Asynchronous Distance Learning of the National Institutes of Health Stroke Scale during the COVID-19 Pandemic, E-learning versus Video: a Randomized Trial

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Submitted to: Journal of Medical Internet Research
on: August 17, 2020

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Abstract

Background: The COVID-19 pandemic has considerably altered the regular medical education curriculum while increasing the need for healthcare professionals. Senior medical students have been incrementally used on the front line to overcome the shortage of certified physicians. These students, some of whom will be fast-tracked as physicians, might lack knowledge regarding the initial management of time-critical emergencies such as stroke.

Objective: Our aim was to determine whether an electronic learning (e-learning) module could improve distance knowledge acquisition of the National Institutes of Health Stroke Scale (NIHSS) in senior medical students compared to the traditional didactic video.

Methods: A randomized, controlled, data-analyst blinded web-based trial was conducted at the University of Geneva Faculty of Medicine between April and June 2020. Fifth year medical students followed a learning path designed to distantly learn the NIHSS. The control group followed the traditional didactic video created by Patrick Lyden while the e-learning group followed the updated version of a previously tested highly-interactive e-learning module. The main outcome was the score on a 50-question quiz displayed upon completion of the learning material. Difference in the proportion of correct answers for each specific NIHSS item was also assessed.

Results: Out of 158 potential participants, 88 started their allocated learning path, and 75 completed the trial. Participants who followed the e-learning module performed better than those who followed the video (38 [95%CI 37 to 39] correct answers versus 35 [95%CI 34 to 36], P<.001). Participants in the e-learning group scored five elements better than the video group: key NIHSS concepts (P=.02), the consciousness – global item (P<.001), the facial palsy item (P=.04), the ataxia item (P=.03) and the sensory item (P=.04).

Conclusions: Compared to the traditional didactic video, a highly-interactive e-learning module enhances distance learning and NIHSS knowledge acquisition in senior medical students.

(JMIR Preprints 17/08/2020:23594)
DOI: https://doi.org/10.2196/preprints.23594

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Asynchronous Distance Learning of the National Institutes of Health Stroke Scale during the COVID-19 Pandemic, E-learning versus Video: a Randomized Trial

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Abstract word count: 294
Main text word count:
Tables: 2
Figure: 3

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Conclusions: Compared to the traditional didactic video, a highly-interactive e-learning module enhances asynchronous distance learning and NIHSS knowledge acquisition in senior medical students.

Keywords: stroke; covid-19; e-learning; medical students; medical education

Introduction

The swift strengthening of public health policies in the context of the coronavirus disease 2019 (COVID-19) crisis has wrought deep changes in the regular medical education curriculum of many countries [1–4] while also increasing the need for healthcare professionals, including physicians. Senior medical students have been incrementally used on the frontline to overcome the shortage of such professionals [5,6] and others might soon be required to follow suit [7]. Accelerated graduation procedures have also been described in some regions [8]. Senior medical students as well as some of these fast-tracked physicians might lack knowledge regarding the initial management of specific emergencies such as stroke. Stroke is a time-critical emergency that must be treated swiftly to improve functional and vital prognoses [9] but disruptions in acute stroke pathways have been described in the wake of the COVID-19 pandemic [10]. The National Institutes of Health Stroke Scale (NIHSS) is widely used to assess stroke victims [11] and senior medical students as well as junior residents should be familiar with its application.

Traditional classroom or bed-side teaching can be difficult to conduct in certain situations such as a pandemic [12–14]. Many universities have strived to increase distance learning capabilities, thereby highlighting the potential benefits of electronic learning (e-learning) [15–17]. E-learning is a generic term covering many kinds of technologically enhanced learning materials [18–20]. Asynchronous distance learning using such methods has yielded mixed results, probably owing to the differences regarding content quality and mode of delivery [21].

Since the release of Patrick Lyden’s didactic video in 1994 [22], the development of NIHSS teaching material has been rather limited. We have recently shown that, compared to this didactic video, a highly-interactive e-learning module improved NIHSS knowledge acquisition in paramedics [23]. We defined this module as « highly interactive » as multiple learning mechanics were used to promote interaction and engagement. Among such mechanics, avoiding content skipping [24] and the use of feedbacks tailored to the user's answer were the most prominent [25]. Branching logic was extensively used to create such feedbacks.

This first study was performed with the participants present on the study site, therefore allowing them to immediately access technical support if needed. Moreover, though most results favoured the use of the e-learning module, the control group was better at scoring the ataxia element than the e-learning group. Although video extracts were used within the e-learning module to demonstrate the assessment of almost all NIHSS items, the chapter regarding the ataxia element did not contain any video extract. We therefore hypothesized that systematically embedding videos could improve NIHSS learning acquisition and updated the module accordingly.

Given the need for social distancing during the COVID-19 pandemic, our goal was to compare medical students’ asynchronous distance learning of the NIHSS using two different teaching tools: the gold standard didactic video versus the updated version of our e-learning module.

Method

Study design and setting

We performed a randomized, controlled, data-analyst blinded, web-based trial following the CONSORT-EHEALTH guidelines and incorporating relevant elements from the CHERRIES checklist [26,27]. The study took place between April 28th and June 8th 2020 in Geneva, Switzerland. Fifth year medical students at the University of Geneva Faculty of Medicine (UGFM) were invited to take part in this trial on a voluntary basis.

Standard protocol approvals, registrations, and participant consents

Since the study included no patient and as no health outcome was recorded, trial registration was not required according to the International Committee of Medical Journal Editors guidelines. Though participants were not part of a vulnerable group according to the Swiss federal law on human research [28], we filed a jurisdictional enquiry, and the regional ethics committee issued a "Declaration of no objection" (Req 2020-00474). The study was also approved by the Board of the Teaching Committee of the UGFM. Informed consent was gathered electronically.

Enrolment

After gathering the necessary authorizations, the UGFM students' secretary transmitted the exact number of fifth year medical students to MS, who performed a 1:1 computer assisted randomization without having access to any other data regarding the students. MS then created specific identifiers which were transmitted back to the UGFM along with a mailing template. The UGFM staff were therefore unable to determine student allocation or results. In addition, we were prevented from determining students' identities.

The students were informed of the goals of the investigation, were given information regarding data security and anonymization procedures, and were supplied with the e-mail addresses of three investigators to allow them to ask further questions. Students who elected to browse the website were provided with additional information, as well as with a link to a full 4-page consent form in PDF format they could either print or save. Using their identifiers to log into the site was considered as acceptance to participate in the study. All participants were free to withdraw at any time. No financial incentive was provided.

Online platform and learning material

We created a specific online platform under the Joomla 3.9 content management system (Open Source Matters, New York, USA) [29]. The control was Patrick Lyden's original video, which was subtitled in French [22]. The experiment was version 21 of our e-learning module, which was developed under Articulate Storyline 3 (Articulate Global). This software allows the creation of many kinds of interactive contents, including gamified modules and serious games [30,31], which can be used on regular computers as well as on smartphones and tablets.

The e-learning module contains 16 independent chapters. The first chapter is the introduction, which is automatically displayed when the module is launched. Avoiding content skipping is the first learning mechanic used in the module and already appears in the introductory slides (Figures 1-3) [24].

Figure 1. Avoiding content skipping. The user cannot click on the *Cliquez ici pour continuer* (Click here to continue) button until both blue buttons have been clicked.

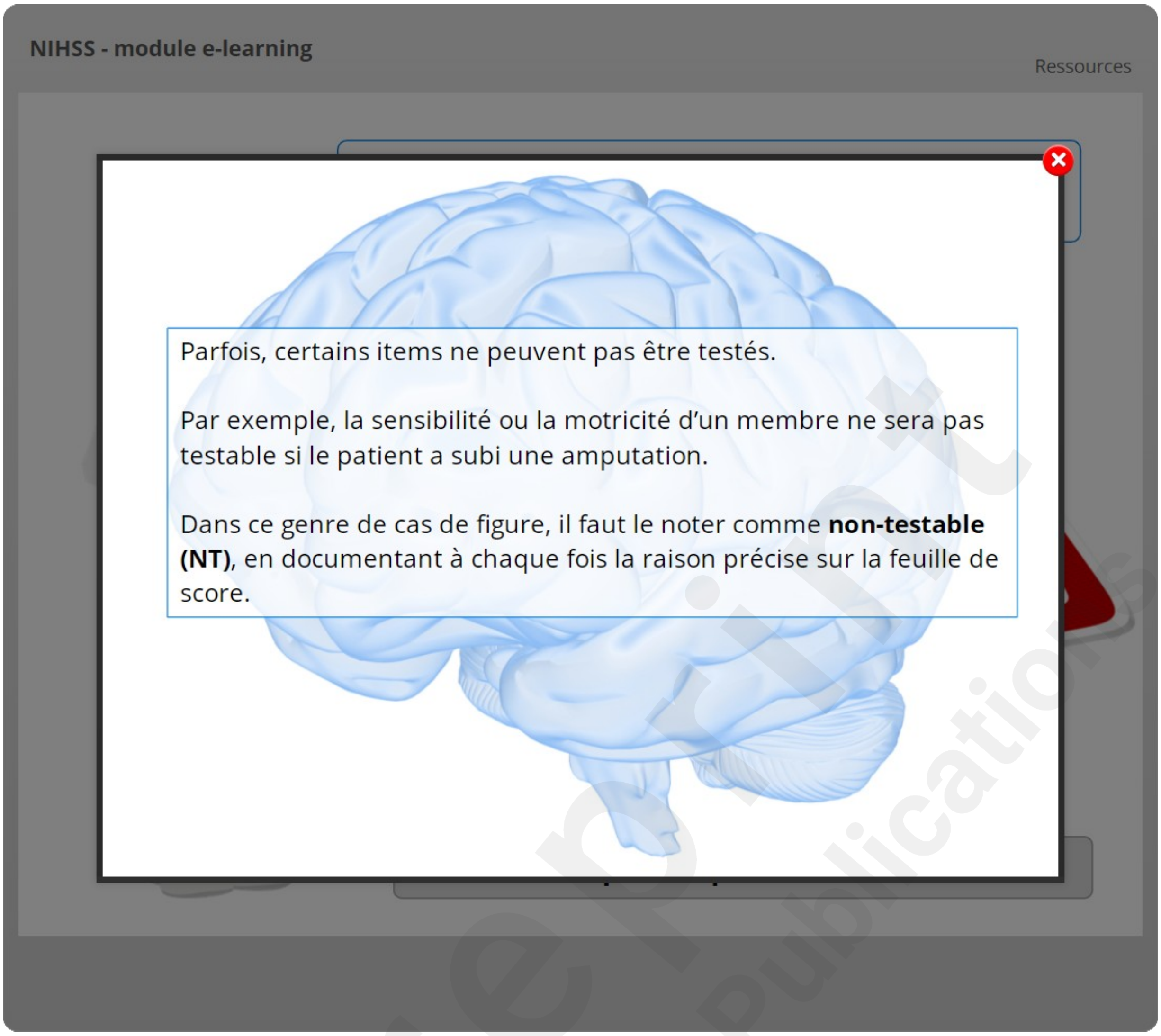

Figure 2. The user has clicked on one of the two buttons, and the learning content is now displayed in a lightbox. The *Cliquez ici pour continuer* (Click here to continue) button, which can just be identified in the background, is still in grey and, therefore, inactive.

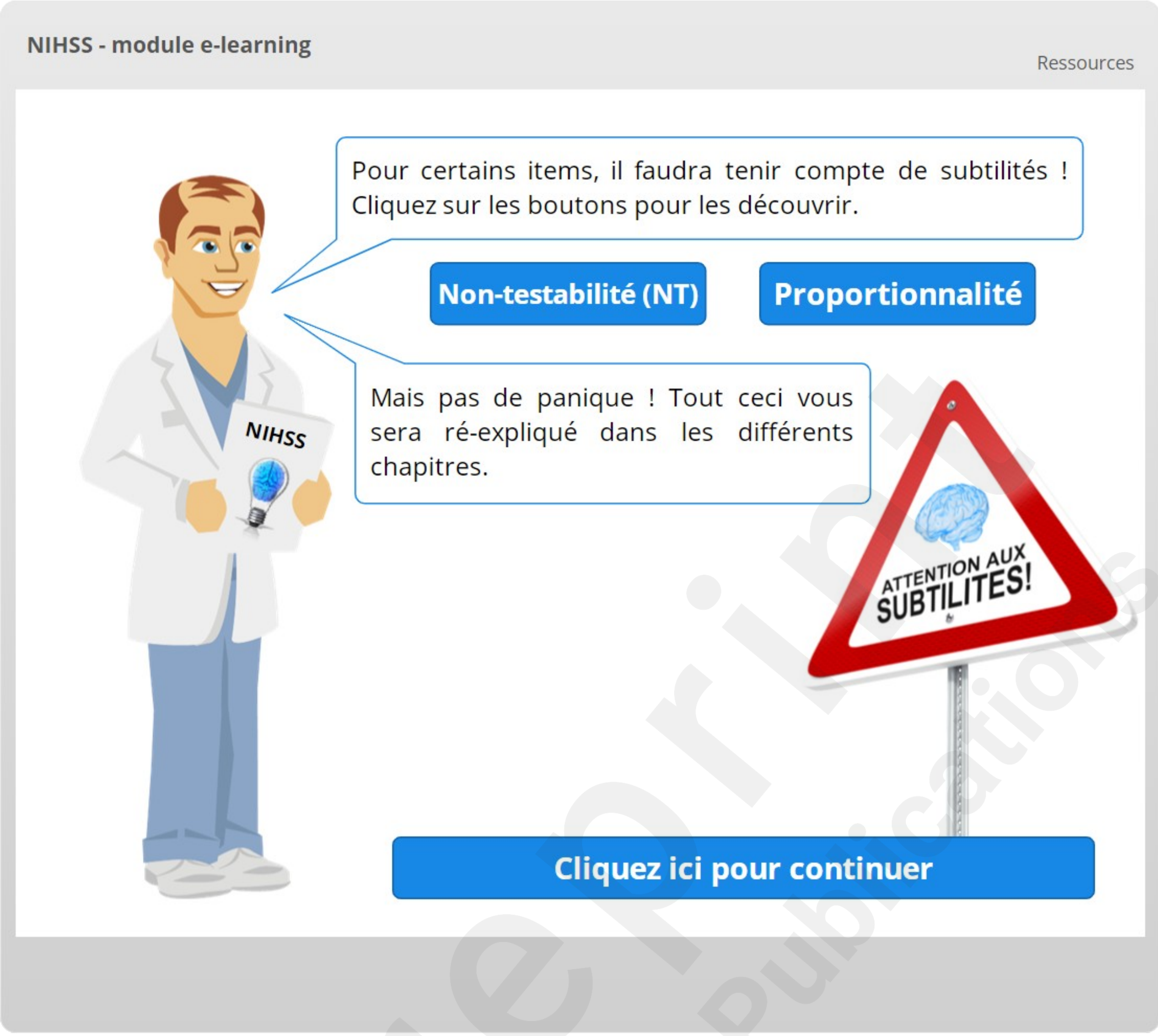

Figure 3. Both buttons have been clicked and the user has seen both lighboxed slides. The *Cliquez ici pour continuer* (Click here to continue) button has thus been activated and is now coloured in blue.

A table of contents is displayed as soon as the user has completed the introduction. The user can then choose to review the introduction or to access any other chapter apart from a summary (Figure 4).

Figure 4. Table of contents. The *Résumé* (summary) can only be accessed once all the other chapters have been completed.

Thirteen chapters are used to explain each specific NIHSS item (three chapters are used to cover the first item, "consciousness", which is divided into three elements). Although the chapters are numbered consecutively according to the NIHSS scoring logic, the user can freely elect the order in which to follow the chapters.

All chapters include at least two learning mechanics. First, each chapter begins by displaying the NIHSS score specific to the scoring item, and users are once again prevented from skipping content, as they must click on each numbered button to discover the score (Figure 5).

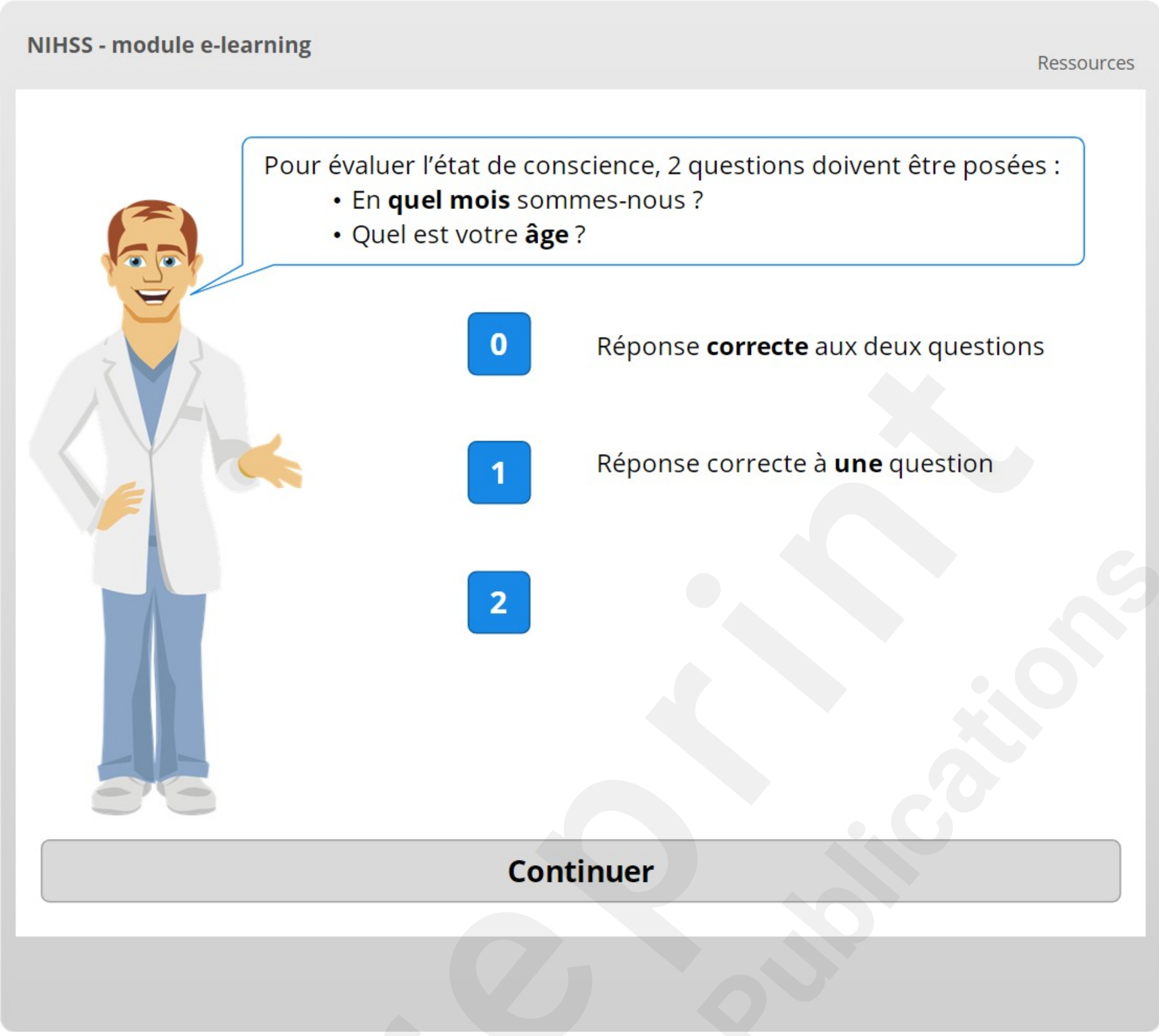

Figure 5. Avoiding content skipping. The user cannot click on the *Continuer* (Continue) button until all blue buttons have been clicked.

The second learning mechanic is linked to the use of subtitled videos. Video extracts are shown to the user, who must correctly score the NIHSS item (Figure 6). This version of the module contains video extracts in all chapters, including for the dysarthria and level of consciousness (global and questions) items. In the previously studied version of our module (version 20), there were no video extracts for these two items [23].

Figure 6. Video-based question. The user must choose the correct score for the patient displayed in the video before clicking on *Valider la réponse* (Validate the answer).

A feedback is always provided [25]: if the answer is incorrect, a clue is given (Figure 7) and the user has the possibility to review the NIHSS item scoring.

Figure 7. Feedback and clue. The user can choose either to *Réessayer* (Try again) or to review the scoring specific to this item (*Cliquez ici pour afficher l'échelle* – Click here to display the scale).

If the answer was correct, a feedback is also given to reinforce the message (Figure 8).

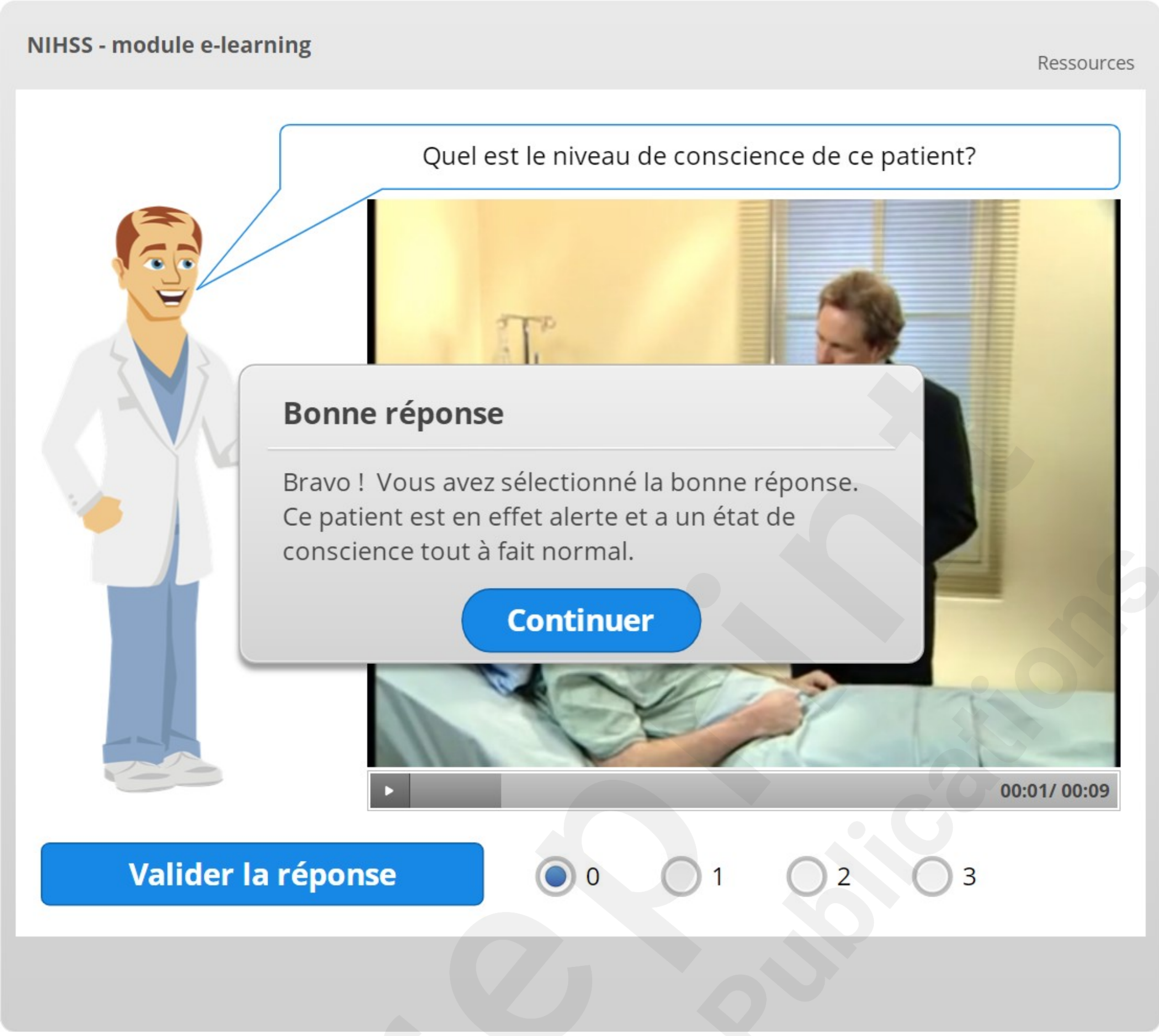

Figure 8. Positive feedback after a correct answer.

Specific interactions have been designed to further illustrate particular elements, such as visual field deficits (Figure 9) or extinction and inattention (Figure 10).

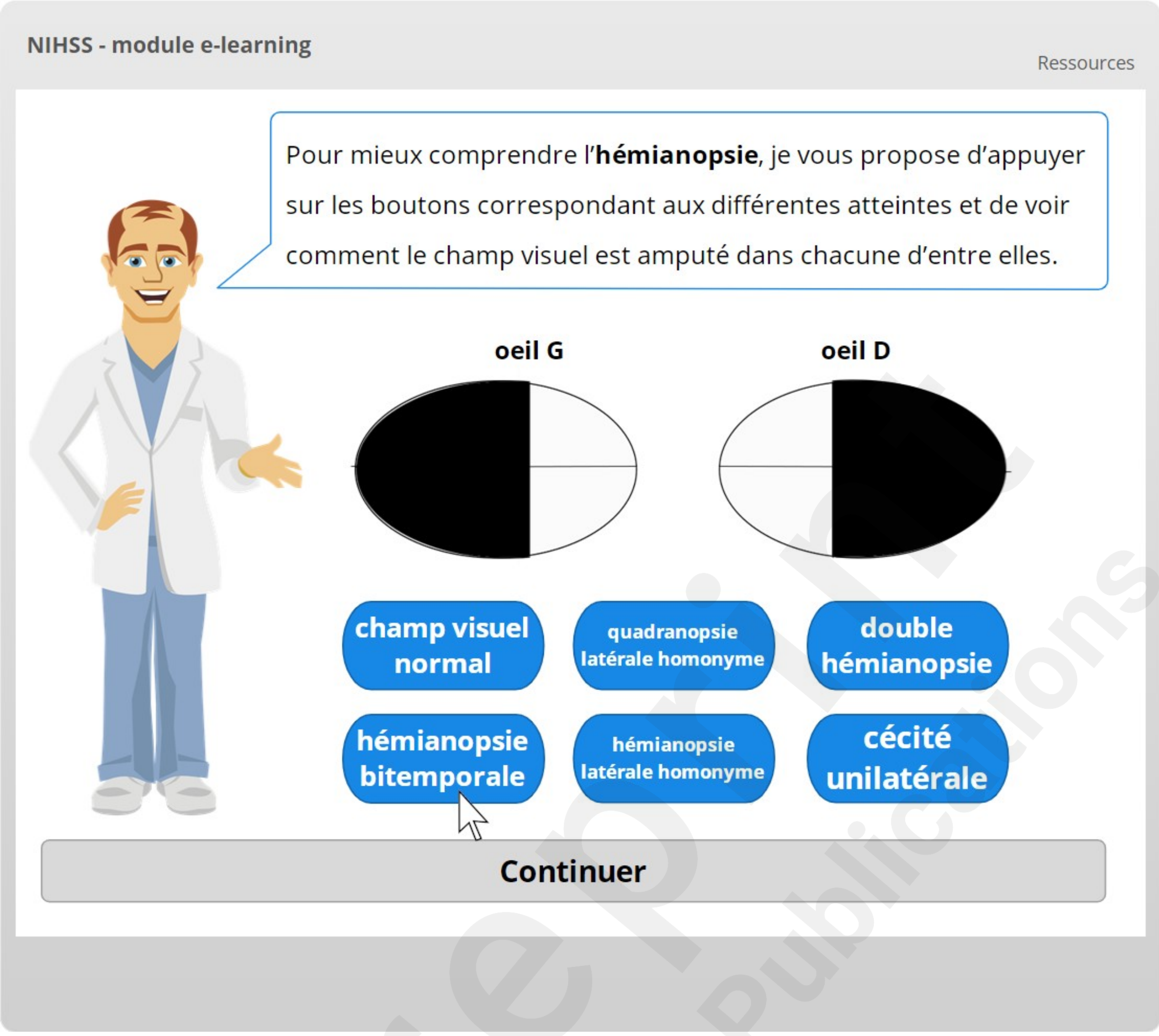

Figure 9. Interactive explanation of visual field deficit.

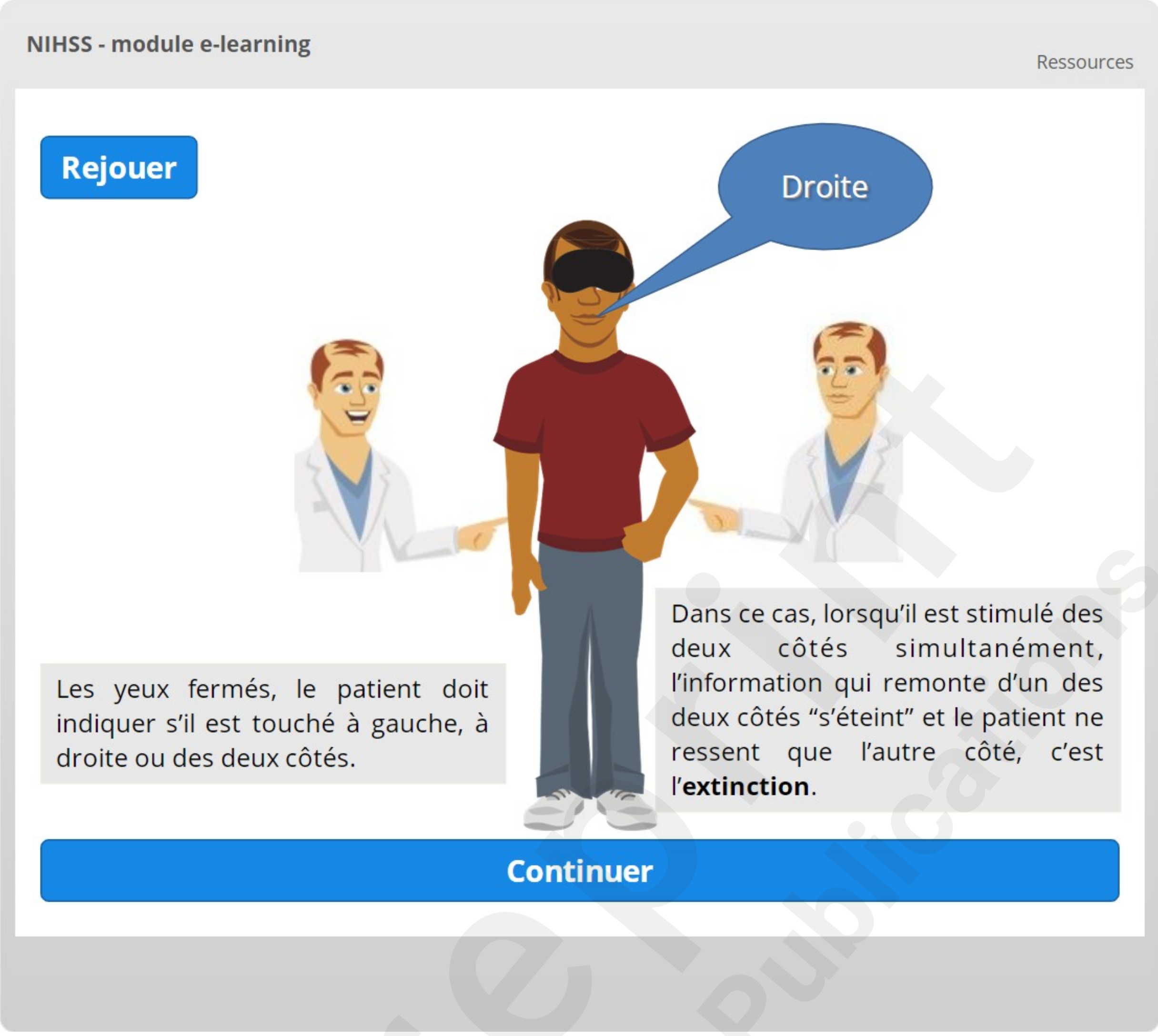

Figure 10. Animation used to explain extinction and inattention.

The user can choose to exit the module at any time, as a prompt will be shown to allow the user to either resume the module or reset it. Before the summary chapter can be activated, users must complete a fourteenth chapter which details the "coma score".

This e-learning module, along with its previously studied iteration, can be accessed freely on the internet [32].

Study sequence

Immediately after login, the medical students discovered the group to which they had been allocated and were asked a first set of 6 questions displayed over a single page. Upon answering these questions, they could then access the learning material. No time limit was applied apart from the study end date (June 8th 2020). Once the learning material was completed, students were allowed to proceed to a 50-question quiz. This quiz was identical for all participants and contained five questions related to basic NIHSS concepts, followed by the clinical evaluation of three patient taken from Patrick Lyden's certification videos. The NIHSS elements were displayed and scored one after the other according to the NIHSS scoring logic. After finalizing the quiz, participants were given their overall score as well as the possibility to review all questions at will and were shown their answers as well as the correct ones. Four questions, based on a 5-point Likert scale, were then asked to assess secondary outcomes such as satisfaction. Students were finally given access to both the video and the e-learning module to discover the other teaching modality and/or to review the one they had just followed.

Outcomes

The primary outcome was the proportion of correct answers to the 50-question quiz. Secondary outcomes were proportion of correct answers for each specific NIHSS item, user satisfaction, perceived adequacy of the time needed to complete the course, perceived difficulty of the course, probability the participant would recommend the course, and whether the learning path had been completed over multiple days.

Data collection and curation

Data was securely stored on an encrypted MariaDB 5.5.5 database (MariaDB foundation, Redwood City, USA) located on a Swiss server, before being extracted in CSV format. We used STATA (StataCorp. College Station, Texas, USA) for data curation and anonymization.

Statistical analysis

STATA 15.1 was used by LSt for statistical analysis. Incomplete answers to the 50-question quiz were not analysed.

Normality was assessed by graphical evaluation and, if in doubt, we used the Shapiro-Wilk test. We applied Fisher's exact test to categorical variables, and the Student's t-test or the Mann-Whitney U test to continuous variables accordingly to normality. We considered a two-sided *P* value lower than .05 as significant.

We used a convenience sample and calculated the power post-hoc. We defined, a priori, four sensitivity analyses, according to whether the participant had prior knowledge of the NIHSS, had already followed a specific NIHSS course, had worked in either an intensive care unit or in a neurology or neurosurgery ward for more than 3 months, or if the learning path had been completed over multiple days. This was defined as more than 12 hours elapsed between initiation and completion of the course.

Finally, we performed a univariate then multivariable linear regression to look for possible confounding factors.

Data availability

Our curated data file is available on Mendeley Data [33].

Results

Out of 158 potential participants, 75 (47.5%) completed the trial (Figure 11). Table 1 details their characteristics.

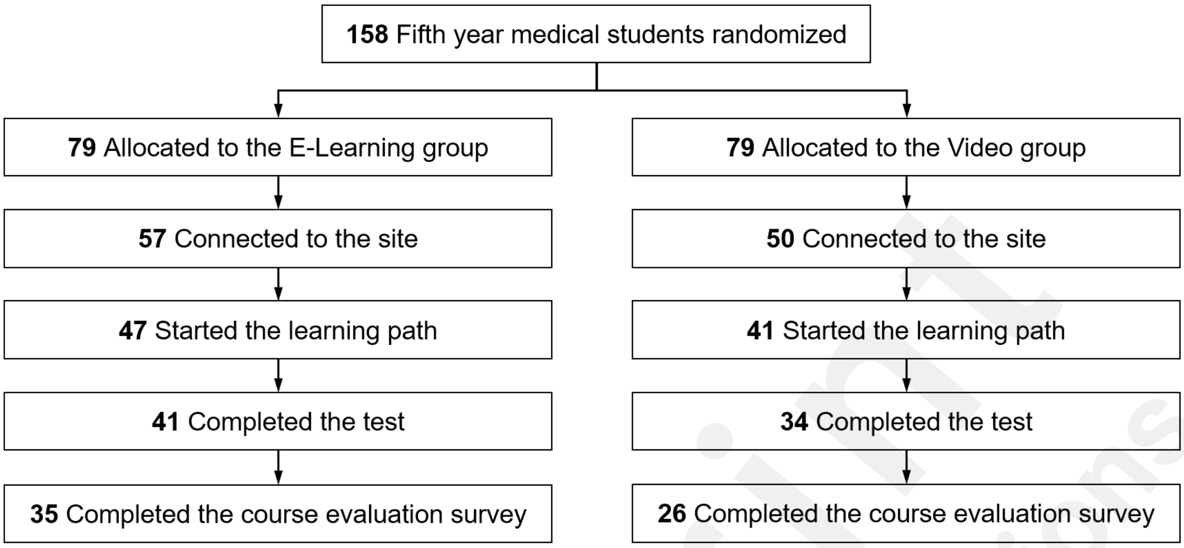

Figure 11. Study flowchart.

	Video (n=34)	E-Learning (n=41)
Missing, n (%)	2 (6)	2 (5)
Age, median [Q1;Q3]	24 [23;25]	24 [23;24]
NIHSS application already known, n (%)	3 (9)	3 (7)
Specific NIHSS course followed, n (%) among which by e-learning	4 (12) 0 (0)	2 (5) 0 (0)
Had worked in ICU or neurology ward, n (%)	0 (0)	1 (2)

ICU, Intensive Care Unit; NIHSS, National Institutes of Health Stroke Scale

Table 1. Participant data.

After the first mailing (April 28th, 2020) 21 students completed the trial. The first reminder (May 11th, 2020) led 29 more students to complete the course, while another 25 participated after the second and last reminder (May 18th, 2020).

Participants who followed the e-learning module performed better than those who followed the video (38 [95%CI 37 to 39] correct answers versus 35 [95%CI 34 to 36], *P*<.001). Participants in the e-learning group scored five elements better than the video group: key NIHSS concepts (*P*=.02), the consciousness – global item (*P*<.001), the facial palsy item (*P*=.04), the ataxia item (*P*=.03) and the sensory item (*P*=.04). There was no such effect in the video group. Detailed results are shown in Table 2.

	Video (n=34)	E-Learning (n=41)	*P* value
Overall score, mean (SD) [95%CI]	35 (3) [34 to 36]	38 (3) [37 to 39]	<.001
Detailed results by item, median [Q1;Q3]			
Key NIHSS concepts	5 [4;5]	5 [5;5]	0.02
Consciousness – Global	2 [2;2]	3 [2;3]	<.001
Consciousness – Questions	3 [2;3]	3 [3;3]	0.70
Consciousness – Commands	2 [2;3]	3 [2;3]	0.06
Gaze	2 [2;3]	3 [2;3]	0.34
Visual	2 [2;2]	2 [2;2]	0.23
Facial Palsy	1 [0;2]	2 [1;2]	0.04
Motor arm	4 [4;5]	5 [4;5]	0.17
Motor leg	5 [4;6]	5 [4;5]	0.23
Ataxia	1 [1;1]	1 [1;2]	0.03
Sensory	3 [2;3]	3 [3;3]	0.04
Language	1 [1;2]	1 [1;1]	0.63
Dysarthria	2 [2;2]	2 [2;2]	0.07
Extinction and inattention	2 [2;3]	2 [2;3]	0.14

Abbreviations: CI, Confidence Interval; NIHSS, National Institutes of Health Stroke Scale; SD, Standard Deviation

Table 2. Quiz results.

The rate of « very satisfied » participants was higher in the e-learning group (40% [95%CI 24 to 56] versus 15% [95%CI 5 to 25], *P*=.02) (Figure 12).

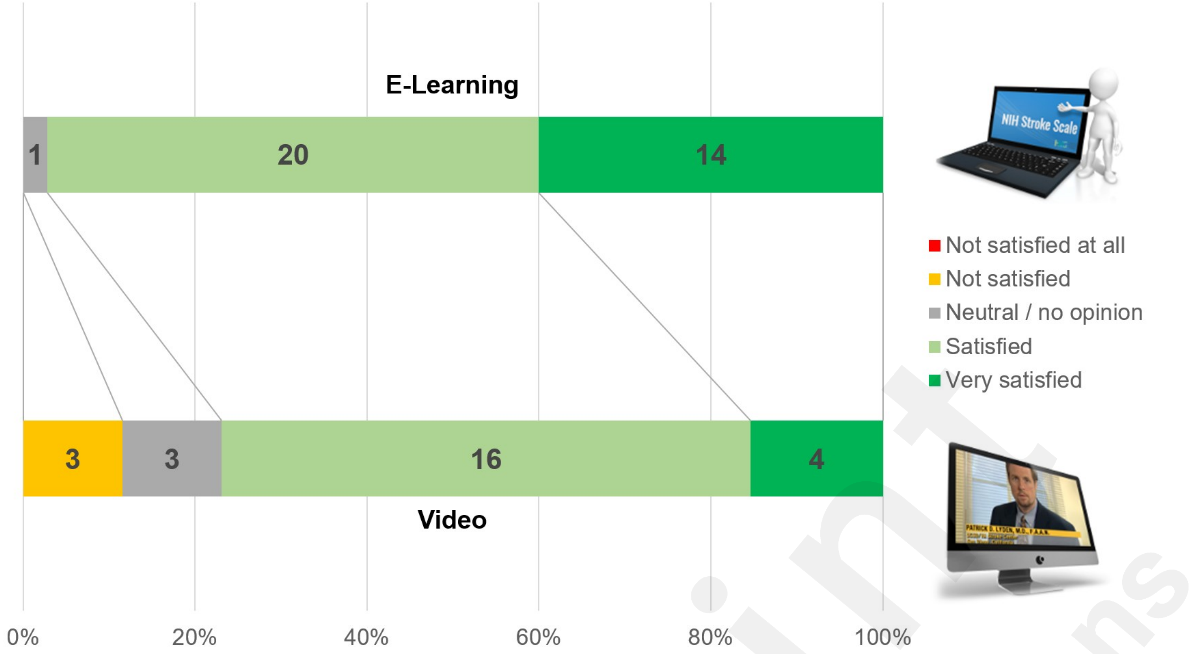

Figure 12. Satisfaction regarding the learning method.

Though the precise total learning time dedicated to either method could not be assessed owing to the study design, no statistical difference regarding the perceived duration of the course was identified (80% adequate in the e-learning group [95%CI 67 to 93] versus 65% [95%CI 47 to 83], *P*=.25). There was no significant difference regarding the perceived difficulty of the course, as 84% [95%CI 68 to 100] found it «easy or very easy» in the e-learning group versus 53% [95%CI 28 to 78] in the video group (*P*=.07). Participants who followed the e-learning method were more likely to recommend it to a colleague (66% answered «Yes, most certainly » [95%CI 50 to 82] versus 31% [95%CI 13 to 49] in the video group, *P*=.007) (Figure 13). The proportion of participants who followed the course over less than 12 hours was similar in both groups (58% in the e-learning group [95%CI 38 to 78] versus 52% [95%CI 35 to 69], *P*=.79).

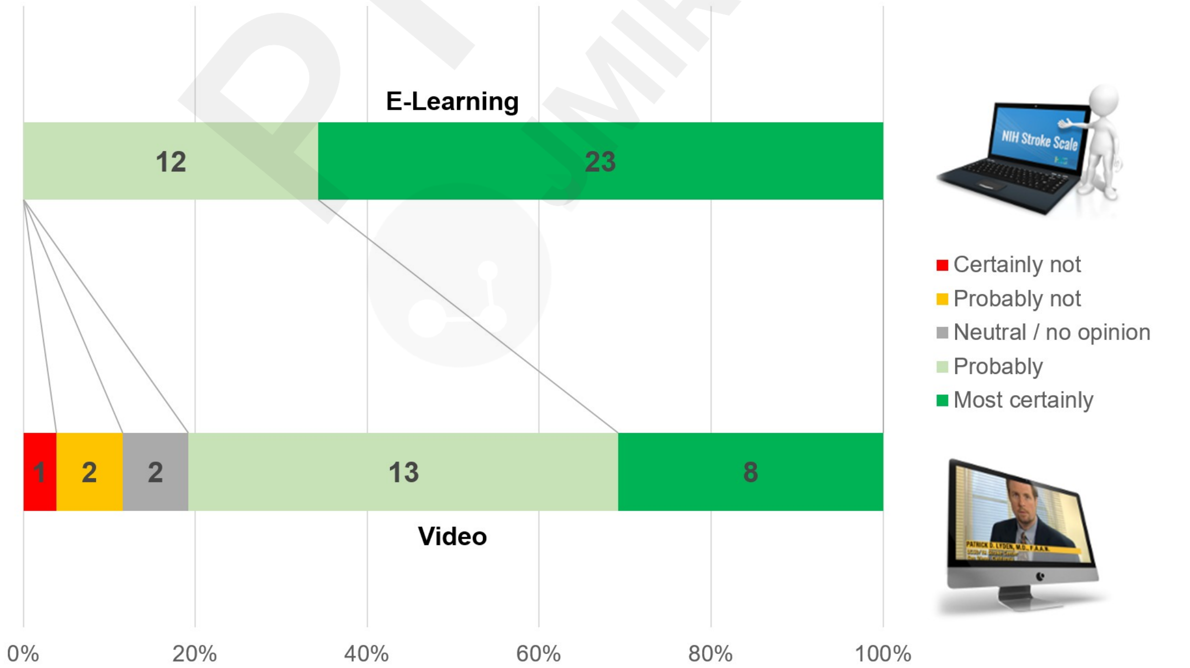

Figure 13. Probability that participants would recommend the course.

The post-hoc calculation showed a power of 97%. None of the four pre-planned sensitivity analyses showed any major change in the direction of the effect. The multivariable linear regression only showed a minor change in the coefficient (<15%), thus confirming these results.

Discussion

In this study, asynchronous distance learning using a highly-interactive e-learning module yielded better results than following the traditional didactic video online. The superiority of a previous version of this module has already been established in Swiss paramedics following an onsite computer-based course [23]. The present study confirms the generalizability of these findings when using this method for asynchronous distance learning in a different population of learners, i.e., fifth year medical students. Indeed, while paramedics follow a 3-year curriculum focusing on critical emergencies, baseline knowledge and understanding of neurosciences should be higher in students on the verge of getting their master of medicine degree [34]. This assumption is supported by the median score of the control group, which was higher by two points in this study than it was in paramedics [23].

The shortcomings we had identified in the previous iteration of the e-learning module seem to have been addressed as embedding cut scenes from the original video into every chapter of the module has improved its impact on knowledge acquisition. The use of short videos associated with active learning activities such as guiding questions or interactive elements has been shown to enhance knowledge acquisition and retention [35]. Interactivity itself is also known to improve both engagement and performance in medical students [36,37].

Slightly less than half of all potential participants completed their allocated learning path. Considering that the learning material was optional and that students' summative assessments of this year semester were replaced by formative assessments, the participation rate is rather encouraging given the global lack of incentive. More encouraging still is the proportion of students who would recommend the course to their peers since such mechanisms might increase students' involvement [38]. As many medical students actively helped during the crisis, some of them might have been prevented from participating in this study owing to their high workload [39].

The quiz shown to the participants upon completion of the learning material included not only the full evaluation of three different stroke patients, but also five general questions we had designed. While this could be thought as a potential bias in the study design, these questions were solely linked to key elements and basic principles of the NIHSS, and their understanding is essential to the correct application of the scale. Our aim was indeed to evaluate whether knowledge acquisition was different when presenting similar content in different learning formats. As the overall score regarding these questions was high in both groups, and as there were other significant results favouring the e-learning method, there is little probability that these five initial questions induced a bias.

In many hospitals, the NIHSS is commonly used to triage stroke victims and help reduce both door-to-CT and door-to-needle times [9]. Decreasing these times is associated with better neurocognitive and functional outcomes [40]. Moreover, the adoption of a common scale between different specialists seems necessary to improve reproducibility and avoid the misinterpretation that can result from the use of different scores [41]. Swift acquisition and mastery of the NIHSS is therefore an essential skill for medical students, as most will have to take care of stroke patients during their residency while working in the emergency department or in the neurology department. This is further strengthened by the fact that medical students often perceive neurology as the most difficult medical discipline and the development of negative perceptions towards this specialty could lead to avoidance mechanisms when considering a career or treating a patient [42]. We might therefore assume that any kind of stroke-directed educational program could help raise awareness in non-neurologist physicians and thus increase the rate of correct treatment while decreasing door-to-needle time.

This study has limitations that must be acknowledged. The main limitation is that we only measured immediate knowledge acquisition, but were unable, given the study design and the limited timeframe, to assess knowledge retention. As this latter parameter is critical to the clinical application of the NIHSS, further studies will be needed to assess whether the e-learning method improves retention and leads to more accurate application of the scale. Moreover, the precise time taken to complete either learning method was not evaluated in this study. While it could be argued that dedicating more time to learning a given content should yield better results, studies have shown that engagement is the most important factor regarding knowledge acquisition [43]. Though time to learning material completion is nevertheless an interesting outcome, we chose not to record this data for two main reasons: risk of unblinding and technical limitations. As the time required to watch the video is fixed unless the participants elect to use the video commands, and as most of them chose not to use this option in a previous study [23], we thought it better not to risk unnecessarily unblinding the data analyst. The technical aspect was linked to the online learning management system and to the mode of delivery of the teaching material. As access to the university premises was barred during the study period, participants followed the learning material from many different locations. Interruptions in the learning process might therefore have happened but we had no means of recording recurrent short breaks in the group that followed the e-learning module, as pauses might also result from taking notes, mulling over the content, or just re-reading some of the written paragraphs to better understand them. To mitigate this limitation, a sensitivity analysis comparing those who had completed the study path in either less or more than 12 hours was performed. Reassuringly, no difference was noted.

Despite these limitations, this study also has several strengths, among which the randomization, the blinding mechanisms, the electronic data acquisition, the originality of the learning method and its way of delivery in the context of the COVID-19 pandemic could be conceded.

Conclusion

Compared to the traditional didactic video, a highly-interactive e-learning module enhances distant NIHSS knowledge acquisition in medical students.

Acknowledgements

The authors would like to thank Mr Daniel Scherly from the UGFM for his technical assistance as well as for having dispatched the mails and the reminders on our behalf.

Declarations of interest

Funding

None.

Other Disclosures

Though the e-learning module was created by four of the authors (Mélanie Suppan, Loric Stuby, Avinash Koka and Laurent Suppan), these authors declare no financial conflict of interest as the module is freely available on the study's website.
The other authors (Emmanuel Carrera, Philippe Cottet, Frédéric Assal and Georges Louis Savoldelli) report no potential competing interest.

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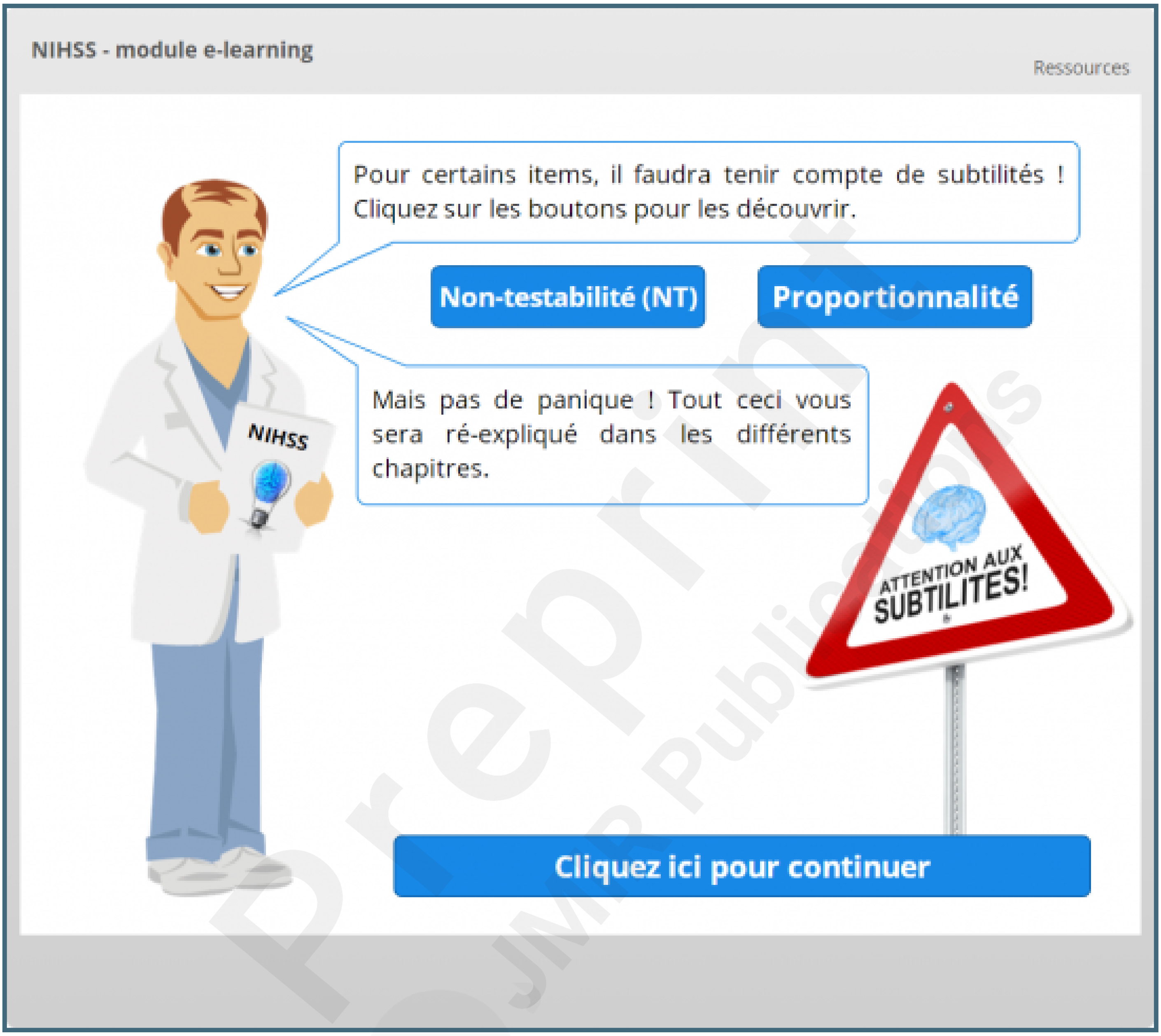
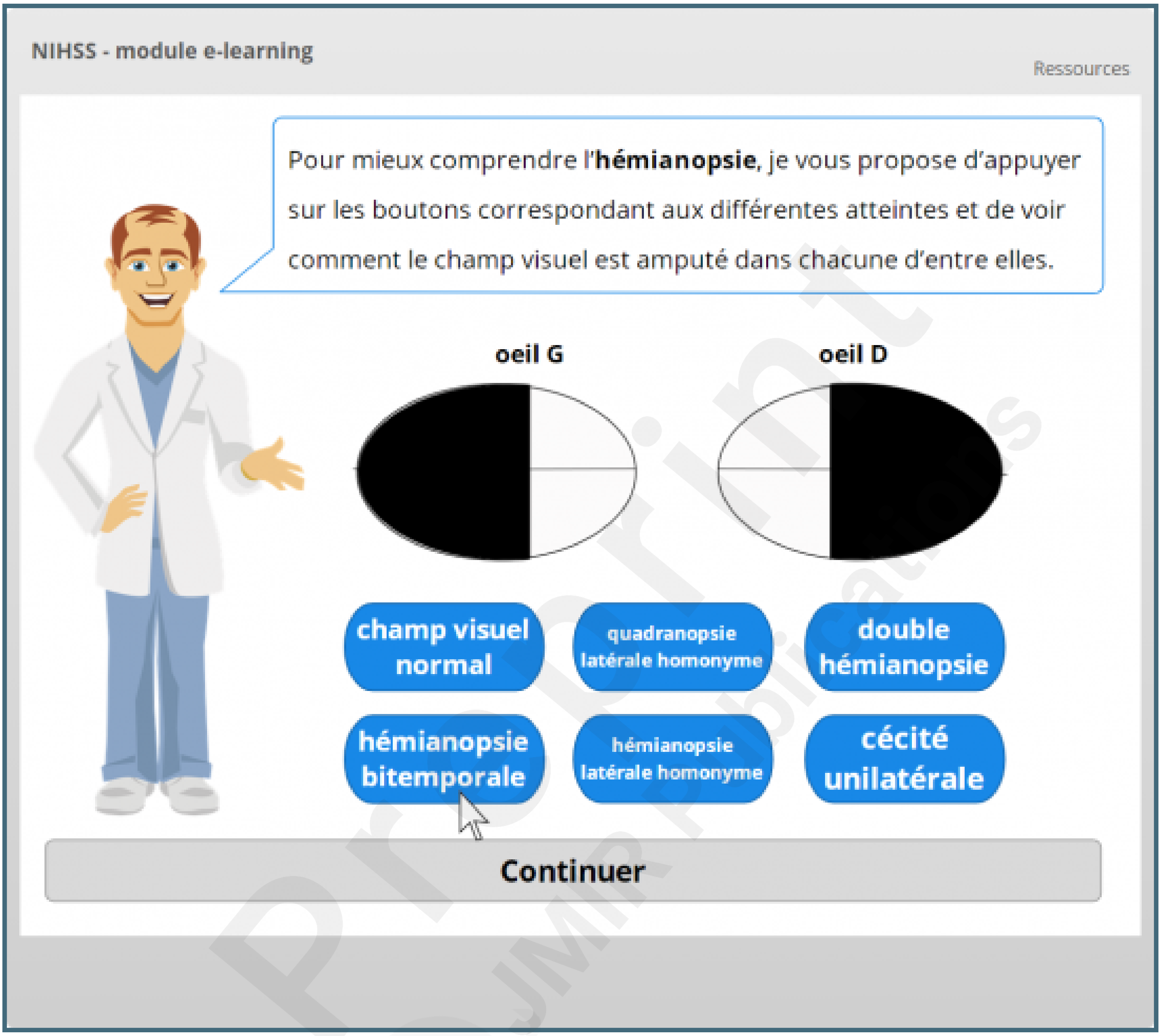
Supplementary Files

Figures

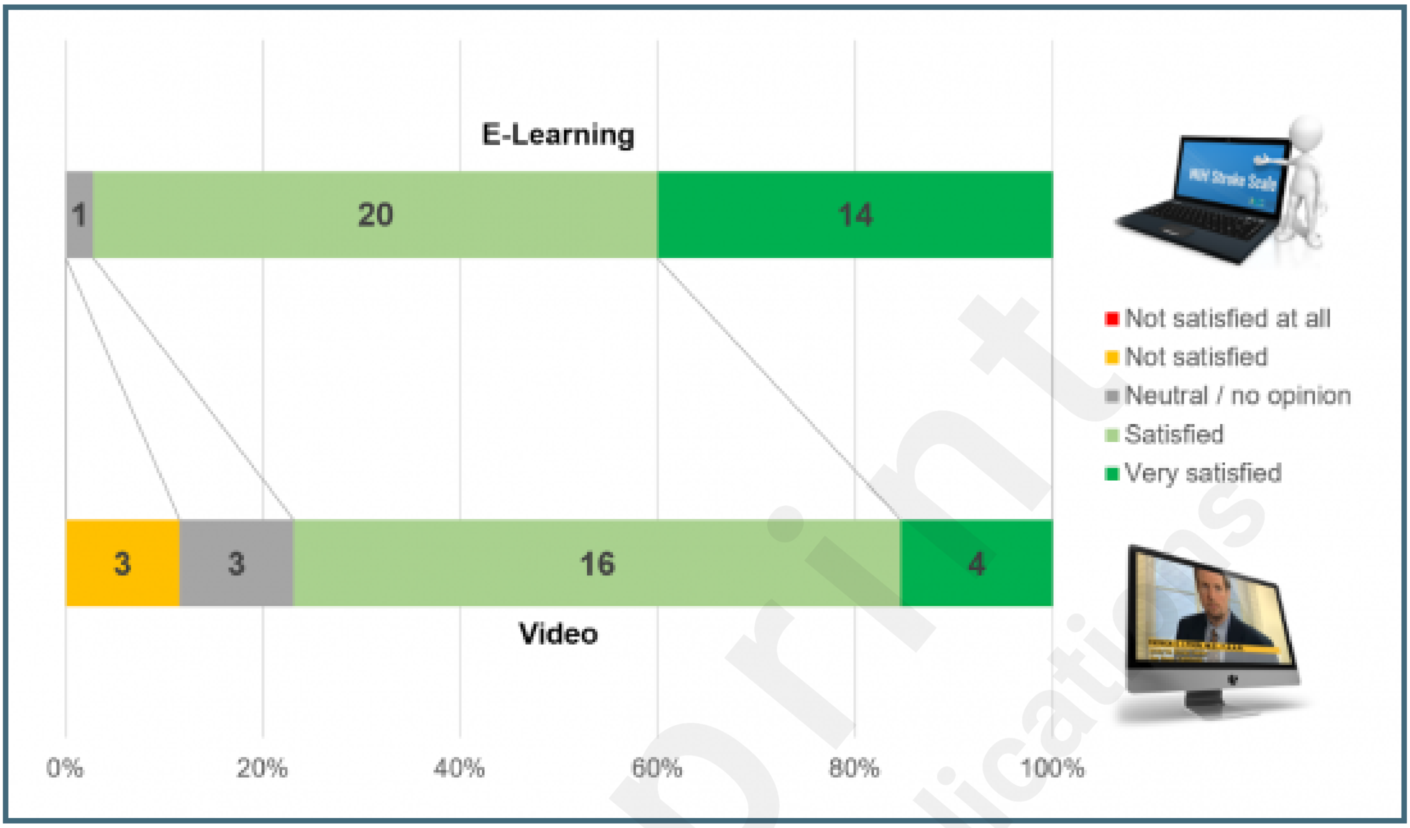
Both buttons have been clicked and the user has seen both lighboxed slides. The *Cliquez ici pour continuer* (Click here to continue) button has thus been activated and is now coloured in blue.



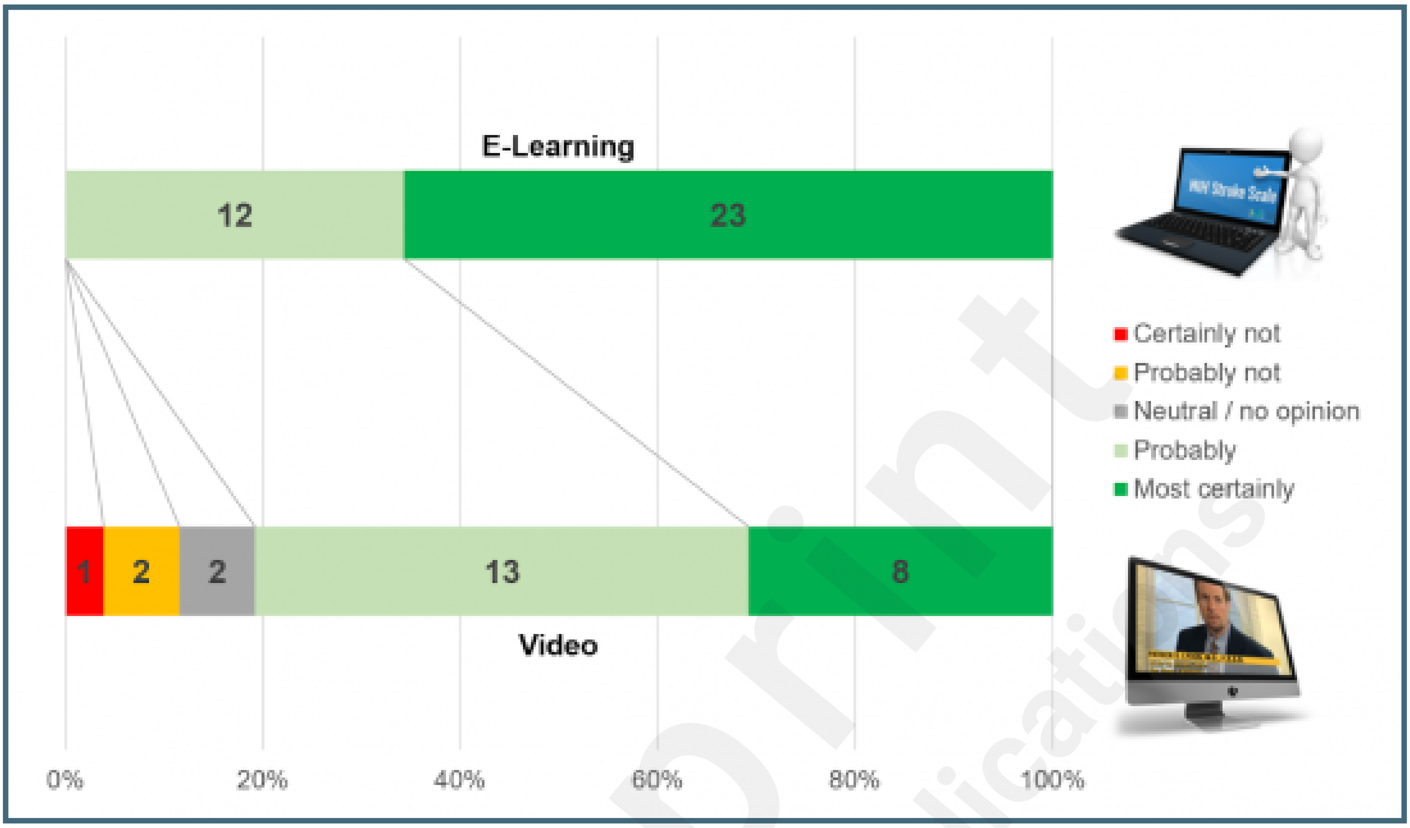
Interactive explanation of visual field deficit.



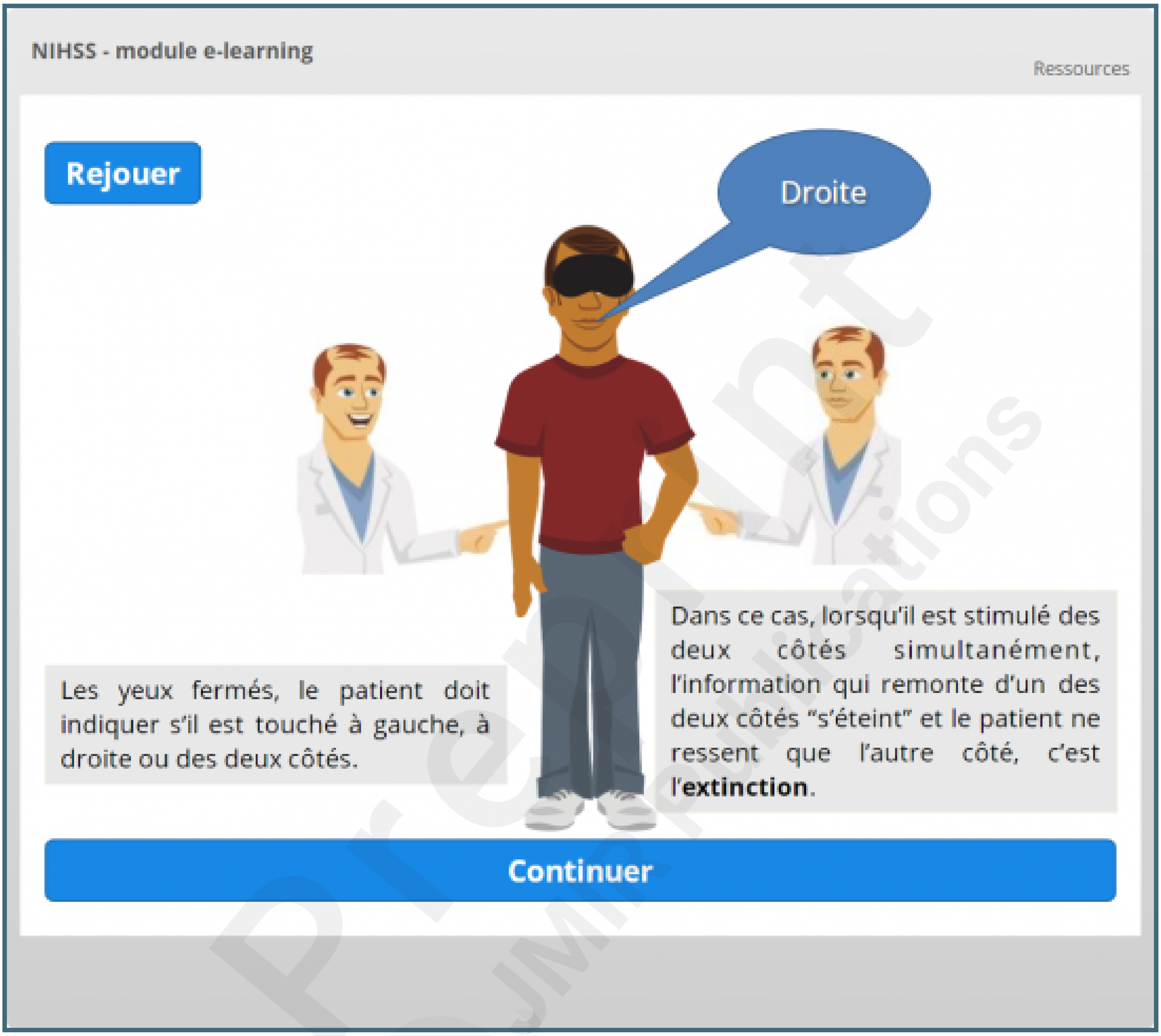
Satisfaction regarding the learning method.



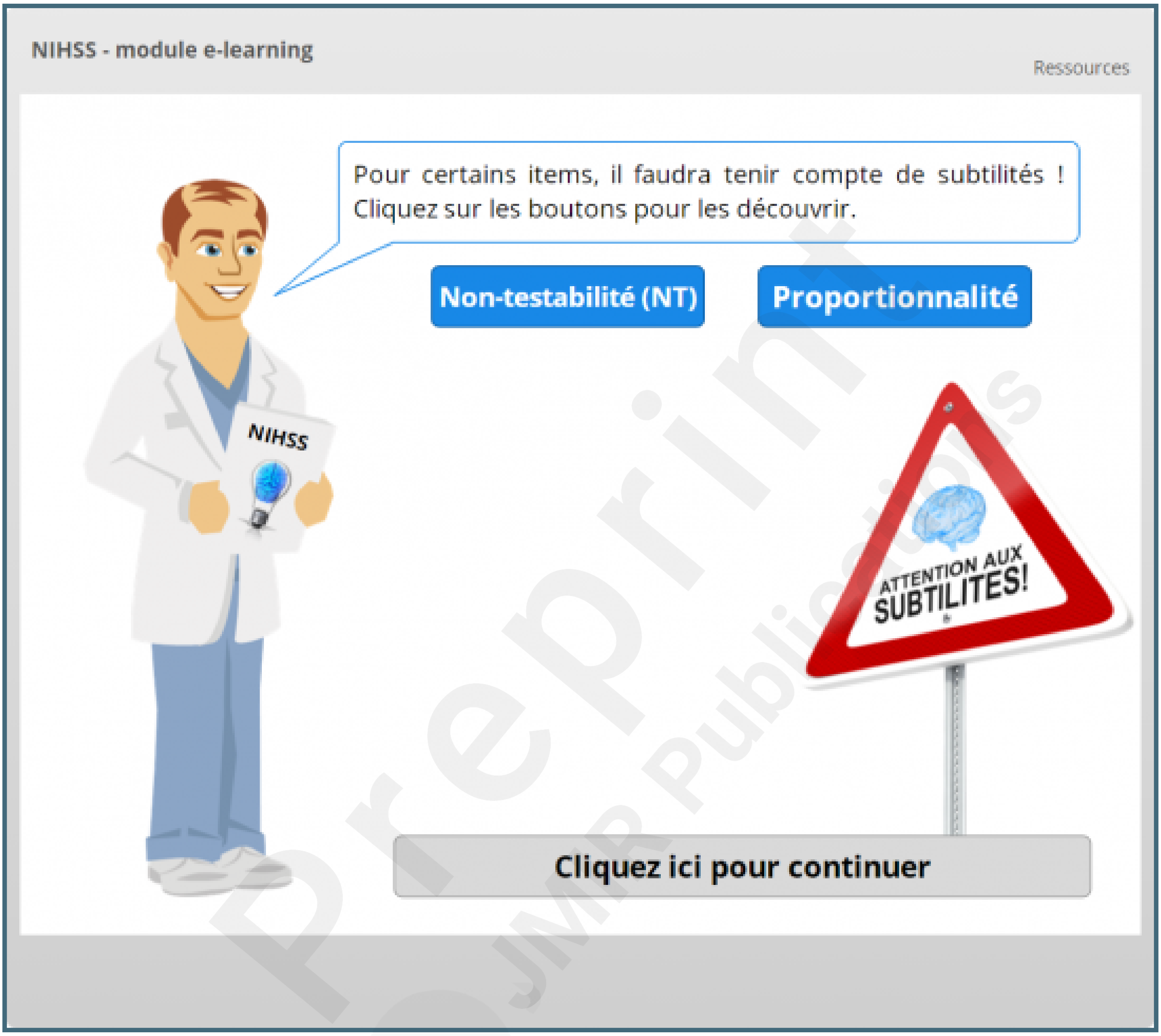
Probability that participants would recommend the course.



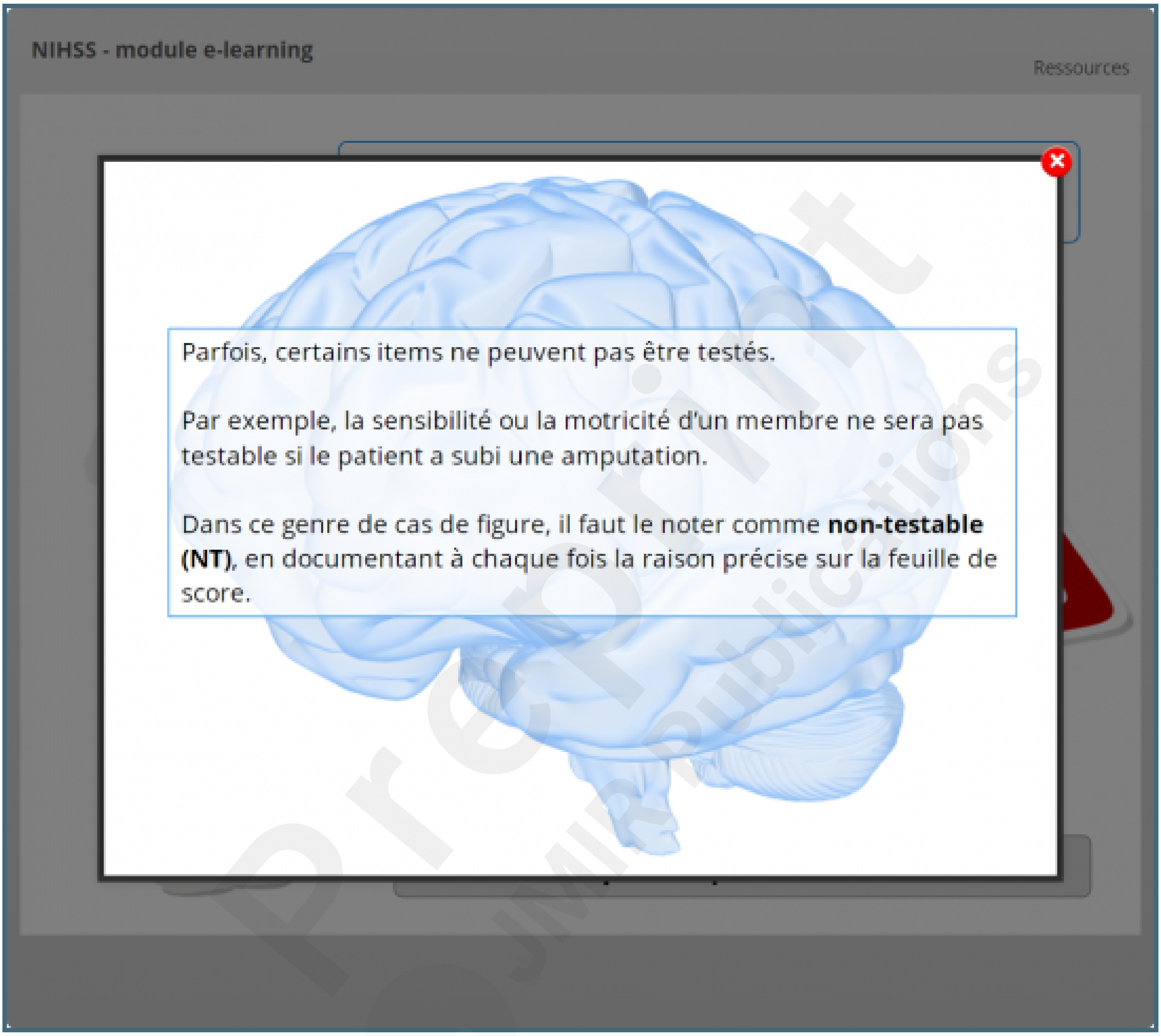
Animation used to explain extinction and inattention.



Avoiding content skipping. The user cannot click on the *Cliquez ici pour continuer* (Click here to continue) button until both blue buttons have been clicked.



The user has clicked on one of the two buttons, and the learning content is now displayed in a lightbox. The *Cliquez ici pour continuer* (Click here to continue) button, which can just be identified in the background, is still in grey and, therefore, inactive.



Study flowchart.

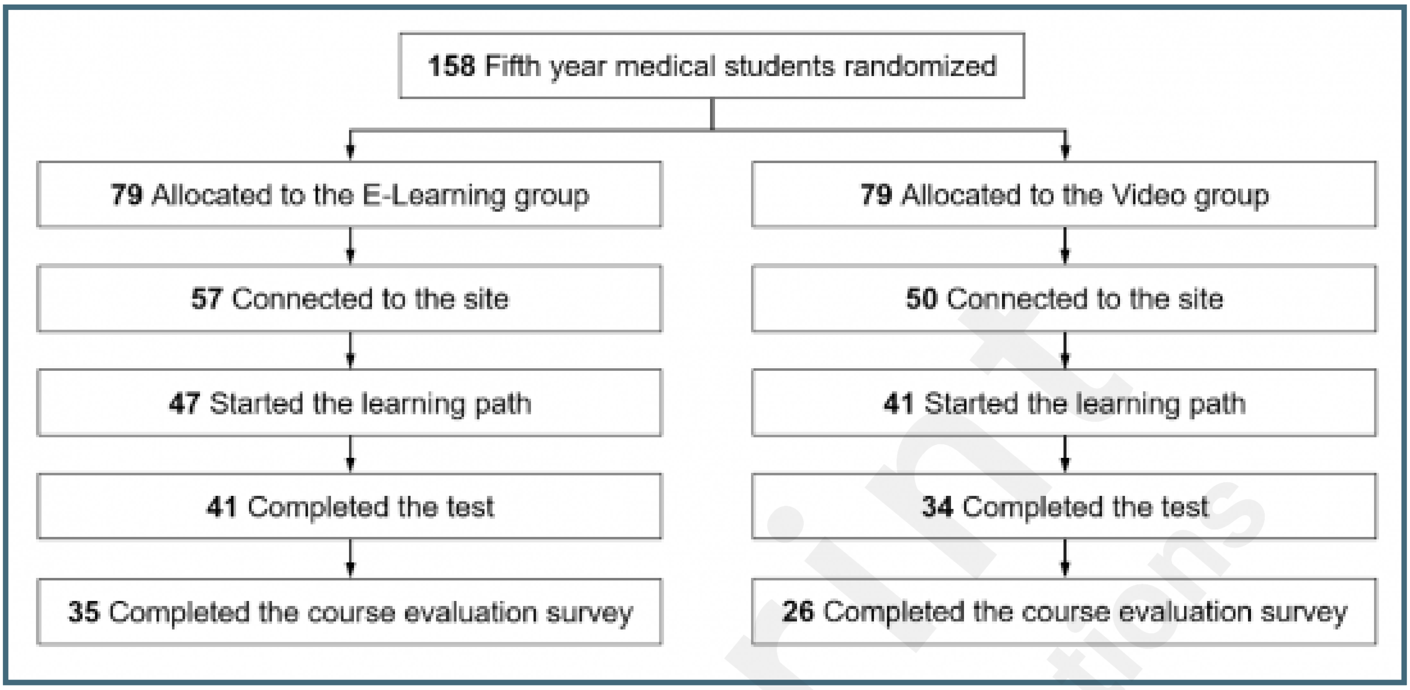
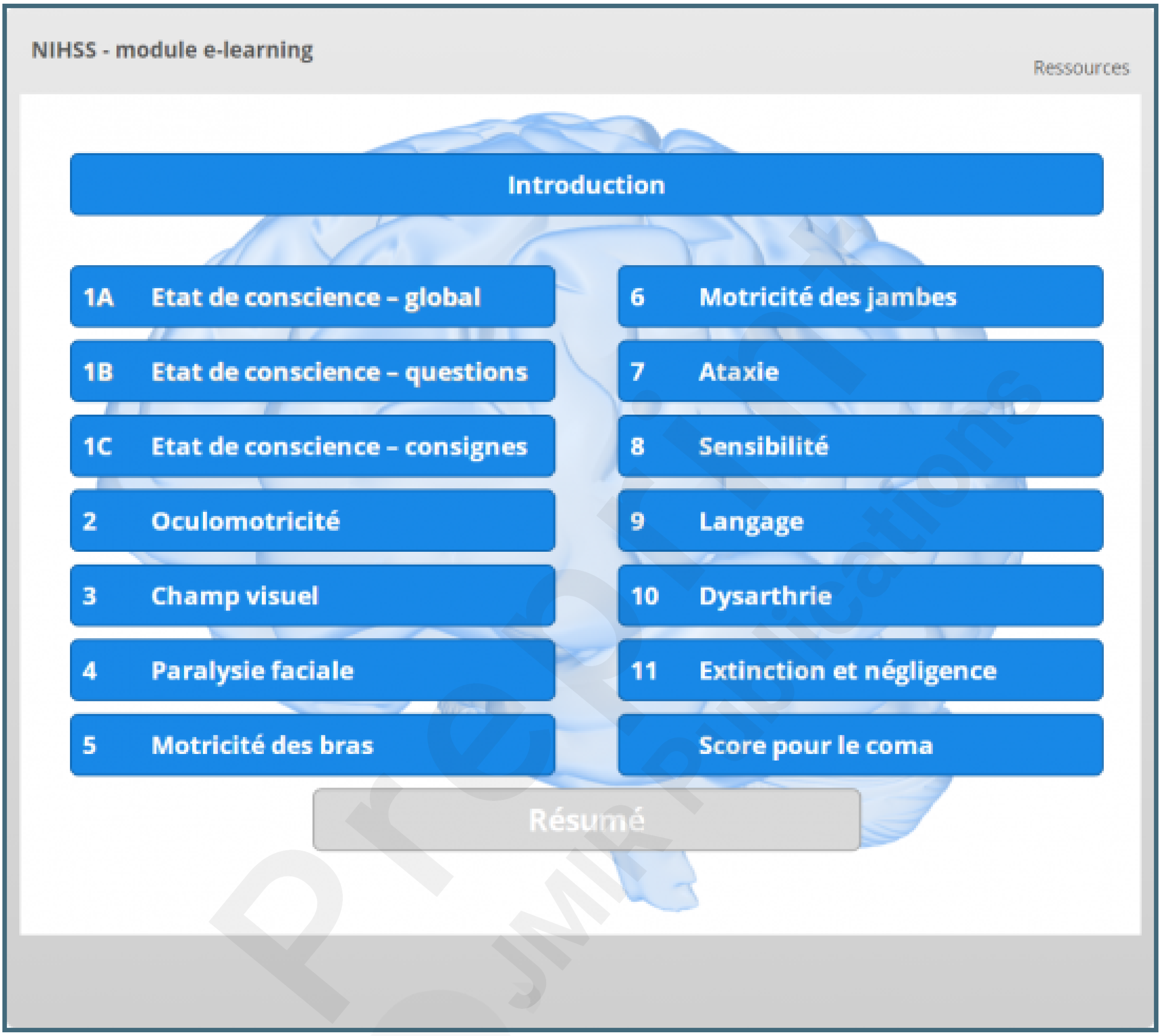
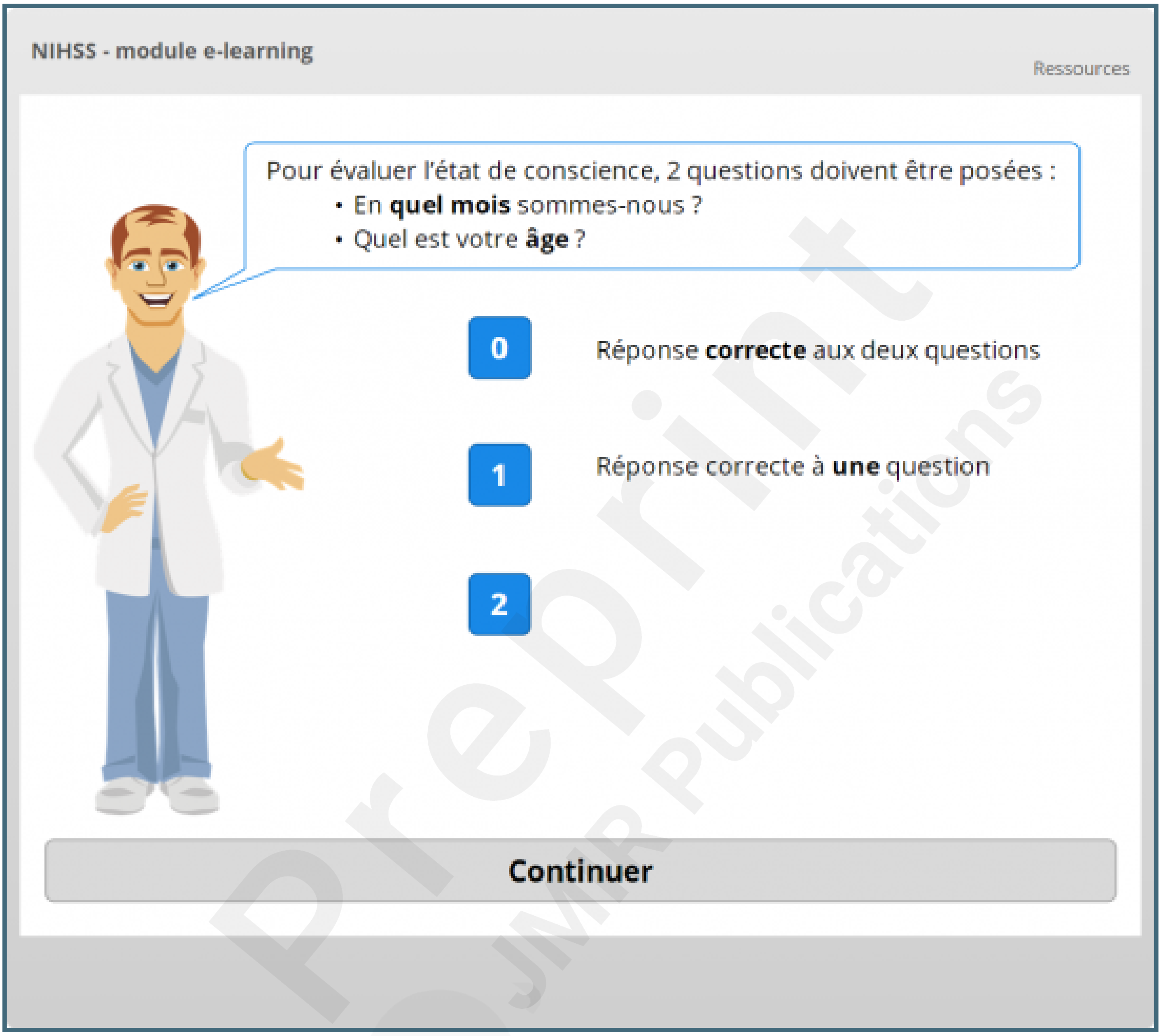


Table of contents. The *Résumé* (summary) can only be accessed once all the other chapters have been completed.

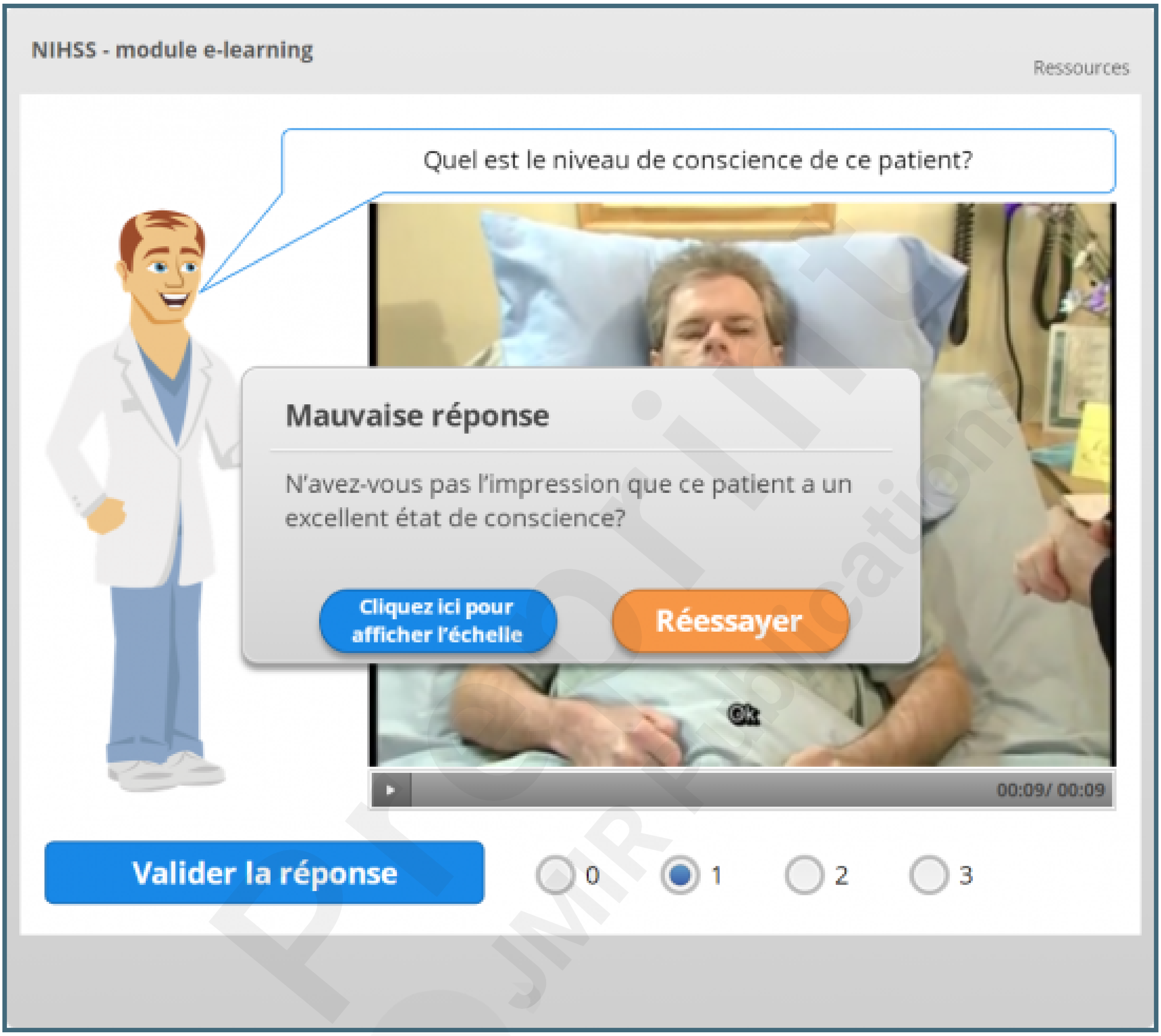


Avoiding content skipping. The user cannot click on the *Continuer* (Continue) button until all blue buttons have been clicked.

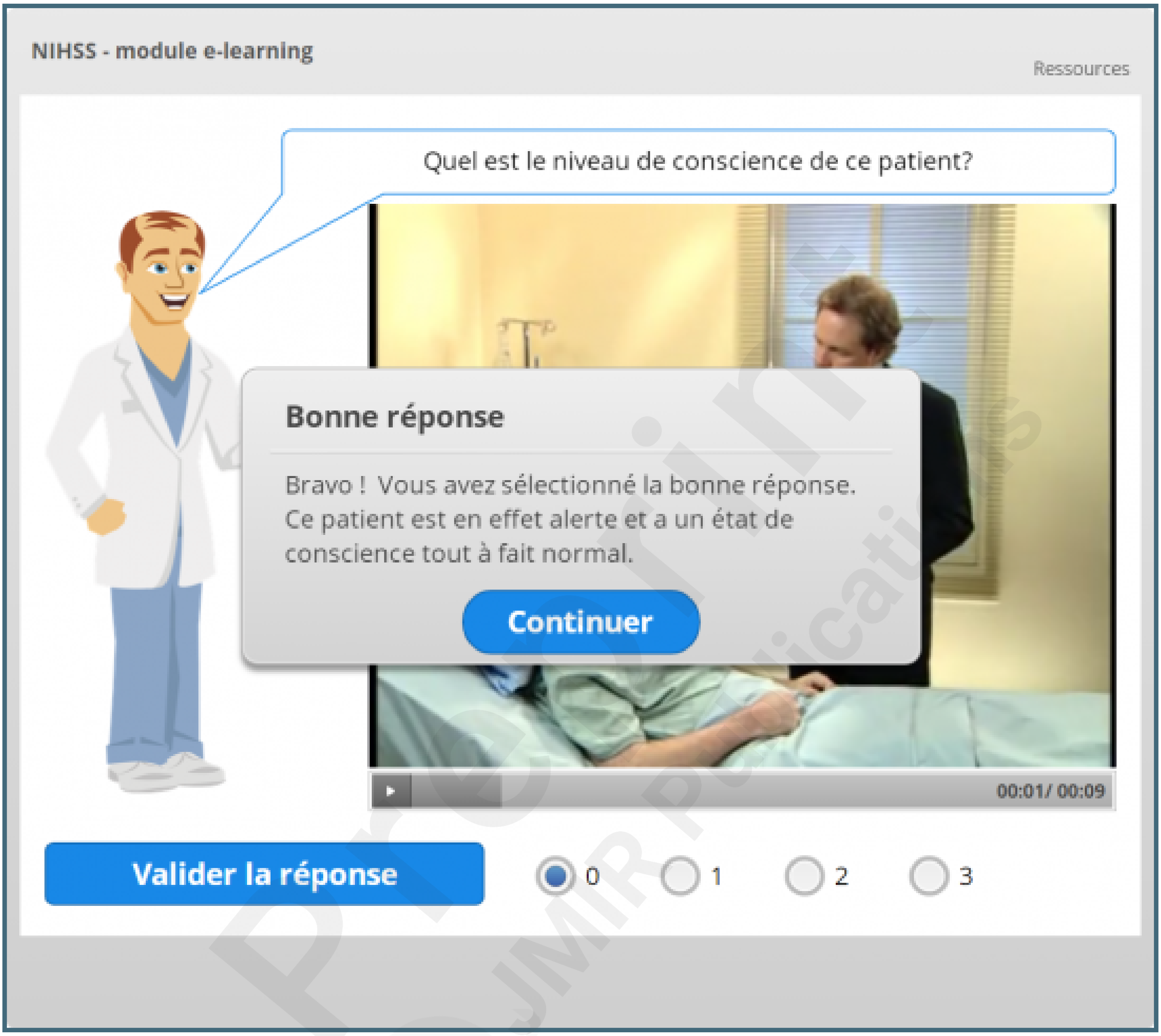


Video-based question. The user must choose the correct score for the patient displayed in the video before clicking on *Valider la réponse* (Validate the answer).

Feedback and clue. The user can choose either to *Réessayer* (Try again) or to review the scoring specific to this item (*Cliquez ici pour afficher l'échelle* – Click here to display the scale).



Positive feedback after a correct answer.



Multimedia Appendixes

Mailing template.
URL: https://asset.jmir.pub/assets/9500bf517f932f67e4c4d8d25050e3c8.pdf

Original questions used in the 50-question quiz.
URL: https://asset.jmir.pub/assets/ae3460cf66b26c5add1a3077e2da8ec0.pdf

CONSORT (or other) checklists

CONSORT-EHEALTH 1.6.1 checklist.
URL: https://asset.jmir.pub/assets/136f5571ae3f7918e6a34e9a570b1f18.pdf