study of NDEs, particularly for characterizing NDE content. The existence of the NDE-C scale will facilitate future research into the understanding and underlying mechanisms of this complex, often life-changing experience.

Acknowledgments

The authors wish to thank J-P Jourdan from IANDS France (www.iands-france.org), Corine Sombrun from TranceScience Institute, Caroline Jacob from Emergence and Anja Mangels from Brussels Diamond Way Buddhism for their help in recruiting NDE, trance, and meditation testimonies. We also would like to thank the external experts and the professional translators. Thank you to Kerry Gabrielson for helping editing the manuscript. This work was supported by the BIAL Foundation, the Belgian National Funds for Scientific Research (FRS-FNRS), the University and University Hospital of Liège, the fund Léon Fredericq, the Fund Generet, the Mind Care International Foundation, the King Baudouin Foundation, DOCMA project (EU-H2020-MSCA-RISE-778234), the AstraZeneca Foundation, the European Union's Horizon 2020 Framework Programme for Research and Innovation under the Specific Grant Agreement No. 945539 (Human Brain Project SGA3), the European Space Agency (ESA) and the Belgian Federal Science Policy Office (BELSPO) in the framework of the PRODEX Programme, the Center-TBI project (FP7-HEALTH- 602150), the Public Utility Foundation 'Université Européenne du Travail', "Fondazione Europea di Ricerca Biomedica", the Mind Science Foundation, and the European Commission. O.G. is research associate and S.L. is research director at the F.R.S-FNRS.

Conflict of interest

Declarations of interest: none.

References

- Athappilly, G. K., Greyson, B., & Stevenson, I. (2006). Do prevailing societal models influence reports of near-death experiences?: a comparison of accounts reported before and after 1975. *Journal of Nervous and Mental Disease, 194*(3), 218–222.
- Bartko, J. J., & Carpenter, W. T. (1976). On the methods and theory of reliability. *Journal of Nervous and Mental Disease, 163*(5), 307–317.
- Barrett, F. S., Johnson, M. W., & Griffiths, R. R. (2015). Validation of the revised mystical experience questionnaire in experimental sessions with psilocybin. *Journal of Psychopharmacology, 29*, 1182–1190.
- Beauregard, M., Courtemanche, J., & Paquette, V. (2009). Brain activity in near-death experiencers during a meditative state. *Resuscitation, 80*(9), 1006–1010.
- Belanti, J., Perera, M., & Jagadheesan, K. (2008). Phenomenology of near-death experiences: a cross-cultural perspective. *Transcultural Psychiatry, 45*, 121–133.
- Blackmore, S. (1993). *Dying to live: Science and near-death experience*. London: Grafton.
- Bodart, O., Fecchio, M., Massimini, M., Wannez, S., Virgillito, A., Casarotto, S., *et al.* (2018). Meditation-induced modulation of brain response to transcranial magnetic stimulation. *Brain Stimulation 11*(6), 1397–1400.
- Cassol, H., Bonin, E.A.C., Bastin, C., Puttaert, N., Charland-Verville, V., Laureys, S., & Martial, C. (2020). Near-death experience memories include more episodic components than flashbulb memories. *Frontiers in Psychology, 11*, 888.
- Cassol, H., D'Argembeau, A., Charland-Verville, V., Laureys, S.*, & Martial, C* (2019a). Memories of near-death experiences: Are they self-defining? *Neuroscience of Consciousness, 5*, niz002.
- Cassol, H., Martial, C., Annen, J., Martens, G., Charland-Verville, V., Majerus, S. & Laureys, S. (2019b). A systematic analysis of distressing near-death experience accounts. *Memory 27*(8), 1122–1129.
- Cassol, H.*, Pétré, B.*, Degrange, S., Martial, C., Charland-Verville, V., Bragard, I., Guillaume, M.*, & Laureys, S.* (2018). Qualitative thematic analysis of the phenomenology of near-death experiences. *PLoS One, 13*(2), e0193001.
- Charland-Verville, V., Jourdan, J.-P., Thonnard, M., Ledoux, D., Donneau, A.-F., Questermont, E., *et al.* (2014). Near-death experiences in non-life-threatening events and coma of different etiologies. *Frontiers in Human Neuroscience, 8*, 203.
- Charland-Verville, V., Martial, C., Cassol, H. & Laureys, S. (2017). Near-death experiences: actual considerations. In C. Schnakers & S. Laureys (Eds.), *Coma and Disorders of Consciousness, 2nd Ed.* (pp. 235–263). Springer.
- Charland-Verville, V.*, Ribeiro de Paula, D.*, Martial, C., Cassol, H., Antonopoulos, G., Chronik, B.A., Soddu, A., & Laureys, S. (2020). Characterization of near-death experiences using text mining analyses: a preliminary study. *PlosONE, 15*, e0227402.
- DeVellis, R. F. (2003). *Scale development: Theory and applications (2nd Ed.)*. Newbury Park, CA: Sage Publications
- Facco, E., & Agrillo, C. (2012). Near-death-like experiences without life-threatening conditions or brain disorders: A hypothesis from a case report. *Frontiers in Psychology, 3*, 490.
- Gosseries, O., Fecchio, M., Wolff, A., Sanz, L.R.D., Sombrun, C., Vanhauzenhuyse, A., & Laureys, S. (2020). Behavioural and brain responses in cognitive trance: A TMS-EEG case study. *Clinical Neurophysiology, 131*(2), 586–588.
- Greyson, B. (1983). The near-death experience scale. Construction, reliability, and validity.

- Journal of Nervous and Mental Disease*, 171, 369–375.
- Greyson, B. (1990). Near-death encounters with and without near-death experiences: Comparative NDE Scale profiles. *Journal of Near-Death Studies*, 8, 151–161.
- Greyson, B. (2003). Incidence and correlates of near-death experiences in a cardiac care unit. *General Hospital Psychiatry*, 25(4), 269–276.
- Greyson, B. (2006). Near-death experiences and spirituality. *Journal of Religion & Science*, 41(2), 393–414.
- Greyson, B. (2007). Consistency of near-death experience accounts over two decades: Are reports embellished over time? *Resuscitation*, 73(3), 407–411.
- Greyson, B., & Bush, N.E. (1992). Distressing Near-Death Experiences. *Psychiatry*, 55, 95–110.
- Griffiths, R.R., Richards, W.A., McCann, U., & Jesse, R. (2006) Psilocybin can occasion mystical-type experiences having substantial and sustained personal meaning and spiritual significance. *Psychopharmacology* 187, 268–283.
- Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis*. (5th Ed.). Upper Saddle River, NJ: Prentice Hall.
- Houran, J., Lange, R., & Greyson, B. (2017). Research note: Exploring linguistic patterns in NDE accounts. *Journal of the Society for Psychical Research*, 81, 228–240.
- Jansen, K. L. R. (1997). The ketamine model of the near-death experience: A central role for the N-Methyl-D-Aspartate receptor. *Journal of Near-Death Studies*, 16(1), 5–26.
- Knoblauch, P.H., Schmied, I., & Schnettler, B. (2001). Different Kinds of Near-Death Experience : A Report on a Survey of Near-Death Experiences in Germany. *Journal of Near-Death Studies*, 20(1), 15–29.
- Kondziella, D., Dreier, J. P., & Olsen, M. H. (2019). Prevalence of near-death experiences in people with and without REM sleep intrusion. *PeerJ*, 7, 1–17.
- Lai, C.F., Kao, T.W., Wu, M.S., Chiang, S.S., Chang, C.H., Lu, C.S., *et al.* (2007). Impact of Near-Death Experiences on Dialysis Patients: A Multicenter Collaborative Study. *American Journal of Kidney Diseases*, 50(1), 125–135.
- Lange, R., Greyson, B., & Houran, J. (2015). Using computational linguistics to understand near-death experiences: Concurrent validity for the Near Death Experience Scale. *Psychology of Consciousness: Theory, Research, and Practice*, 2, 79–89.
- Lange, R., Greyson, B., & Houran, J. (2004). A Rasch scaling validation of a “core” near-death experience. *British Journal of Psychology*, 95, 161–177.
- Lempert, T., Bauer, M., & Schmidt, D. (1994). Syncope and near-death experience. *The Lancet*, 344(8925), 829–830.
- Lester, D. (2000). Major dimensions of near-death experiences. *Psychological Reports*, 87, 835–836.
- MacLean, K.A., Leoutsakos, J.M., Johnson, M.W., & Griffiths, R.R. (2012) Factor analysis of the Mystical Experience Questionnaire: a study of experiences occasioned by the hallucinogen psilocybin. *Journal for the Scientific Study of Religion*, 51, 721–737.
- Martial, C., Charland-Verville, V., Dehon, H.*, & Laureys, S.* (2017c). False memory susceptibility in coma survivors with and without a near-death experience. *Psychological Research*, 1–13.
- Martial, C., Mensen, A., Charland-Verville, V., Vanhaudenhuyse, A., Rentmeister, D., Ali Bahri, M., *et al.* (2019). Neurophenomenology of near-death experience memory in hypnotic recall: a within-subject EEG study. *Scientific Reports*, 9, 14047.
- Martial, C., Cassol, H., Antonopoulos, G., Charlier, T., Herosa, J., Donneau, A.-F., *et al.* (2017b). Temporality of features in near-death experience narratives. *Frontiers in Human*

Neuroscience, 11, 311.

- Martial, C., Cassol, H., Laureys, S. & Gosseries, O. (2020). Near-death experience as a probe to explore (disconnected) consciousness. *Trends in Cognitive Sciences*, 24(3), 173–183.
- Martial, C., Charland-Verville, V., Cassol, H., Didone, V., Van Der Linden, M. & Laureys, S. (2017a). Intensity and memory characteristics of near-death experiences. *Consciousness and Cognition*, 56, 120–127.
- Martial, C.*, Cassol, H.*, Charland-Verville, V., Pallavicini, C., Sanz, C., Zamberlan, F., et al. (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.
- 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.
- Moody, R.A. (1975). *Life after life*. New York: Bantam Books.
- Moore, L.E., & Greyson, B. (2017). Characteristics of memories for near-death experiences. *Consciousness and Cognition*, 51, 116–124.
- 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.
- Nunnally, J., & Bernstein, I. (1994). *Psychometric theory*. McGraw-Hill, New York
- Pahnke, W.N. (1963). *Drugs and mysticism: An analysis of the relationship between psychedelic drugs and the mystical consciousness*. Cambridge, MA: Harvard University Press.
- Parnia, S., Waller, D.G., Yeates, R., & Fenwick, P. (2001). A qualitative and quantitative study of the incidence, features and aetiology of near death experiences in cardiac arrest survivors. *Resuscitation*, 48(2), 149–156.
- Pasricha, S., & Stevenson, I. (1986). Near-death experiences in India. *Journal of Nervous and Mental Disease*, 174, 165–170.
- Perera, M., Padmasekara, G., & Belanti, J.W. (2005). Prevalence of Near-Death Experiences in Australia. *Journal of Near-Death Studies*, 24(2), 109–116.
- Prosnick, K. P., & Evans, W. J. (2003). Validity and reliability of the Near-Death Experience Scale-6 (NDE-6). *Journal of Near-Death Studies*, 22(2), 133–144.
- Rasch, G. (1960/1980). *Probabilistic models for some intelligence and attainment tests*. Chicago, IL: MESA Press.
- Ring, K. (1980). *Life at Death: A Scientific Investigation of the Near-Death Experience*. New York, NY: Coward, McCann & Geoghegan.
- Sabom, M. B. (1982). *Recollections of death: A medical investigation*. New York: Harper & Row.
- Schwaninger, J., Eisenberg, P., Schechtman, K., & Weiss, A. (2002). A prospective analysis of near-death experiences in cardiac arrest patients. *Journal of Near Death Studies*, 20, 215–232.
- Sleutjes, A., Moreira-Almeida, A., & Greyson, B. (2014). Almost 40 years investigating near-death experiences: An overview of mainstream scientific journals. *Journal of Nervous and Mental Disease*, 202(11), 833–836.
- Thonnard, M.*, Charland-Verville, V.*, Brédart, S., Dehon, H., Ledoux, D., & Laureys, S. (2013). Characteristics of near-death experiences memories as compared to real and imagined events memories. *PloS one*, 8, e57620.
- Timmermann, C., Roseman, L., Willimans, L., Erritzoe, D., Martial, C., Cassol, H., et al. (2018). DMT models the near-death experience. *Frontiers in Psychology*, 9, 1424.
- van Lommel, P., van Wees, R., Meyers, V., & Elfferich, I. (2001). Near-death experience in

survivors of cardiac arrest: a prospective study in the Netherlands. *The Lancet*, 358, 2039–2045.

Zhi-ying, F., & Jian-xun, L. (1992). Near-death experiences among survivors of the 1976 Tangshan earthquake. *Journal of Near-Death Studies*, 11(1), 39–48.