Abbreviated title: New neuropsychological questionnaire for dizziness

The development of a new questionnaire for cognitive complaints in vertigo : The Neuropsychological Vertigo Inventory (NVI)

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ABSTRACT

Objective: Vertigo patients frequently complain of emotional and associated cognitive problems, yet currently, there is no satisfactory questionnaire to measure these associated problems. In the present paper, we propose a new internet-based Neuropsychological Vertigo Inventory (NVI; French) that evaluates attention, memory, emotion, space perception, time perception, vision and motor abilities.

Methods: The questionnaire was created using four steps: (i) open-interviews with patients suffering from vertigo; (ii) semi-structured interviews with an analysis grid to quantify and define the various cognitive and emotional problems reported by the patients; (iii) a first version of an internet questionnaire tested on 108 vertigo participants, and; (iv) the selection of subscale items using Principal Component Analyses (PCA). From the development phase, the revised NVI was composed of 7 subscales, each with 4 items (28 items). In the validation phase, Cronbach's alphas were performed on the revised NVI for total and each subscale score, and in order to test extreme groups validity, Analyses of Covariance (ANCOVAs) taking into account age were performed between 108 vertigo and 104 non-vertigo participants.

Results: The Cronbach's Alphas showed good to satisfactory coefficients for the total and for all subscale scores, demonstrating acceptable reliability. The extreme groups validity analyses (ANCOVAs) were reliable for the total scale and for four subscales. Supplementary analyses showed no effect of hearing difficulties, and an inverse age effect for attention and emotion subscales, with reduced problems with increased age in the vertigo participants.

Conclusion: The NVI provides a useful new questionnaire to determine cognitive and emotional neuropsychological complaints that are associated with vertigo.

INTRODUCTION

Vertigo is a common symptom that occurs in various central and peripheral pathologies, and has been reported to affect up to 48.3% of the north-eastern France population [1]. The term vertigo is usually defined as a feeling that things are spinning or moving around [2–5]. However, in the general population, this term is frequently associated with symptoms in dizziness (feeling of being light-headed or 'swimmy'), visual perception and/or balance. All these symptoms could be sustained by overlapping cerebral networks, notably the vestibular system [6–8]. Damage to this system could lead to vertigo/dizziness/imbalance, but also to more general cognitive or emotional complaints. For example, abnormal emotional processing and vertigo symptoms have been frequently reported in Ménière's disease (MD) [9–12], leading to a profound deterioration of patients' quality of life [13].

In addition to the frequent association between vertigo and emotional disorders, clinician reports suggest that vertigo patients also frequently complain of associated cognitive symptoms, including attention, memory and space perception. For example [14] reported evidence of memory, disorientation, anxiety and mood problems in patients with perilympathic fistula associated with mild cranio-cervical trauma. Since this paper, research has either followed-up the study by evaluating cognitive disorders (with behavioural experiments) or by evaluating emotional disorders (with questionnaires) associated to vestibular/vertigo disorders. In these latter studies, the majority of the questionnaires used to evaluate emotional disorders have particularly focused on anxiety and depression symptoms.

The role of anxiety in vertigo has been intensively investigated, showing that the percentage of vertigo patients (and dizziness) with anxiety can vary from 13.3% [15] to 28.3% [16]. Anxiety is considered to be either an indirect cause of vertigo in vestibular disorders, or the consequence of the vestibular affection [17–19]. In support of the latter, the evolution of anxiety presented by some patients with vestibular neuritis has been explained, at least partially, by a specific anxious personality style (such as insecure personality type) [20]. The psychological distress (anxiety and depression) associated with vertigo is more linked to the severity of the vertigo (evaluated by the Dizziness Handicap Inventory – DHI) compared to the type of disease causing the vertigo (Ménière's disease, vestibular neuritis, etc.) [21]

For behavioural research, the study by [14] reported a series of cognitive symptoms in patients with perilymph fistula associated with mild cranio-cervical trauma. These patients showed significant impairments in cognitive tasks such as block design and paired associate learning despite having normal intellectual functioning. Following this original work, research focused on the potential links between visuo-spatial cognition and vestibular function. Specific spatial navigation path deficits have been reported in patients with compared to without vestibular deficits [22–26] Brandt et al. [25] showed that patients with acquired chronic bilateral vestibular loss from neurofibromatosis type 2 had more difficulties to find an immersed platform in a virtual variant of the Morris water task if the patient had to remember the location of the platform compared to when the platform was always present during the task. These results were correlated to hippocampal atrophy (16.9%), demonstrating a relation between vestibular impairment and memory. However, the performance on the classical Weschler Memory Scale didn't show any significant difference between patients and control participants, suggesting that the impairment was specific to spatial memory in the navigational task.

A related field of research has focused on measuring the influence of vestibular stimulation on cognitive performance in healthy (non-vestibular) participants. For example, Galvanic vestibular stimulation has been shown to modify attention on a line bisection task, creating a bias towards the side of stimulation [27]. Also, rotatory vestibular stimulation has been shown to alter self-centred mental imagery, demonstrating a role of vestibular function in perspective [28].

Despite the growing body of literature about the role of vestibular function in visuo-spatial cognitive processing, few studies have investigated (in a single instrument), the subjective cognitive complaints of vertigo patients. Instead, most questionnaires that have investigated vertigo have evaluated physical symptoms and their impact on patient quality of life (mostly from an emotional point of view). The DHI is the most commonly used questionnaire in vertigo. It's original internal consistency (Cronbach's Alpha from 0.72 to 0.89) and test-retest reliability (interclass correlation coefficient [ICC] from 0.72 to 0.97) are considered as established [29]. However, the validity has been investigated only with item-total correlation instead of factor analysis [30, 31]. Furthermore, there are only a few questions about cognitive complaints (difficulty of reading and difficulty to concentrate).

Other questionnaires have used general patient quality of life not specific to vertigo or dizziness [30]. In **Table 1**, we summarise the different questionnaires that have been used in research for evaluating vertigo/dizziness symptoms and their impact on quality of life and/or on the emotional statute of the patients. None of these questionnaires evaluated specific cognition disorders that could be linked to vestibular impairments.

In the present paper, we propose a new questionnaire, for the first time specifically evaluating physical, emotional and cognitive complaints in one single inventory. Our aim was to provide a new accurate clinical tool to refine the diagnosis of vertigo patients. As a newly developed instrument, our new questionnaire must show some psychometrics qualities. Reliability could be evaluated through reproducibility/repeatability of participants' score after a certain period (test-retest reliability), in another form of the questionnaire (parallel form reliability), or it could also be evaluated through the internal consistency of the items within each subscale [32]. This last option was used to confirm each of the subscales and the total score of our new questionnaire using Cronbach's alpha analyses. In addition, validity (does our new questionnaire measure what it intends to measure) could be demonstrated using face, content, criterion-related, construct, concurrent, predictive, discriminant, convergent or extreme groups validity analyses [32]. In this study, we choose to explore extreme groups validity in order to show that participants with vertigo had a higher score of complaints compared to control participants, and thus, that our new questionnaire is valid for the specific vertigo population. We first present the methods and results for the development of the NVI questionnaire, followed by the methods and results for the extreme groups validity of the NVI questionnaire.

140 **Table 1**

Instrument (Abbreviation name)	Domains evaluated				References
	Physical symptoms	Daily activities / Quality of life	Emotion	Cognition	
Activities-specific Balance Confidence (ABC)		X			[33]
Activity of Daily Living Questionnaire (ADLQ)		X			[34]
Dizzy Factor Inventory (DFI)	X	X	X	2 questions	[35]
Dizziness Handicap Inventory (DHI) + short form	X	X	X	2 questions	[29]
European Evaluation of Vertigo (EEV)	X				[36]
Falls efficacy scale		X			[37]
Medical outcomes study short form 36 (SF-36)	X	X	X		[38]
Meniere's Disease Patients-Oriented Severity Index (MD-POSI)	X	X	X	2 questions	[39, 40]
Modified falls efficacy scale (MFES)	X				[41]
Patient Heath Questionnaire (PHQ-9)	X		X	1 question	[42]
Prototype Questionnaire (PQ)	X	X	X	2 questions	[43]
Situational Characteristics Questionnaire (SitQ)		X			[44]
UCLA Dizziness questionnaire (UCLA-DQ)	X	X	X		[45]
Vestibular Activities and Participation (VAP)		X	X	1 question	[46]
Vertigo-Dizziness-Imbalance Questionnaire (VDI)	X	X	X	2 questions	[47]
Vertigo Handicap Questionnaire (VHQ)	X	X			[48]
Vertigo Symptom Scale (VSS) + short form	X			1 question	[49]
Vestibular Disorders of Daily Living Scale (VADL)		X			[23, 50]
Vestibular Rehabilitation Benefit Questionnaire (VRBQ).	X	X	X	1 question	[51]

141 Classification of commonly used questionnaires and their related domains in vestibular studies.

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Development of the NVI Questionnaire

Methods

Participants, Design and Procedure

The NVI questionnaire was created using a 4-step process. First we conducted open interviews on patients suffering from vertigo (following various vestibular disorders such as vestibular neuritis, MD, etc.) who consulted in the Ear-Nose and Throat department of our clinic. Second, from these open interviews, we created a grid of general question categories and we performed a semi-structured interview with a new group of 14 vertigo patients to define different subcategories of cognitive complaints. We formulated 17 general question categories using "before/after" questioning such as "how was your memory before your balance difficulties?", with supplementary sub-questions used to facilitate patient responses if they could not find a spontaneous answer. The 17 question-categories consist of difficulties in : (1) general perception of balance; environment perception in (2) dynamic or (3) static conditions; (4) fine motor skills; (5) spatio-temporal orientation; (6) 2-dimension motor abilities; (7) 3-dimension motor-abilities; (8) 2-dimension reproduction abilities; (9) 3-dimension reproduction abilities; (10) 2-dimension mental imagery abilities; (11) 3-dimension mental imagery abilities; (12) mental rotation; (13) planning; (14) attention; (15) memory; (16) emotions, and (17) other complaints (17). In the third step, we created a first version of the questionnaire by selecting the seven most relevant question categories that we renamed as subscales of cognitive complaints based on the previous steps. These subscales were Space Perception; Time Perception; Attention; Memory; Emotion; Vision and Motor. Each subscale was composed of 6 items making a total of 42 (for example "I read slowly" in Vision Subscale, see **appendix 1** for the original French version). To ensure that each question was clearly understandable, we pre-tested the first original version of the questionnaire on naïve control participants (25) and corrected any unclear items.

The final step of the questionnaire development involved new participants completing the questionnaire online. The participants rated each item using a 5-point Likert scale (1, never; 2, rare; 3, sometimes, 4, very often; 5, permanently). This was selected to reduce the time needed to complete the questionnaire and to provide the patient with an opportunity to make a non-dichotomous response. We added a "Distractor" subscale in order to analyse extreme groups validity. We expected to observe significant differences between vertigo and

non-vertigo participants in the target subscales, but no difference in the distractor subscale. Differences for this last subscale would suggest a higher level of non-specific complaints in vertigo participants. In addition to the online questionnaire, additional demographic questions were given to the participants. These included questions asking for the sex, age, associated health conditions, etc. of the participant.

The questionnaire was sent to vertigo participants through patient associations in Belgium using the internet platform Limesurvey® (https://www.limesurvey.org). One hundred and eight vertigo participants completed the questionnaire. Vertigo-participants were mostly female (69) and right-handed (94). Their mean age was 54.3 $\pm$ 15.2 years. The participants were recorded as suffering from vertigo due to their positive answer to the question, "Do you suffer from vertigo?". More than the half of the participants (58) indicated that they suffered from vertigo for more than five years, and that they experienced vertigo several times a day (52). The majority of the participants (78) also suffered from associated deafness or hard of hearing (D/HOH). Due to the online administration of the questionnaire, the exact degree of hearing loss was uncertain or unknown. Of the D/HOH participants, some indicated that they wore conventional hearing aids (21) or cochlear implant (33).

The procedure of the online questionnaire first involved a description of the questionnaire and a consent by the participant to participate in the study. After consent was given, the demographic questions were given to the participant. This was followed by the main NVI questionnaire. The items of the questionnaire were randomly assigned by the internet platform to each participant. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Analyses

We conducted Principal Component Analyses (PCA) on each pre-defined subscale and on the total score in order to refine the NVI. Analyses were performed with R commander [52, 53]. We determined the items most correlated to the cognitive subscale and in order to keep homogeneity, we chose to remove the 2 items less represented for each subscale. This included the same reduction process for the distractor subscale. After this reduction, the final

total number of items was 28, and the total score for the NVI was 140 without the distractors items (4 for each of the 7 subscales).

Results for structural validity and internal consistency

Table 2 shows the results of the PCA for the percentage of variance for each subscale, before and after the item reduction for vertigo participants. The results show that most of the selected subscales after item reduction (to 4 items) explained more than 50% of variance. The subscales of time perception and motor appeared to be more heterogeneous, with less internal consistency than the other subscales (matched to the distractor subscale). Cronbach's alpha confirmed good internal consistency for the total scale (without distractors), and for the subscales "space perception", "attention" and "memory" (Cronbach alpha coefficients at or higher than 0.8). A satisfactory internal consistency was demonstrated for two more of the seven subscales (Cronbach alpha coefficients greater than 0.7 for "emotion" and "vision"). Consistently with the PCA, the items for the "time perception", "motor" and for the distractor subscales were lower, but acceptable for subscales containing only 4 items as suggested by Bradley [32] (Cronbach alpha coefficients below 0.7) (see **Table 2**).

Table 2

Percentage of variance explained before and after PCA and Cronbach's alpha on vertigo participants (after PCA).

Categories	**Percentage of variance explained (N = 108)**		**Cronbach's alpha (N = 108)**
	Before PCA[1]	After PCA[2]	After PCA[2]
Space Perception	53.23	65.31	.82
Time Perception	37.19	46.88	.52
Attention	51.15	62.33	.80
Memory	54.92	63.39	.80
Emotion	47.07	60.58	.77
Vision	42.16	57.03	.75
Motor	29.26	40.85	.50
Distractor	30.21	42.63	.55
Total (without distractors)			.88

[1] : Before items reduction
[2] : After items reduction

Extreme groups validity **of the NVI**

Methods

Participants, Stimuli and Procedure

In order to analyse the extreme groups validity, we used the same data from the sample of 108 vertigo participants and data collected from 104 additional control participants (mean age 43 ± 13.2 years). The control group was mostly female (77) and right-handed (83). They were recorded as control participants due to their negative response to the question, "Do you suffer from vertigo?". Some of the participants (21) suffered from associated deafness or hard of hearing (D/HOH). Due to the online administration of the questionnaire, the exact degree of hearing loss was uncertain or unknown. Some of the 21 D/HOH participants wore conventional hearing aids (5) or cochlear implants (4). The comparison between age for the 104 control and 108 vertigo participants was significant ($F(1,210) = 32.7$, $p = .000$; with younger control participants) and age was taken into account as a covariate in the analyses. The stimuli and procedure was the same as that described in step four in the previous section.

Data Analysis

We performed analyses of covariance (ANCOVA) analyses using SPSS-22 (SPSS Inc., Chicago, IL.). Analyses were corrected with Bonferroni-adjusted P values for multiple testing and the factor of age was added as a covariate for the total score and for all subscales with vertigo and D/HOH as independent variables. Partial eta-squared (η_p^2) was used to measure effect size (0.0099, 0.0588 and 0.1379 for small, medium, and large effects respectively; as recommended by Cohen, 1988 and Richardson, 2011). The age effect was also analysed with Spearman's rho correlation coefficient.

Supplementary analyses evaluated the role of hearing difficulties in the sample. This was included as it is well known that vestibular impairments (that can lead to vertigo) are frequently associated with hearing difficulties (odds-ratio of 1.9 to 2.3; [54, 55]. It has also been shown that D/HOH persons might develop different attentional abilities (e.g., enhanced peripheral visual attention) [56–58].

Results for extreme groups validity ***and age effect***

After controlling for age, we found a significant extreme groups validity of having vertigo (e.g., difference between vertigo and control participants) for four of the seven subscales: motor subscale, $F(1,207) = 30.51$, $p=.000$, $\eta_p^2 =.128$; vision subscale, $F(1,207) = 31.90$ $p=.000$, $\eta_p^2 =.134$; attention subscale, $F(1,207) = 20.43$, $p = .000$, $\eta_p^2 =.090$; and emotion subscale, $F(1,207) = 23.54$, $p = .000$, $\eta_p^2 =.102$). There was also a significant effect for the total score, $F(1,207) = 27.90$, $p = .000$, $\eta_p^2 =.119$). Participants with vertigo had higher scores (more complaints) on all subscales and on the total scale (see **Table 3**). As expected, we found no significant effect of vertigo for the distractor subscale, but more surprisingly, three other subscales did not show significant effects: memory, $F(1,207) = 3.379$, $p = .067$, $\eta_p^2 =.016$, space perception, $F(1,207) = .720$, $p = .397$, $\eta_p^2 =.003$ and time perception, $F(1,207) = 1.45$, $p = .230$, $\eta_p^2 =.007$) subscales.

Table 3

Average score (M) and standard deviation (S.D) for NVI total and subscales scores for each participant sample.

Scales	***Vertigo (N = 108) M (S.D)***	***Non-vertigo-participants (N = 104) M (S.D)***	***Deaf/HOF participants (N = 99) M (S.D)***	***Non-Deaf/HOF participants (N =113) M (S.D)***
Space perception	8.89 (3.97)	8.81 (3.46)	8.62 (4.00)	9.05 (3.46)
Time perception	6.14 (2.16)	5.96 (1.51)	5.95 (2.14)	6.14 (1.60)
Attention	10.27 (3.57)	8.78 (2.88)	9.55 (3.65)	9.53 (3.03)
Memory	9.80 (3.65)	8.71 (2.64)	9.57 (3.62)	9.00 (2.85)
Emotion	11.47 (3.52)	9.85 (2.61)	10.84 (3.50)	10.53 (2.94)
Vision	9.82 (3.62)	7.58 (2.32)	8.99 (3.59)	8.49 (2.91)
Motor	11.21 (3.24)	8.99 (2.64)	10.43 (3.09)	9.85 (3.20)
Distractor	14.06 (3.12)	14.70 (2.53)	14.21 (3.19)	14.51 (2.53)
All items (except distractors)	67.61 (15.69)	58.67 (12.30)	63.94 (16.49)	62.59 (13.17)

The ANCOVA Analyses showed significant main effects of age for attention $F(1,207) = 8.71$, $p=.03$, $\eta_p^2=.04$ and emotion subscales, $F(1,207) = 21.56$, $p=.000$, $\eta_p^2=.094$. Spearman's rho correlation coefficient analyses showed an inverse correlation between age and total NVI score for vertigo participants ($r_s = -.303$, $p = .001$). This effect was also present for the subscales of attention, emotion and vision ($r_s = -.271$, $p = .005$; $r_s = -.473$, $p = .000$

and; r_s = -.303, p = .001 respectively).There were no significant correlations for the non-vertigo group (see **Table 4** for the complete results). The supplementary analyses of D/HOH showed no significant effects.

Table 4

Spearman rank correlation among participants' age and NVI total and subscales scores.

	Age of Vertigo participants (N = 108)	Age of Non-vertigo participants (N = 104)
Space perception	-.128	-.026
Time perception	-.090	-.002
Attention	**-.271***	-.187
Memory	.070	-.025
Emotion	**-.473****	-.094
Vision	**-.303****	-.015
Motor	-.116	-.134
Distractor	-.174	.010
Total	**-.303****	-.106

Values are Spearman correlation coefficients: ** correlation is significant at .001 level (2-tailed); * correlation is significant at the .005 level (2-tailed).

DISCUSSION

This present paper provides a new questionnaire, the NVI, specifically adapted to measure the self-reported associated neuropsychological cognitive (attention, memory, emotion, space perception, time perception, vision and motor) problems in patients suffering from vertigo. The questionnaire was created in four steps, and the final revised version was composed of 7 subscales, each with 4 items (28 items). Reliability of the NVI was performed using Cronbach's alphas and this showed a good to satisfactory internal consistency for the total score, and for five subscales. The remaining two subscales were less consistent (time perception and motor subscale), suggesting that the items were perhaps less well-defined. However, for subscales of 4 items, it has been suggested that a lower Cronbach's alpha value is acceptable [32]. Furthermore, our choice to use PCA on each predetermined subscale was justified by the questionnaire novelty. We used focus group and semi-structured patient interviews to classify items into subscales based on common content, and then to reduce item number by PCA. As the time perception and motor subscales were defined from the original patient interviews in the development phase of the NVI, we were concerned by the fact that some specific complaints could be missed. For example, a patient with a higher score on these particular items and subscales would probably express a higher degree of difficulties in these domains. Excluding these responses could lead to the potential to miss these difficulties. This is why we propose to keep the two subscales in the final version of the NVI. However, future studies should determine whether keeping the two less valid subscales is worthwhile. Content validity of the items composing these subscales (and the other subscales) could be re-examined through specific method such as the use of Content Validity Index [59].

The extreme groups validity of the NVI was evaluated using ANCOVAs that tested age as a covariate. The results showed significant differences between vertigo and non-vertigo participants for the total and four subscale scores. The three subscales that did not show significant differences between participants with and without vertigo were time perception, memory and space perception. For the subscale of time perception, it is possible that the lack of extreme groups validity could be explained by the previous demonstrated lower internal validity. For the space perception subscale, the absence of significant difference was surprising. The Cronbach's alphas showed a good internal consistency (.821), and we would have expected a significant difference between vertigo and non-vertigo participants based one the previous literature (see [60] for an extensive review). There are a number of explanations

that can explain the lack of effect for the space perception subscale. One potential explanation could be linked to the item specificity that composed this subscale. Here, and based on the interviews conducted during the development of the NVI, items were linked to bodily orientation in space ("I have a bad orientation sense"; "I have difficulty to find my way on a map" etc.). Items in the "vision" subscale were linked to visual attentional abilities and visual acuity ("I read slowly", "I experience visual fatigue in computer" etc.). This difference in these two subscales refers to different cognitive concepts, one oriented on body perception in space, and the other oriented on visual attention involving vision process/visual acuity. It might be that these two subscales are both associated with what has been defined in the literature as visual spatial cognition, but here, separated by two scales.

A second explanation is that spatial perception (or navigational abilities) might be truly altered in patients with vestibular disorders [22, 24, 61–63], but that the impairment could be rapidly compensated, or reduced through vestibular rehabilitation [64]. Furthermore, spatial perception may be more difficult to self-evaluate because of the temporary characteristic of their affection in vertigo. A final explanation could be that the literature reporting spatial difficulties are particularly true for defined vestibular pathologies rather than for subjective vertigo symptoms. Spatial perception disorders may therefore be less prevalent in subjects responding to our questionnaire than in patients diagnosed with a defined vestibular disorder.

More research is needed to determine if a difference truly exists between vestibular and vertigo patients. This could be disentangled in future studies by analysing the subscale specifically in patients with complete or partial vestibular disorders in comparison to patients with vertigo from another origin.

In addition to the main study, we also observed interesting age effects. It is already well-known that with increased age, there are increased frequencies of vertigo and vestibular disorders [65–67], as well as reduced cognition and increased emotional problems [68–72]. Based on these findings, we might have expected that increased age might have led to more complaints in the NVI (higher scores). However, on the contrary, we observed an inverse age effect where increased age was related to a reduction in cognitive complaints in the vertigo patients (particularly for the attention and emotion subscales). One potential explanation for this effect could be linked to the fact that younger people tend to be more active, and so the impact of vertigo and their cognitive associated complaints might be more detrimental than

for less active people. It has been reported that vertigo patients have a tendency to stay at home and avoid some activities that can increase their discomfort [48, 73]. Younger people may not always the same opportunity to stay at home, and so they may be more exposed to higher frequencies of physical and cognitive discomfort than adults of increased age.

In conclusion, the NVI has been developed in response to the lack of instruments to detect neuropsychological problems associated with vertigo. Our goal was to create a new inventory that could detect specific subjective impaired cognition in vertigo patients, and provide a simple to use, reliable clinical tool that is quick to administer. With the NVI, we have created a bridge between the classical questionnaires that investigate the emotional side of vertigo, and the behavioural experiments that focus on the cognitive difficulties associated with vertigo. Our results shed light on vertigo patients subjective (self-reported) problems in a more extended view than that of previous questionnaires that mostly assessed emotional symptoms and/or quality-of-life (see Duracinsky et al. for an extensive review [30]. We also bring new information that could lead to a better comprehension of vestibular-associated disorders. We show that cognitive processes are more perceived as dysfunctional by vertigo patients themselves, and importantly, we can no longer limit the participant's complaints to the uncontrollability and unpredictability of the vertigo, such as is the case with critical life events[74].

As a potential new clinical instrument, some complementary research is needed to complete this first study. For example, A forward–backward translation procedure is necessary to make the original NVI available in other languages. This rigorous procedure guarantees that the original meanings of each item are preserved. Future research should also evaluate test-re-test effects and convergent validity with other scales. If the NVI is to be used for a diagnosis of vertigo/vestibular associated cognitive problems, it will be necessary to determine a cut-off score. This could be used to determine which patients with vertigo might benefit from a more comprehensive neuropsychological assessment. This direction might be critical as the difficulties described by these patients might lead to vertigo patients requiring a higher use of health care [16] and leading to substantial costs for society [75]. Cognitive rehabilitation therapies should be developed for vertigo patients as it has been shown that cognitive deficits may persist even after complete vertigo recovery [76].

Q6: J’ai un mauvais équilibre. Q6: J’ai un bon niveau de vocabulaire.

Compliance with Ethical Standards :

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