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Personality traits predict the need for cognitive closure in advanced undergraduate medical students

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Abstract

Background Uncertainty in medical decision-making is a significant challenge influenced by various patient- and physician-related factors. They include physicians' clinical reasoning skills and their tolerance for uncertainty. Medical students are trained in clinical reasoning and have to learn to manage uncertainty. This study investigates the influence of personality traits on the need for cognitive closure (NCC) among final-year undergraduate medical students participating in a simulation of a first day of residency.

Methods The study included 373 students who participated in a simulation of a first day of residency between March 2022 and November 2023. The simulation included a consultation, a management, and a patient handoff phase, followed by self-assessments of confidence in clinical reasoning. We used the 16-Need for Cognitive Closure Scale (16-NCCS) and the HEXACO Personality Inventory - Revised (HEXACO-PI-R) to assess NCC and personality traits. Multiple linear regression analysis was performed to explore the impact of personality traits and gender differences on the NCC.

Results Openness, Extraversion, and Honesty-Humility negatively predicted NCC, suggesting these dimensions favor a more explorative and less hurried approach to medical decision-making. Conscientiousness and Emotionality positively predicted NCC, indicating a preference for structured and decisive processes among medical students with high scores on these dimensions. Notably, gender emerged as a significant moderator, particularly influencing the relationship between Emotionality and NCC, with female students showing a higher tendency towards seeking closure when Emotionality was high.

Conclusion The personality dimensions Openness, Extraversion, and Honesty-Humility are negatively predictive of medical students' tendency towards cognitive closure. Learning to reflect on these interrelations is critical for medical students, as inappropriate responses to uncertainty can lead to poor medical decisions. Integrating self-reflective exercises into the curriculum could support students to recognize how their personality influences their response to uncertainty in medical practice.

Keywords Clinical reasoning, Need for cognitive closure, Medical decision-making, Personality traits, Uncertainty, Undergraduate medical education

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Background

Uncertainty accompanies physicians in their daily medical decision making [1]. Different patient- and physician-related aspects have been identified as factors resulting in medical uncertainty [2]. Among the physician-related factors adding to medical uncertainty

are aspects associated with clinical reasoning such as insufficient communication skills, inappropriate assessment of pretest probability, and insufficient medical knowledge to interpret test results as well as physicians' tolerance of uncertainty [2–4]. Physicians' higher stress from uncertainty correlates with higher discomfort with ambiguity [5] and can lead to reduced clinical reasoning performance in the decision making process [6, 7]. The response to uncertainty comprises cognitive, emotional, and behavioral aspects, e.g. curiosity or doubt about, comfort or discomfort with, and embracing or avoiding uncertainty, and is influenced by personal factors [8]. These include personality traits such as the Big Five, i.e. Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism [9, 10] and individual characteristics including age, gender, education, and experience [11]. Personality traits significantly influence clinical decision-making. High manifestations of Extraversion and Conscientiousness were, for instance, associated with junior physicians' choice of more aggressive treatments for leukemia [12]. When physicians' had high levels of Agreeableness, their presumption of negative outcomes in risk situations was lower [13], and Neuroticism was positively associated with general practitioners' fear of uncertainty [14].

In response to uncertainty, the need for cognitive closure (NCC) is a highly relevant concept [8]. It reflects an individual's tendency to seek cognitive closure when facing ambiguity and can be elicited to varying extend depending on the context [15–18]. Increased NCC is associated with a higher perception of stress [5, 19] and impacts physicians' clinical practice, for example, in researching less scientific sources when prescribing new medications [20]. Furthermore, physicians' subjective sense of confidence in their clinical reasoning, which is linked to medical knowledge and experience, plays a pivotal role in clinical decision making [21] and hence in dealing with uncertainty. Gender differences have also been described with respect to clinical decision making. Male physicians, for instance, use less information and take less time to make decisions [22] while female physicians diagnose more thoroughly [23].

Medical students who have more difficulties in dealing with uncertainty are more likely to suffer from psychological distress [24]. They felt discouraged when they were uncertain about an unambiguous diagnosis to communicate to patients or when they were unsure about the right timing for seeking senior support in simulated medical scenarios [25]. Furthermore, medical students perceived their competence to prioritize their tasks and plan subsequent steps for patient work-ups as relatively low [26, 27] which can contribute to feelings of uncertainty. Additionally, the personality dimensions Openness, Conscientiousness, and Agreeableness have been shown to positively influence the academic performance of medical students [28, 29]. Research has shown that Agreeableness, Openness, and Extraversion seem to positively influence medical students' attitudes towards communication and learning, facilitating better patient-physician connections [30] which are crucial for reducing medical errors and improving patient care [31]. Moreover, a lower need for cognitive closure was detected in medical school applicants who were admitted to medical school versus those who were not admitted [32]. In the light of these findings, our study aims to explore how medical students' personality traits influence their need for cognitive closure during a simulated first day of residency [33, 34].

Methods

Study design and participants

From March 2022 to November 2023, 373 final-year medical students participated in different groups in a first day of residency simulation [33, 34]. Each simulation included the same three main phases: (1) a consultation hour with simulated patients, (2) a management phase where tests could be ordered, and (3) a patient handoff. Before the simulation, participants need for cognitive closure and six-personality dimensions were assessed using the 16-Need for Cognitive Closure Scale (16-NCCS) and the HEXACO Personality Inventory – Revised (HEXACO-PI-R), respectively [35, 36]. After the simulation, participants assessed how confident they felt regarding their clinical reasoning during the patient management phase. Participants also provided sociodemographic data regarding age and gender as well as their result of a national knowledge exam (M2) before entering the final year. Participation in this study was voluntary and all participants gave their informed written consent. The study was approved by the Ethics Committee of the Chamber of Physicians, Hamburg (PV3649).

Instruments

16-Need for Cognitive Closure Scale (16-NCCS)

To assess the need for cognitive closure (NCC), the 16-Need for Cognitive Closure Scale (16-NCCS), validated in German language, was used [35]. This scale consists of 16 items rated on a 6-point Likert scale ranging from 1:'strongly disagree' to 6: 'strongly agree'. The internal consistency for the 16-NCCS was $\alpha = .76$. The brevity of this scale suited the procedure of our simulation well.

HEXACO personality inventory – revised (HEXACO-PI-R)

For self-assessment of personality traits, we used the validated German edition of the HEXACO Personality

Inventory – Revised (HEXACO-PI-R) [36]. The HEXACO model provides a valuable complement to the Big Five personality model, introducing the dimensions of emotionality and honesty-humility. These additional dimensions contribute to a more nuanced understanding of personality traits that are particularly relevant in the context of medical education. While the Big Five's Neuroticism dimension addresses emotional stability, HEXACO's Emotionality provides greater emphasis on empathy and emotional awareness, which are crucial for effective patient care. Furthermore, the addition of Honesty-Humility surpasses the Big Five's scope by assessing traits such as integrity and moral awareness, which are vital for fostering ethical behaviour and ensuring patient safety in medical practice [10, 36, 37]. With a total of 60 items, this inventory comprises six dimensions of personality (Agreeableness, Conscientiousness, Emotionality, Extraversion, Honesty-Humility, and Openness to Experience). Each item is rated on a 5-point Likert scale, with 1:'strong agreement', 2: 'agreement', 3: 'neutral', 4: 'disagreement', and 5: 'strong disagreement', which we used as an inverted scale to match the scale orientation of the other instruments in this study. The internal consistencies for the dimensions of HEXACO-PI-R were $\alpha = 0.70$ for Agreeableness, $\alpha = 0.76$ for Conscientiousness, $\alpha = 0.74$ for Emotionality, $\alpha = 0.77$ for Extraversion, $\alpha = 0.71$ for Honesty-Humility, and $\alpha = 0.63$ for Openness to Experience.

National knowledge exam (M2)

A mandatory part of obtaining a German medical license is the national knowledge examination (M2). It has to be successfully accomplished before entering the final year of the six-year undergraduate medical curriculum and consists of 320 clinical multiple-choice questions. Grades for the examination are 1: 'very good', 2: 'good', 3: 'satisfying', 4: 'sufficient'. A grade beyond 4 indicates failure of the examination.

Self-assessed confidence in clinical reasoning during patient management

After the simulation, participants assessed their confidence in patient management by rating the statement: 'During the management phase I felt confident (in clinical reasoning)'. A 5-point Likert scale (1: 'does not apply', 2: 'applies somewhat', 3: 'applies partially', 4: 'applies mostly' 5: 'applies completely') was used for answering this question.

Data analysis

Data analysis was performed using R Version 4.2.2 [38]. Original item scales were inverted whenever indicated and scaled according to the instruments' guidelines. We ran a linear multiple regression analysis with moderation with NCC as dependent variable and gender as a categorical moderator, as well as the six HEXACO-PI-R dimensions, the M2 grade, and the confidence in clinical reasoning as independent variables. We also included all possible interactions between moderator and the other independent variables in the model. Furthermore, we contrasted regression slopes of both genders by visual inspection of the moderation pattern. For examination of gender differences, we ran multiple t-tests for the independent variables included in the regression model. All statistical tests were conducted with a general alpha level of 0.05. To address the issue of multiple testing, the alpha level for the multiple t-tests was adjusted to 0.00625 using Bonferroni correction [39].

Results

Complete data sets were available for 293 participants (71.3% female, 28.7% male). Their average age was 26.8 ± 2.9 years. Table 1 shows the means of the six personality dimensions, the confidence in clinical reasoning, and the grade of the national knowledge exam by gender. The group comparison revealed significantly higher mean scores for Emotionality and Honesty-Humility among female participants, while male participants had significantly higher mean scores for Confidence in clinical reasoning. Mean scores of the NCC were 3.11 ± 0.56 for female students and 3.05 ± 0.46 for male students.

The results of the regression analysis (Table 2) revealed associations between HEXACO-PIR and NCC. In particular, higher scores on Openness, Extraversion, and Honesty-Humility predicted significantly lower NCC scores. A higher score on Conscientiousness and Emotionality significantly predicted a higher score on NCC. These predictions remain robust and independent of other predictor variables, including final grade, gender,

Table 1 Means of variables and t-test results for gender

	gender			
	female $n = 209$	**male** $n = 84$	***p***	**Cohen's d**
Variables	**M ± SD**	**M ± SD**		
Openness	3.74 ± 0.48	3.68 ± 0.50	0.378	-0.11
Conscientiousness	3.78 ± 0.47	3.62 ± 0.55	0.012	-0.33
Agreeableness	3.33 ± 0.46	3.26 ± 0.50	0.301	-0.13
Extraversion	3.54 ± 0.52	3.58 ± 0.47	0.522	0.08
Emotionality	3.38 ± 0.48	2.89 ± 0.48	0.003	-1.03
Honesty-Humility	3.78 ± 0.50	3.48 ± 0.52	< 0.001	-0.60
Confidence	2.93 ± 0.82	3.23 ± 0.81	0.006	0.36
Grade	2.61 ± 0.63	2.57 ± 0.80	0.710	-0.05

Table 2 Multiple regression analysis results

Variables	Estimate	SE	t	*p*	partial r^2
Openness	-0.347	0.07	-5.142	< 0.001	0.088
Conscientiousness	0.172	0.07	2.498	0.013	0.022
Agreeableness	-0.040	0.07	-0.540	0.589	0.001
Extraversion	-0.288	0.06	-4.545	< 0.001	0.070
Emotionality	0.308	0.07	4.329	< 0.001	0.064
Honesty-Humility	-0.211	0.06	-3.268	0.001	0.037
Confidence	0.009	0.04	0.222	0.824	< 0.001
Grade	0.085	0.05	1.682	0.094	0.010
Gender	1.417	1.09	1.297	0.196	0.006
Interactions with gender					
Openness	0.064	0.12	0.520	0.603	< 0.001
Conscientiousness	-0.160	0.13	-1.281	0.201	0.006
Agreeableness	0.049	0.14	0.356	0.722	< 0.001
Extraversion	0.012	0.13	0.094	0.925	< 0.001
Emotionality	-0.313	0.13	-2.327	0.021	0.019
Honesty-Humility	-0.002	0.12	-0.013	0.990	< 0.001
Confidence	-0.038	0.07	-0.519	0.604	< 0.001
Grade	-0.073	0.08	-0.883	0.378	0.003

and the subjective sense of confidence in clinical reasoning during the management phase.

Gender was considered as a potential moderator and did show a significant effect on the association of Emotionality and NCC. Visual inspection revealed a moderate positive regression slope for women whereas the regression slope for men was marginally negative (Fig. 1).

Discussion

In our study, Openness, Extraversion, and Honesty-Humility negatively predicted the Need for Cognitive Closure (NCC) in undergraduate medical students. Openness has been shown to be compatible with intellectual and emotional autonomy and not compatible with security [40]. Our results suggest that students with

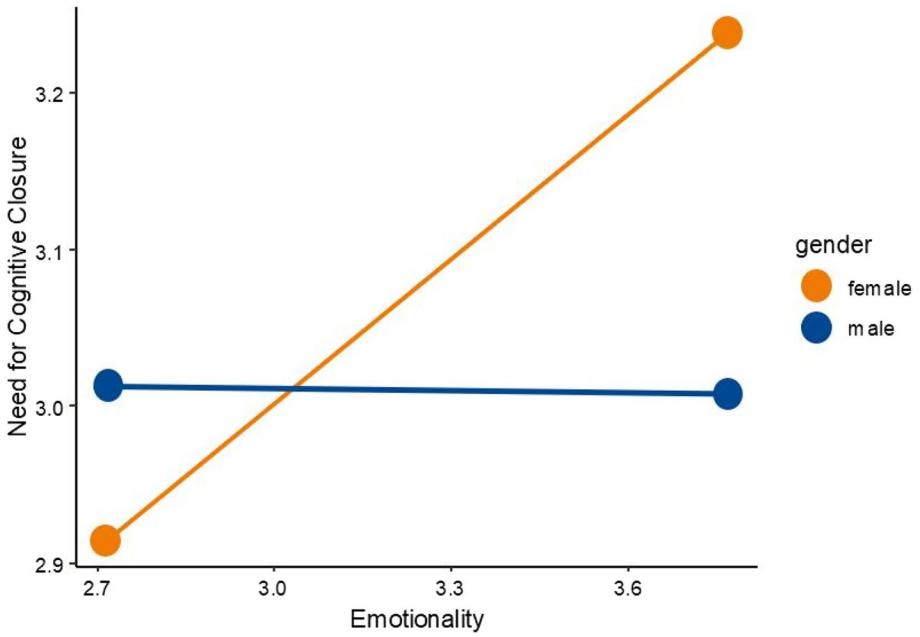

Fig. 1 Regression slopes for Emotionality by gender

high levels of Openness tend to explore more diagnostic options and endure medical uncertainty longer rather than rushing to decisions and cognitive closure. Extraverts, characterized by social affinity and warmth [40], might prefer collaborative, iterative decision-making processes. These types of decision making are more complex because different perspectives need to be explored and discussed [41] which can be facilitated by a lower need for cognitive closure. Individuals with high levels of Honesty-Humility prioritize accuracy and integrity [42] over quick outcome, which would also be in line with a lower need for cognitive closure. This suggests that these personality dimensions could be relevant for medical students in dealing with complex clinical situations by fostering a more flexible and thorough approach to problem-solving. Such an approach is crucial in medical practice where premature closure can cause patient harm [43]. In turn, Conscientiousness and Emotionality positively predicted NCC in our students. This is consistent with the findings that individuals with higher levels of Conscientiousness are more careful [44] and avoid risks [40]. Furthermore, people with higher levels of Emotionality are more fearful [44] and have higher risk perception [45]. Hence, people with high levels of Conscientiousness and Emotionality could prefer structured processes and clear outcomes. This preference matches with seeking cognitive closure more frequently [15], presumably to reduce stress [46].

Gender showed a significant effect on the association of Emotionality and NCC. The moderate positive regression slope in female but not in male students suggests that as women's emotionality, e.g., anxiety, increases, so does their desire to seek closure and resolution. This could imply a less tolerant approach to ambiguity and uncertainty. When watching videos triggering different emotions, female participants expressed their experienced emotions, especially negative ones, more frequently than men [47]. Furthermore, it has been shown that women used a wider range of verbal expression for uncertainty [48]. Regarding women's greater expressiveness of emotions and broader verbal strategies when facing uncertainty, our findings suggest that female medical students might take a proactive approach towards seeking clarity, when their Emotionality is high, which is expressed in a higher NCC. Besides Emotionality, female student in our study had higher scores for Honesty-Humility when compared to male students, suggesting greater emotional sensitivity and a stronger orientation towards fairness and sincerity [44]. Male students showed higher scores in Confidence in Clinical Reasoning, which is consistent with other findings on self-confidence regarding clinical knowledge and skills [49, 50]. However, neither Honesty-Humility nor Confidence in Clinical Reasoning showed a significant gender-specific prediction of NCC in our study.

Our study has several limitations. One limitation is the sample itself, which consisted of voluntary participants. This introduces a selection bias. While all HEXACO-PI-R dimensions showed acceptable internal consistencies, Openness to Experience was an exception with $\alpha = 0.63$, indicating a limitation in its internal consistency. An additional limitation is that the confidence in clinical reasoning was asessed using a single item, which restricts psychometric properties of the confidence assessment. On the other hand, a significant strength of our study lies in the context of the simulation of the first day of residency, which provided a practical, work-based context with substantial validity [33] for assessing the need for cognitive closure. Using validated psychometric instruments, especially the 16-NCCS and the HEXACO-PI-R is another strength of our study. The robustness of the predictions, even when controlling for gender, final grades, and confidence in clinical reasoning, underscores the potential influence of personality traits on the need for cognitive closure. With this finding we hypothesize that personality traits could be considered relevant predictors of cognitive closure, independent of academic performance or self-rated confidence in specific professional tasks.

The significant impact of personality traits on our medical students' need for cognitive closure (NCC) could be important for their patient management and clinical reasoning. Inappropriate response to uncertainty based on higher levels of NCC in certain situations can lead to premature closure and, therefore, to clinical errors and incorrect treatment decisions [51, 52]. Hence, it seems to be important to sensitize medical students for their individual expression of NCC and the influences and effects their personality traits can have on clinical reasoning skills and medical decisions. As with other medical skills that medical students learn to reflect on [53–55], tools, sessions or courses could be integrated in the undergraduate curriculum where students self-reflect on their personality traits and NCC. HEXACO-PI-R [36] and 16-NCCS [35] could be used for individual assessment of personality traits and need for cognitive closure, accompanied by guided journaling [56] to encourage reflection on how these dispositions can influence clinical reasoning.

Similar to courses in learning clinical interviewing skills with virtual patients where the need for cognitive closure and psychological characteristics influenced the effectiveness [57], courses in clinical reasoning could be established where students' awareness for influences of openness, extraversion, and need for cognitive closure could be raised and discussed. Increased self-reflection

could enable students to better understand expressions of their personality traits and their respective impact as well as emotional responses in clinical settings. This is particularly important in medical situations, where effective decision-making is crucial and needs to be balanced with emotional involvement in patient care. Opportunities for self-reflection would not only contribute to personal growth and the development of professional competencies, but would also ensure that future doctors are well equipped to deal with uncertainty and the psychological demands of their profession.

Conclusions

This study highlights the negative prediction of the need for cognitive closure in medical students by the personality dimensions Openness, Extraversion, and Honesty-Humility as well as its positive prediction by Conscientiousness and Emotionality. As the NCC is important for clinical reasoning and inappropriate responses to uncertainty can lead to incorrect medical decisions, undergraduate medical students need to learn about the relevance of their personality traits and how they can affect their NCC during clinical decision making. By integrating self-reflective practices into the curriculum, medical students could gain insight how their personality traits affect their experience of and reaction to uncertainty in medical practice expressed by their NCC.

Abbreviations

NCC	Need for Cognitive Closure
16-NCCS	16-Item Need for Cognitive Closure Scale
HEXACO-PI-R	HEXACO Personality Inventory Revised
M2	German national knowledge exam

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Authors' contributions

All authors designed and performed the study. All data were analyzed by LJ. JG drafted the manuscript. All authors read and approved the final manuscript.

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Data availability

All data and materials are available from the manuscript.

Declarations

Ethical approval and consent to participate

The study was performed in accordance with the Declaration of Helsinki and the Ethics Committee of the Chamber of Physicians, Hamburg, approved this study and confirmed its innocuousness (PV3649). Participation was voluntary and all participants provided informed written consent for participation in this study. All data were anonymized.

Consent to publication

Not applicable.

Competing interests

SH has a position as Senior Editorial Board Member to BMC Medical Education. JG, and LJ have no competing interest.

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