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RESEARCH SUBMISSION

German language adaptation of the Cogniphobia Scale for Headache Disorders (CS-HD) and development of a new short form (CS-HD-6)

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Abstract

Objective: This study is part of the ODIN-migraine (Optimization of Diagnostic Instruments in migraine) project. It is a secondary, a priori analysis of previously collected data, and aimed to assess the psychometric properties and factor structure of the Cogniphobia Scale for Headache Disorders (CS-HD). We aimed to construct a German-language version and a short version.

Background: Cogniphobia is the fear and avoidance of cognitive exertion, which the patient believes triggers or exacerbates headache. High cogniphobia may worsen the course of a headache disorder.

Methods: The 15-item CS-HD was translated into German and back translated in a masked form by a professional translator. Modifications were discussed and carried out in an expert panel. A cross-sectional online survey including the CS-HD and further self-report questionnaires was conducted in a sample of $N = 387$ persons with migraine (364/387 [94.1%] female, $M = 41.0$ [SD = 13.0] years, migraine without aura: 152/387 [39.3%], migraine with aura: 85/387 [22.0%], and chronic migraine: 150/387 [38.8%]).

Results: Exploratory factor analysis resulted in two clearly interpretable factors (*interictal* and *ictal cogniphobia*). Confirmatory factor analysis yielded an acceptable to good model fit ($\chi^2(89) = 117.87$, $p = 0.022$, $\chi^2/df = 1.32$, RMSEA = 0.029, SRMR = 0.055, CFI = 0.996, TLI = 0.995). Item response theory-based analysis resulted in the selection of six items for the short form (CS-HD-6). Reliability was acceptable to excellent (interictal cogniphobia subscale: $\omega = 0.92$ [CS-HD] or $\omega = 0.77$ [CS-HD-6]; ictal cogniphobia subscale: $\omega = 0.77$ [CS-HD] or $\omega = 0.73$ [CS-HD-6]). The pattern of correlations with established questionnaires confirmed convergent validity of both the CS-HD and the CS-HD-6.

Abbreviations: CFI, comparative fit index; CS-HD, Cogniphobia Scale for Headache Disorders; CS-HD-6, Cogniphobia Scale for Headache Disorders, 6-item short form; DASS, Depression Anxiety Stress Scales; FAMI, Fear of Attacks in Migraine Inventory; GAD-7, Generalized Anxiety Disorder Screener; HIT-6, Headache Impact Test; HMSE-G-SF, Headache Management Self-Efficacy Scale, short form; HTSAQ-SF, Headache Triggers Sensitivity and Avoidance Questionnaire, Short-Form; ICHD-3, International Classification of Headache Disorders, 3rd version; IRT, item response theory; NEO-FFI-30, NEO-Five-Factor Inventory, 30-Item-Short-Version; ODIN-migraine, Optimization of Diagnostic INstruments in migraine; PASS-20, Pain Anxiety Symptom Scale 20; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

Conclusion: Both the CS-HD and the CS-HD-6 have good psychometric properties and are suitable for the assessment of cogniphobia in migraine.

Plain Language Summary

Cogniphobia is the fear of cognitive exertion, in which the patient believes effortful thinking triggers or exacerbates headache. The Cogniphobia Scale for Headache Disorders (CS-HD) provides an assessment of this headache specific-fear. A German version and a six-item short form of the CS-HD were developed from an online sample of 387 persons with migraine, and our results showed that this version was suitable.

KEYWORDS
cogniphobia, cognitive exertion, fear, headache, migraine, questionnaire

INTRODUCTION

Fear is associated with heightened pain awareness and chronification.[1] Fear-avoidance models in the context of musculoskeletal or back pain have provided substantial evidence that fear of movement (kinesiophobia) and the resulting avoidance of movement can contribute to chronification of musculoskeletal pain.[2–5] Similarly, the trigger avoidance model of headaches postulates that fear-motivated avoidance of headache triggers can lead to chronification of primary headache disorders, although there is less evidence for this assertion.[6] Avoidance may not always be dysfunctional; for example, obtaining high quality sleep is an important foundation of health for people with and without headache disorders.[7] However, to the extent that avoidance of perceived triggers heightens interoceptive awareness and sympathetic activation (which in and of itself may contribute to headache frequency), and reduces engagement with activities of daily living, avoidance is likely maladaptive.[6]

Research has shown that patients believe a wide variety of factors are possible headache attack triggers (e.g., activity/exertion-, stress-, emotion-, sleep-related triggers).[8] Diary studies have confirmed that many of these factors, including changes in stress,[9] perceived sleep quality,[10] and ingestion of caffeine and alcohol,[11] are indeed present more often in the hours to days prior to headache attack onset, although the causal links for many of these factors remain unclear.[12] In the context of headache, activity-related triggers include not only bodily movement but also cognitive exertion.[6]

A specific, fear-related construct in the field of headaches is cogniphobia. Initially, researchers observed that people with post-traumatic headache did not exhaust their cognitive potential in neuropsychological assessments,[13] leading to the development of the construct of cogniphobia, defined as "an unreasonable or irrational fear of headache pain or painful reinjury upon cognitive exertion."[13] The 17-Item Cogniphobia Scale was adapted from the well-validated and commonly used Tampa Kinesiophobia Scale[14] to assess fear-related avoidance of cognitive exertion.[13,15,16] In a later study, the Cogniphobia Scale was adapted by adding three items and by conceptualizing the two subscales "escape/avoidance" and "dangerousness," each with a good internal consistency (Cronbach's alpha = 0.83 or 0.86) in a sample of $N = 74$ undergraduate students with frequent headaches.[17] A further adaption aimed to develop an instrument for a wide range of headache disorders (and not only for persons with post-traumatic headache), the Cogniphobia Scale for Headache Disorders (CS-HD), defining cogniphobia as "the specific fear and avoidance of cognitive exertion, which is believed to precipitate or exacerbate headache" (Seng & Klepper, 2017, p. 1296).[18] Thus, the focus on injury or re-injury was shifted in favor of more generally worded items. Data analyses from a sample of $N = 80$ adults with migraine yielded a single scale, comprising 15 items, and with a very good internal consistency (Cronbach's alpha = 0.94).[18] The authors noted that the dimensionality of the questionnaire may depend on the studied population, and the previously described "dangerousness" subscale may be more appropriate for people with post-traumatic headache.[18] Since migraine is the headache disorder with the highest burden[19] and with a high prevalence,[20] the scale will be most useful if it also applies to people with migraine.

The psychometric properties and the factor structure of the CS-HD have so far only been determined on the basis of medium-sized samples. Further, a German-language version is not yet available. The aim of this study was therefore to develop a German-language version, to determine its psychometric properties on the basis of a larger sample, and to construct a short version for an even more economical assessment of cogniphobia.

METHODS

Study design, participants, and procedure

This study is the second part of the Optimization of Diagnostic INstruments in migraine (ODIN-migraine) project. The ODIN-migraine project aimed to improve the assessment of psychological factors in migraine. The first part of ODIN-migraine led to the construction and validation of the Fear of Attacks in Migraine Inventory (FAMI).[21] Since this analysis is the secondary, a priori analysis of previously collected data, the detailed methodology for ODIN-migraine is described elsewhere.[21]

Briefly, the study was conducted as a cross-sectional online survey in a German-speaking sample of adult persons with migraine (meeting the International Classification of Headache Disorders, 3rd edition [ICHD-3], criteria,[22] of either migraine without aura, migraine with aura, or chronic migraine). Exclusion criteria were not defined. The study was performed at the Department of Psychology (University of Mainz, Germany). The study protocol was approved by the local ethics committee of the Department of Psychology, University of Mainz, Germany (2020-JGU-psychEK-009) and prospectively registered with the German Clinical Trials Register (DRKS-ID: DRKS00022812).

Participants were recruited via the website of two umbrella associations of pain-related self-help groups, as well as via social media and a university's press release. The advertisement informed that the study was investigating anxiety and fear in persons with migraine, and it included a link to the survey. The online survey was provided via the portal SoSci-Survey (www.soscisurvey.de).[23] After activating the corresponding link, participants were informed about the aim of the study and other issues (e.g., data protection and that the survey was estimated to take about 45 min). The participants had to confirm the inclusion criteria (age of at least 18 years, a medically diagnosed migraine disease, i.e., that migraine was stated by a physician, and a disease duration of at least 1 year), and to give their informed consent to participate in the study, each by ticking a checkbox. The survey comprised a query of sociodemographic and disease data, including a differentiated assessment of diagnostic criteria of migraine (according to the ICHD-3),[22] and a battery of questionnaires on headache-related factors (including the German version of the CS-HD), as well as more generic instruments (such as the German version of the Depression Anxiety Stress Scales, DASS).[24] Migraine diagnosis was verified by querying the respective symptoms (based on ICHD-3 criteria). At the end of the survey, the participants had to confirm that they had processed the survey conscientiously and that they had consented to the use and storage of the data for scientific purposes.

The focus of the ODIN-migraine project was to examine the factor structure and the psychometric properties of both the FAMI and the CS-HD. Based on the length of the more extensive FAMI (study version with 45 items), a total sample size of $N = 225$ was strived for in the ODIN-migraine project (according to the rule of thumb of a ratio of at least 5 participants [N] per item or variable [p], i.e., $N{:}p \triangleq 5{:}1$, leading to a sample size of 5×45, and a minimum of $N > 100$, cf. Kyriazos, 2018, p. 2216).[25]

Construction of the questionnaire

The CS-HD was translated into German by the first author. This translation was reviewed by the other two members of the working group (Department of Psychology, Johannes Gutenberg-University of Mainz, Germany). Discrepancies or critical aspects of the translation were discussed in the working group, after which an initial German version was agreed upon by consensus. This initial German version was back translated in a masked form by a professional translator (native English speaker with expertise in the field of psychology). Based on the results of the back translation, further modifications to the German version were discussed and carried out. Here, feedback on specific questions on the translation was obtained from the first author of the original English version. Taking this into account, a final German version was created (Figure S1).

Measures

To assess the CS-HD's validity, the data of the following self-report questionnaires were analyzed: (1) Headache Disability Inventory (HDI),[26] (2) Headache Impact Test (HIT-6),[27] (3) DASS,[24] (4) Pain Anxiety Symptom Scale 20 (PASS-20),[28] (5) Headache Triggers Sensitivity and Avoidance Questionnaire, Short-Form (HTSAQ-SF),[29] (6) Generalized Anxiety Disorder Screener (GAD-7),[30] (7) short form of the Headache Management Self-Efficacy Scale (HMSE-G-SF),[31] (8) FAMI,[21] and (9) Pain Vigilance and Awareness Questionnaire.[32] To assess discriminant validity, four scales (extraversion, openness, agreeableness, conscientiousness) of the NEO-Five-Factor Inventory, 30-Item-Short-Version (NEO-FFI-30) were used.[33] Since neuroticism is related to anxiety,[34] the neuroticism subscale was not used for the assessment of discriminant validity. Each questionnaire was applied in German.

Statistical analyses

Mean values, standard deviations, and percentages were calculated to describe the sample and subsamples. Distributions of all variables and items on the CS-HD were described and visualized. Suitability of the data for exploratory factor analysis was assessed with the Kaiser-Meyer-Olkin criterion and Bartlett test. The number of factors for the exploratory factor analysis (using promax rotation and weighted least squares estimation) was determined with a scree plot and Horn's parallel analysis. The goodness of fit of the observed two-factor model as well as the one-factor solution of the original English version of the CS-HD[18] were tested with confirmatory factor analyses (containing only main loadings and correlated factors) using diagonally weighted least squares estimation due to ordinal data. Model fit was evaluated with χ^2, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker Lewis fit index utilizing the recommendations of Schermelleh-Engel and colleagues.[35] The one- and two-factor solutions were compared with the difference test to assess superiority.

A short form of the CS-HD was developed using item response theory (IRT)-based analyses (polytomous Graded Response Model)[36] of difficulty and discriminatory power, following the recommendations of Kleka and Soroko.[37] The Graded Response Model extends the two-parameter logistic model for items of dichotomous response to the polytomous case. It is appropriate when the responses to an

item can be classified into more than two ordered categories, such as to represent different degrees of agreement with a certain statement. One outlier was identified using Mahalanobis distance and excluded from the analysis. Considering reliability and practical reasons, we decided to keep three items for each subscale of the CS-HD resulting in a 6-item short form (CS-HD-6). The dataset was split into a training ($n = 309$, 80% of the data) and a test dataset ($n = 76$, 20% of the data), and the item selection was based on the training set. The items for the subscale ictal cogniphobia were retained. For the selection of the three items of the subscale interictal cogniphobia, the following steps were carried out. First, items with a lower than average ($M = 5.5$) information value were excluded, which resulted in the retention of five items. Second, items with a lower than average determination coefficient ($M = 2.2$) were excluded (none of the remaining items were excluded). The final item set was chosen in a way covering the broadest possible range of theta (estimating individual ability). The assumption tests are described in the Supplementary Document S1.

The reliability of both the CS-HD and CS-HD-6 (the latter using the test dataset) was investigated with McDonald's ω. Construct validity was tested using Pearson correlations of the respective subscales with questionnaire scores (cf. Section Measures) and clinical characteristics (i.e., headache days, migraine days, and days with the intake of acute medication, referring to the past month for each item). In the case of bivariate non-normality (assessed with Mardia's test), Spearman correlations were calculated. For the analysis of subgroups (migraine with/without aura vs. chronic migraine), a Student's *t*-test was applied. The criterion for statistical significance was $p = 0.05$ (two-tailed). The analyses were calculated with JASP version 0.15.0.0[38] and R version 4.0.3.[39]

RESULTS

Participants were recruited from September to November 2020. In total, 387 people with migraine were included in our analysis (Figure 1). Persons who did not fulfill the migraine criteria according to the ICHD-3 were excluded (Figure 1). Most participants (Table 1) met the criteria for migraine without aura (39.3%, $n = 152$), followed by chronic migraine (38.8%, $n = 150$), and migraine with aura (22.0%, $n = 85$). The majority of the sample was female (94.1%, $n = 364$).

Factorial structure, model fit, and IRT-based development of a short form

The Kaiser-Meyer-Olkin criterion indicated that the data were suited for factor analysis (measure of sample adequacy [MSA] = 0.92),[40] and the Bartlett test confirmed correlations among items ($\chi^2(105) = 3242.46$, $p < 0.001$). Both scree plot and parallel analysis (Figure S2) proposed the extraction of two factors, deviating from the one-factor solution of the original scale. Eleven items loaded on Factor 1 (Table 2), which was interpreted as *interictal cogniphobia* (Item 2, "I worry that when I have to think or concentrate too hard, that I will bring on a headache," with the highest loading, 0.96). Three items loaded on Factor 2, which was interpreted as *ictal cogniphobia* (Item 13, "I will stop concentrating as soon as I sense headache pain coming on," with the highest loading, 0.82). One item (Item 8, "Headache pain lets me know when to stop concentrating so that I don't hurt myself") had a double loading on both factors (Factor 1: 0.39, Factor 2: 0.34). The eigenvalues of the factors were $\lambda_1 = 5.64$ and $\lambda_2 = 2.02$ and the factors were correlated ($r = 0.74$). The two factors accounted for 51.1% of the variance in the CS-HD items.

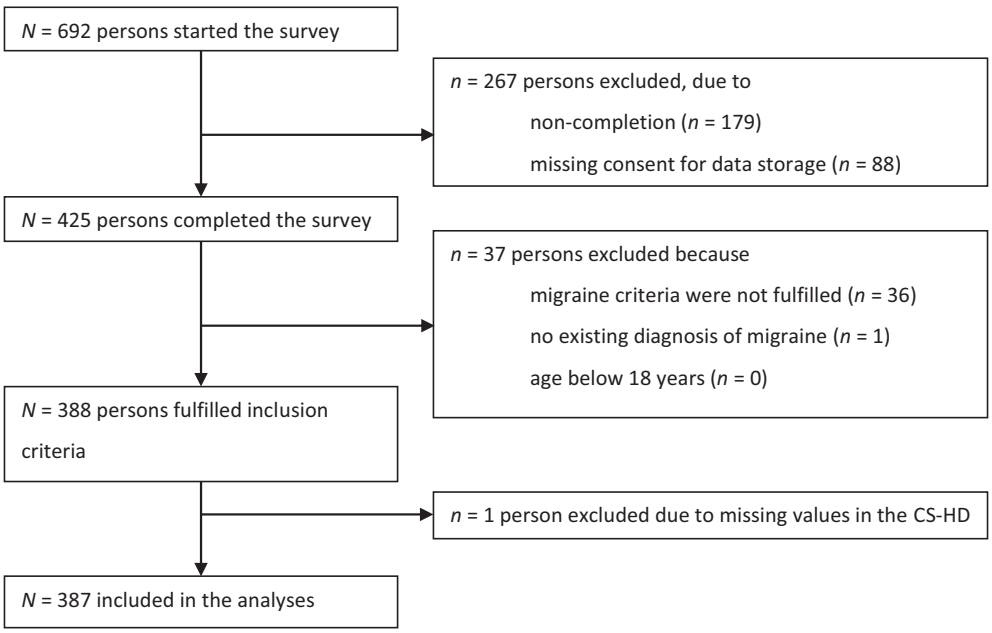

FIGURE 1 Flowchart of attrition.

TABLE 1 Sample characteristics.

	N = 387
Age, years	41.0 (13.0)[a]
Female	94.1% (*n* = 364)
Headache diagnosis	
Migraine without aura	39.3% (*n* = 152)
Migraine with aura	22.0% (*n* = 85)
Chronic migraine	38.8% (*n* = 150)
Disease duration (years)	16.0 (12.2)[b]
Current headache activity (past month)	
Headache days	12 (8)[c]
Days with medication intake (analgesics or triptan)	6 (5)[d]
Sick leave days due to headache	4 (6)[e]

Note: Data are % (*n*) or mean (SD).
[a]*n* = 385.
[b]*n* = 381.
[c]*n* = 382.
[d]*n* = 385.
[e]*n* = 310.

TABLE 2 Factor loadings (>0.3) and uniqueness of the exploratory factor analysis.

Item No.	Factor 1	Factor 2	Uniqueness
01	0.89		0.33
02	0.96		0.24
03	0.75		0.56
04	0.62		0.64
05	0.90		0.20
06	0.62		0.42
07	0.41		0.80
08	0.39	0.34	0.57
09	0.71		0.45
10	0.52		0.69
11	0.48		0.58
12		0.75	0.52
13		0.82	0.50
14	0.51		0.47
15		0.61	0.36

Note: Factor 1: Interictal cogniphobia; Factor 2: Ictal cogniphobia; applied rotation method is promax.

The confirmatory factor analysis of the one-factor solution (cf. original English version of the CS-HD) yielded an acceptable to good model fit ($\chi^2(90) = 175.33$, $p < 0.001$, $\chi^2/df = 1.95$, RMSEA = 0.050, SRMR = 0.067, CFI = 0.988, TLI = 0.986), as did the two-factor solution ($\chi^2(89) = 117.87$, $p = 0.022$, $\chi^2/df = 1.32$, RMSEA = 0.029, SRMR = 0.055, CFI = 0.996, TLI = 0.995). The factor covariance was 0.70. Factor loadings of both solutions can be found in Tables S1 and S2. The χ^2-difference test indicated that the two-factor model fits the data better than the one-factor model ($\chi^2(1) = 57.46$, $p < 0.001$).

IRT-based analysis (Table S3) resulted in the selection of Items 1, 6, and 9 for the interictal cogniphobia subscale for the short form of the CS-HD. The three items of the ictal cogniphobia subscale were retained (Items 12, 13, 15). Referring to the six remaining items, the short form is designated as "CS-HD-6" (Figures S3 and S4).

Reliability

McDonald's ω of the interictal cogniphobia subscale was excellent ($\omega = 0.92$) for the CS-HD and acceptable for the CS-HD-6 ($\omega = 0.77$). For the ictal cogniphobia subscale McDonald's ω was acceptable both for the CS-HD ($\omega = 0.77$) and the CS-HD-6 ($\omega = 0.73$).

Validity

The CS-HD sum score as well as both subscale scores showed small- to large-sized correlations in expected directions for convergent validity questionnaires (Table 3), including headache-related disability (HDI and HIT-6), depression and anxiety symptoms (DASS and GAD-7), and cognitions related to pain anxiety, fear, and avoidance (PASS-20, HTSAQ-SF, FAMI, and Pain Vigilance and Awareness Questionnaire). Further, there was a small-sized correlation in the expected direction between the clinical parameters (e.g., headache days) and the CS-HD (sum score and interictal cogniphobia subscale; Table 3). Finally, higher CS-HD scores demonstrated a weak association with higher self-efficacy (assessed by the HMSE-G-SF, Table 3), which is the opposite direction than hypothesized.

Similarly, the sum score of the CS-HD-6, as well as both subscale scores, correlated in expected directions with the convergent questionnaires, showing small- to large-sized effects (HDI, HIT-6, PASS-20, DASS, HTSAQ-SF, FAMI; Table 4). As with the CS-HD, the correlations of the CS-HD-6 scales with self-efficacy (assessed by the HMSE-SF) were weak and in an unexpected direction (Table 4).

Regarding discriminant validity, the sum score or subscales of the CS-HD unexpectedly showed small-sized correlations with the majority of subscales of the NEO-FFI-30 (e.g., agreeableness subscale, $r = -0.15$, -0.15, and -0.11; $p = 0.002$, 0.003, and 0.028, respectively; Table 3), and some of the sum scores or subscales of the CS-HD-6 showed even medium-sized correlations with this inventory (Table 4).

Subgroup analyses

Compared to participants with episodic migraine (migraine with/without aura), participants with chronic migraine showed significantly higher cogniphobia on both the CS-HD sum score ($M = 32.7$, $SD = 9.1$ vs. $M = 30.4$, $SD = 8.7$, $p = 0.016$) and the

TABLE 3 Measures of criterion validity: Pearson or Spearman correlations of clinical characteristics and questionnaire scores with the subscales of the CS-HD ($N = 387$).

	Sum scale *r* (*p*-value)	Subscale interictal cogniphobia *r* (*p*-value)	Subscale ictal cogniphobia *r* (*p*-value)
Convergent validity			
Headache days[a,b]	**0.12 (0.020)**[h]	**0.15 (0.003)**[h]	−0.03 (0.572)[h]
Migraine days[a,c]	**0.10 (0.044)**[h]	**0.13 (0.014)**[h]	0.01 (0.804)[h]
Days with acute medication intake[a,d]	0.09 (0.094)[h]	**0.11 (0.038)**[h]	0.01 (0.787)[h]
HDI[e]	**0.51 (<0.001)**[h]	**0.53 (<0.001)**[h]	**0.29 (<0.001)**[h]
HIT-6[e]	**0.41 (<0.001)**[h]	**0.39 (<0.001)**[h]	**0.33 (<0.001)**[h]
DASS			
Depression	**0.45 (<0.001)**[h]	**0.47 (<0.001)**[h]	**0.22 (<0.001)**[h]
Anxiety	**0.44 (<0.001)**[h]	**0.46 (<0.001)**[h]	**0.22 (<0.001)**[h]
Stress	**0.45 (<0.001)**[h]	**0.46 (<0.001)**[h]	**0.26 (<0.001)**[h]
GAD-7	**0.43 (<0.001)**[h]	**0.45 (<0.001)**[h]	**0.23 (<0.001)**[h]
PASS-20	**0.57 (<0.001)**	**0.53 (<0.001)**[h]	**0.47 (<0.001)**
HTSAQ-SF[f]			
Triggers	**0.53 (<0.001)**	**0.53 (<0.001)**[h]	**0.30 (<0.001)**
Avoidance	**0.42 (<0.001)**	**0.42 (<0.001)**	**0.27 (<0.001)**
HMSE-G-SF[d]	**0.10 (0.046)**	**0.10 (0.049)**	0.07 (0.152)
FAMI			
Fear/neg consequences	**0.46 (<0.001)**[h]	**0.50 (<0.001)**[h]	**0.20 (<0.001)**[h]
Attention & anticipation[e]	**0.53 (<0.001)**[h]	**0.55 (<0.001)**[h]	**0.31 (<0.001)**[h]
Avoidance[e]	**0.42 (<0.001)**[h]	**0.45 (<0.001)**[h]	**0.22 (<0.001)**[h]
PVAQ[g]	**0.39 (<0.001)**	**0.37 (<0.001)**	**0.32 (<0.001)**
NEO_N	**0.46 (<0.001)**[h]	**0.47 (<0.001)**[h]	**0.28 (<0.001)**[h]
Discriminant validity			
NEO_E	**−0.16 (0.001)**	**−0.17 (0.001)**	−0.08 (0.105)
NEO_O	−0.03 (0.595)	−0.04 (0.497)	0.01 (0.898)
NEO_A	**−0.15 (0.002)**[h]	**−0.15 (0.003)**[h]	**−0.11 (0.028)**[h]
NEO_C	**−0.11 (0.032)**[h]	**−0.12 (0.019)**[h]	−0.02 (0.685)[h]

Note: Values in bold are statistically significant ($p < 0.05$).

Abbreviations: CS-HD, Cogniphobia Scale for Headache Disorders; DASS, Depression Anxiety Stress Scales; FAMI, Fear of Attacks in Migraine Inventory; GAD-7, Generalized Anxiety Disorder Screener; HDI, Headache Disability Inventory; HIT-6, Headache Impact Test; HMSE-G-SF, short form of the Headache Management Self-efficacy Scale; HTSAQ-SF, Headache Trigger Sensitivity and Avoidance Questionnaire, short form, with the subscales *triggers* and *avoidance*; NEO, NEO-Five-Factor Inventory with the subscales *neuroticism* (N), *extraversion* (E), *openness* (O), *agreeableness* (A), *conscientiousness* (C); PASS-20, Pain Anxiety Symptom Scale 20; PVAQ, Pain Vigilance and Awareness Questionnaire.

[a]Referring to the past month.

[b]$n = 382$.

[c]$n = 384$.

[d]$n = 385$.

[e]$n = 386$.

[f]$n = 380$.

[g]$n = 383$.

[h]Spearman correlation.

interictal cogniphobia subscale ($M = 25.6$, $SD = 7.4$ vs. $M = 23.2$, $SD = 7.3$, $p = 0.002$) (Table 5). On the CS-HD-6, we observed no significant differences between persons with episodic migraine (migraine with/without aura) and chronic migraine (Table 5).

Scoring and interpretation for clinical use

In both questionnaires (CS-HD and CS-HD-6), each item requires a response on a 4-point scale (1 = strongly disagree, 2 = disagree,

TABLE 4 Measures of criterion validity: Pearson or Spearman correlations of clinical characteristics and questionnaire scores with the subscales of the CS-HD-6 ($N = 77$).

	Sum scale *r* (*p*-value)	Subscale interictal cogniphobia *r* (*p*-value)	Subscale ictal cogniphobia *r* (*p*-value)
Convergent validity			
Headache days[a,b]	0.01 (0.908)	0.05 (0.669)	−0.08 (0.503)
Migraine days[a,b]	<0.01 (0.971)	<0.01 (0.975)	<0.01 (0.974)
Days with acute medication intake[a,b]	0.03 (0.770)[c]	0.14 (0.244)[c]	−0.08 (0.511)[c]
HDI	**0.41 (<0.001)**	**0.47 (<0.001)**	**0.25 (0.029)**
HIT-6	**0.38 (0.001)**[c]	**0.37 (0.001)**[c]	**0.30 (0.007)**[c]
DASS			
Depression	**0.30 (0.009)**	**0.34 (0.003)**	0.18 (0.119)
Anxiety	**0.35 (0.002)**	**0.43 (<0.001)**	0.17 (0.138)
Stress	**0.40 (0.001)**	**0.42 (<0.001)**	**0.27 (0.017)**
GAD-7	**0.31 (0.006)**[c]	**0.35 (0.002)**[c]	0.20 (0.076)[c]
PASS-20	**0.44 (<0.001)**	**0.40 (0.001)**	**0.38 (0.001)**
HTSAQ-SF[b]			
Triggers	**0.50 (<0.001)**	**0.59 (<0.001)**	**0.30 (0.010)**
Avoidance	**0.48 (<0.001)**	**0.52 (<0.001)**	**0.32 (0.005)**
HMSE-G-SF	0.18 (0.125)	0.15 (0.205)	0.17 (0.148)
FAMI			
Fear/neg consequences	**0.29 (0.010)**[c]	**0.42 (<0.001)**[c]	0.08 (0.483)[c]
Attention & anticipation	**0.45 (<0.001)**	**0.54 (<0.001)**	**0.25 (0.028)**
Avoidance	**0.51 (<0.001)**	**0.54 (<0.001)**	**0.35 (0.002)**
PVAQ[b]	**0.34 (0.003)**	**0.35 (0.002)**	**0.25 (0.031)**
NEO_N	**0.31 (0.006)**	**0.38 (0.001)**	0.16 (0.170)[b]
Discriminant validity			
NEO_E	−0.22 (0.055)	−0.19 (0.098)	0.20 (0.084)
NEO_O	−0.11 (0.326)	−0.08 (0.479)	−0.12 (0.300)
NEO_A	**−0.29 (0.010)**[c]	**−0.28 (0.015)**	**−0.25 (0.028)**[c]
NEO_C	−0.17 (0.130)	**−0.30 (0.009)**[c]	−0.04 (0.744)

Note: Values in bold are statistically significant ($p < 0.05$).

Abbreviations: CS-HD-6, Cogniphobia Scale for Headache Disorders, 6-item short form; DASS, Depression Anxiety Stress Scales; FAMI, Fear of Attacks in Migraine Inventory; GAD-7, Generalized Anxiety Disorder Screener; HDI, Headache Disability Inventory; HIT-6, Headache Impact Test; HMSE-G-SF, short form of the Headache Management Self-efficacy Scale; HTSAQ-SF, Headache Trigger Sensitivity and Avoidance Questionnaire, short form, with the subscales *triggers* and *avoidance*; NEO, NEO-Five-Factor Inventory with the subscales *neuroticism* (N), *extraversion* (E), *openness* (O), *agreeableness* (A), *conscientiousness* (C); PASS-20, Pain Anxiety Symptom Scale 20; PVAQ, Pain Vigilance and Awareness Questionnaire.

[a]Referring to the past month.

[b]$n = 76$.

[c]Spearman correlation.

3 = agree, 4 = strongly agree). Higher values mirror higher fear or higher avoidance. For a total score, all item scores are summed. The interictal cogniphobia subscale score is created by summing Items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 14 on the CS-HD (or Items 1, 2, and 3 on the CS-HD-6). The ictal cogniphobia subscale score is created by summing Items 12, 13, and 15 on the CS-HD (or Items 4, 5, and 6 on the CS-HD-6). Items 12, 13, and 15 on the CS-HD are equivalent to Items 4, 5, and 6 on the CS-HD-6.

DISCUSSION

The CS-HD is a self-report questionnaire for the assessment of cogniphobia, which is defined as the fear and avoidance of cognitive exertion. This study aimed to determine the psychometric properties and the factor structure of the CS-HD based on a large sample of persons with migraine as well as the development of a short version.

TABLE 5 Mean values (SD) of the scales and comparison between the subgroups of participants (migraine with/without aura and chronic migraine).

	Migraine with/without aura (episodic migraine) *M* (SD)	Chronic migraine *M* (SD)	*t*-test
CS-HD[a]			
Sum score	30.4 (8.7)	32.7 (9.1)	$t(385) = -2.42$, $p = 0.016$
Interictal cogniphobia subscale	23.2 (7.3)	25.6 (7.4)	$t(385) = -3.17$, $p = 0.002$
Ictal cogniphobia subscale	7.2 (2.2)	7.1 (2.3)	$t(385) = 0.78$, $p = 0.438$
CS-HD-6[b]			
Sum score	12.9 (3.3)	13.8 (4.1)	$t(75) = -1.09$, $p = 0.279$
Interictal cogniphobia subscale	5.9 (1.9)	6.6 (2.4)	$t(75) = -1.54$, $p = 0.128$
Ictal cogniphobia subscale	7.0 (1.9)	7.2 (2.2)	$t(75) = -0.36$, $p = 0.724$

Abbreviations: CS-HD, Cogniphobia Scale for Headache Disorders; CS-HD-6, Cogniphobia Scale for Headache Disorders, 6-item short form.
[a]Migraine with/without aura $n = 237$, chronic migraine $n = 150$.
[b]Migraine with/without aura $n = 45$, chronic migraine $n = 32$.

Factor analysis yielded two clearly interpretable factors, interictal cogniphobia and ictal cogniphobia. Since migraine is characterized by recurring headache attacks with mainly symptom-free intervals between these attacks, it makes sense to distinguish these two states concerning cogniphobia. This difference is mirrored in measures of migraine disease burden (e.g., the Headache Impact Test assesses the extent to which migraine attacks prevent role engagement, and the Migraine Interictal Burden Scale assesses the extent to which individuals with migraine experience burden in between attacks due to interictal symptoms and anticipatory anxiety).[27,41] The avoidance of cognitive exertion in an ongoing attack may be reasonable, whereas avoidance of cognitive exertion in the attack-free interval is likely to have adverse effects. According to the trigger avoidance model of headaches,[6] excessive avoidance of triggers (here: cognitive exertion) to prevent headache attacks can lead to central sensitization and thus contribute to a chronification of the headache disorder. Apart from that, an excessive avoidance of cognitive exertion can bring further disadvantages (e.g., poorer level of education and thus lower socioeconomic status). In contrast, the brief, momentary avoidance of cognitive exertion in an ongoing attack may be appropriate in some circumstances, since resting and seeking out a low-stimulus environment could advance recovery.

The two-factor solution tended to have a slightly better fit than the one-factor solution found by Seng and colleagues, who analyzed a sample of persons with migraine as well.[18] This same ictal and interictal factor structure was also under consideration by Seng and colleagues.[42] The explained variances (54.0% for the one-factor solution in the US American sample vs. 51.1% for the two-factor solution in our sample) are comparable. It is likely that factor structure determined via empirical measures will differ somewhat depending on the extent to which ictal and interictal states differ in a given patient population. While the proportion of persons with chronic migraine and episodic migraine (migraine with and without aura) is comparable as well, the setting of recruitment (headache center vs. internet sample) is not. Interictal burden and symptoms are a driver of treatment-seeking.[43] Patients who experience symptoms both ictally and interictally may have less of a difference between the cogniphobia items intended to differentiate between these states. Future studies should compare cogniphobia in people with migraine who have sought care and those who have not, while also assessing interictal burden.

Further, it is still unclear whether the two-factorial structure of the CS-HD is appropriate in other headache disorders (e.g., tension-type headache, post-traumatic headache). Particularly in headache disorders that do not have an attack-like appearance, a two-factor structure is questionable.

Correlational analyses confirmed the convergent validity of the questionnaire. Both the sum scale and the two subscales of the CS-HD show small- to large-sized correlations to other established questionnaires (e.g., HIT-6, DASS, GAD-7). Interestingly, the correlations of the interictal cogniphobia subscale with parameters such as anxiety (e.g., GAD-7), disability (e.g., HDI), emotional distress (e.g., DASS), and avoidance behavior (e.g., FAMI-avoidance) are consistently higher than the corresponding correlations of the ictal cogniphobia subscale with these parameters. Presumably, the interictal cogniphobia subscale may be more highly associated with trait anxiety, whereas ictal cogniphobia may be a more direct response to the symptoms of a migraine attack. The observed weak correlations to clinical parameters (such as headache and migraine days) are consistent with previous results.[44] The small-sized positive correlation of cogniphobia with self-efficacy (assessed by the HMSE-SF) initially seems counterintuitive: high self-efficacy is desirable, while

TABLE 6 Areas of application.

Area	CS-HD	CS-HD-6 (Short Form of CS-HD)
Research context	• Factorial structure of cogniphobia in different headache disorders • Evaluation of treatment-efficacy • Assessment of prevalence in different countries	• Limited application
Clinical context	• Neuropsychological assessment in persons with headache/migraine	• Screening for persons with migraine (indication for behavioral treatment of cogniphobia) • Evaluation of (behavioral) treatment on an individual level

Abbreviation: CS-HD, Cogniphobia Scale for Headache Disorders.

high cogniphobia is not. When looking at individual items from the HMSE-SF, it becomes clear why a positive association resulted. For example, the HMSE-SF item number three is "I can prevent headaches by recognizing their triggers." The ability to analyze and manage triggers is important and represents a high self-efficacy; however, recent evidence has demonstrated that many presumed migraine triggers may actually be symptoms of the premonitory phase of migraine.[12] It seems likely that cognitive symptoms fall into this category. Therefore, it is possible the assumption that cognitive exertion causes headaches, or that avoiding cognitive exertion prevents headaches, could be driving this somewhat unintuitive finding.

The pattern of correlations is similar for the CS-HD-6, which was developed on IRT-based analyses, using data subsets (i.e., a training and a test dataset); however, the correlations with established questionnaires tend to be lower in the CS-HD-6, likely due to a more restricted range. Further, the discriminant validity analyses were less compelling for the CS-HD-6, since there are slightly higher correlations to the four subscales of the NEO-FFI-30, which assess theoretically dissimilar constructs.

Overall, the CS-HD as well as the CS-HD-6 are questionnaires with good psychometric properties (i.e., existing validity and reliability). Compared to the CS-HD-6, the CS-HD tends to be the more precise instrument. Both subscales of the CS-HD show better values regarding reliability, and the pattern of correlations with similar (convergent validity) and dissimilar constructs (discriminant validity) is slightly more convenient in the CS-HD. In addition, the CS-HD obviously differentiates better between chronic and episodic migraine (Table 5). Thus, when selecting a measure for research, the CS-HD is likely to be better suited than the CS-HD-6. Since the psychometric properties of the short form (CS-HD-6) are still satisfactory, this instrument may be more useful in clinical practice due to its economy. The clinical utility of the CS-HD-6 could emerge as a screening instrument for the indication of a tailored behavioral treatment to address cogniphobia. Behavioral approaches such as exposure therapy, cognitive restructuring, or behavioral experiments are considered to have benefits in reducing cogniphobia and resulting headache-related disability in people with headache disorders who demonstrate high levels of cogniphobia.[13] Thus, the CS-HD-6 may serve as a decision aid for initiating a specific behavioral intervention. Future research should evaluate the predictive validity of the CS-HD and CS-HD-6 for determining treatment response to exposure-based interventions to inform clinical cutoffs. In the context of neuropsychological testing, poor effort can lead to underperformance on cognitive measures. Cogniphobia could serve as an explanatory factor for poor effort in people with headache disorders, and identify headache and resulting cogniphobia as a modifiable risk factor for underperformance on cognitive measures.[17,45,46] Since the CS-HD is the more precise instrument compared to the CS-HD-6, the CS-HD should be preferred in the context of neuropsychological testing. Future studies should evaluate the extent to which the CS-HD is associated with poor effort and cognitive performance in routine neuropsychological assessment. The recommendation for the areas of application (CS-HD vs. CS-HD-6) is summarized in Table 6.

Limitations

The current sample had a higher proportion of chronic migraine than the general population of people with migraine.[47] The general disadvantages of online surveys skew the attributes of the sample to that of individuals who are more "highly online" (e.g., younger, higher socioeconomic status).[48] Since a medical examination was not provided, there is a certain uncertainty in the migraine diagnosis (although the relevant symptoms according to ICHD criteria were asked for in detail in the online survey). Headache activity was not recorded in a diary but by retrospective recall. Some of the measuring instruments used are not headache-specific (e.g., PASS-20) or pain-specific (e.g., GAD-7). Due to the cross-sectional design, no statements can be made about the sensitivity of the CS-HD to change. Due to a missing external criterion (e.g., determination of clinically relevant avoidance behavior), no cutoff could be defined.

Future research

Future research should examine the factorial structure of the CS-HD in other headache disorders, not least because the difference between ictal and interictal states is likely to be less pronounced in certain headache disorders. Since internet samples have certain biases, the CS-HD should be applied additionally in clinical studies or practice. Research should also strive to collect and compare prevalence data of cogniphobia more systematically in different countries.

As a further approach, the items of the CS-HD-6 could be formulated even more precisely and distinctly concerning the two headache states (ictal/interictal). A confirmatory factor analysis would then be useful to test the two-factorial structure of the CS-HD-6. Finally, it would be very interesting to determine the sensitivity to change of the two questionnaires as well as to establish a useful cutoff.

CONCLUSIONS

Both the CS-HD and the CS-HD-6 are suitable questionnaires for the assessment of cogniphobia. In persons with migraine, cogniphobia can be represented by a two-factorial structure (i.e., interictal and ictal cogniphobia). While ictal cogniphobia may be adaptive in migraine, interictal cogniphobia is not. High interictal cogniphobia has several disadvantages and may be an indication for a specific behavioral treatment.

AUTHOR CONTRIBUTIONS

Timo Klan: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; writing – original draft. **Anne-Kathrin Bräscher:** Conceptualization; data curation; formal analysis; software; visualization; writing – original draft. **Elizabeth K. Seng:** Conceptualization; supervision; writing – review and editing. **Charly Gaul:** Conceptualization; supervision; writing – review and editing. **Michael Witthöft:** Conceptualization; formal analysis; supervision; writing – review and editing.

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CLINICAL TRIALS REGISTRATION NUMBERS

This study (as part of the ODIN-migraine project) is registered with the German Clinical Trials Register (DRKS-ID: DRKS00022812).

CONFLICT OF INTEREST STATEMENT

Charly Gaul has received honoraria for consulting and lectures within the past 3 years from AbbVie, Lilly, Novartis Pharma, Hormosan Pharma, Grünenthal, Sanofi-Aventis, Weber & Weber, Lundbeck, Reckitt-Benckiser, Perfood, and TEVA. He is the honorary secretary of the German Migraine and Headache Society. **Elizabeth Seng** has received honoraria for consulting from GlaxoSmithKline, Theranica, AbbVie, and Click Therapeutics. **Timo Klan** declares no competing interests. **Anne-Kathrin Bräscher** declares no competing interests. **Michael Witthöft** declares no competing interests.

DATA AVAILABILITY STATEMENT

De-identified participant data will be made available by the corresponding author to researchers who propose a reasonable scientific request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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