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RESEARCH ARTICLE

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Prevalence and psychosocial correlates of subjectively perceived decline in five cognitive domains: Results from a population-based cohort study in Germany

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Objective: Subjective cognitive decline (SCD) was frequently investigated for memory in healthy aging or in relation to diseases like dementia. It was found to be related to sociodemographic and psychological variables as well as cognitive abilities. The prevalence of SCD in other cognitive domains and their relation to these variables is largely unknown to date. The present study aimed to fill this gap.

Methods: A total of 807 subjects (18-85 years of age, M = 57.8 years, female: 43%) completed the Juelich Questionnaire on Subjective Cognitive Decline, to investigate SCD in memory, attention, language, motor, and executive functions. Logistic regression analyses were used to estimate association of depressive symptomatology, emotionality, and general cognitive performance as well as age, gender, and educational attainment with domain-specific SCD.

Results: The highest prevalence rate was obtained for the memory domain (65.9%), followed by the attention (54.6%), motor (52.9%), executive (39.7%), and language domain (31.5%). Of the psychosocial factors, only age, depressive symptomatology and emotionality were consistently and strongly associated with domain-specific SCD prevalence.

Conclusions: SCD is prevalent not only in the memory domain, but also in other major cognitive domains. Our results also suggest that the suspicion from previous research, that subjective memory decline might be more strongly associated with depressive symptomatology and emotionality than with actual decline of cognitive performance, might also apply to the attention, motor, executive, and language domain. Further investigations using neuropsychological testing for specific cognitive functions and employing longitudinal designs are required for substantiating this suspicion.

KEYWORDS
cognitive aging, cognitive complaints, cohort study, Germany, prevalence, subjective cognitive decline

1 | INTRODUCTION

Human aging is associated with a decrease in many cognitive abilities.[1] Fluid cognitive abilities, such as memory or attention, which depend heavily on processing speed, have been found to start decreasing already at early adulthood. In contrast, crystallized cognitive abilities that are related to world knowledge, and in particular language use, do not decrease with age or may even increase,[2,3] though there is some evidence that these abilities may decline at very old age.[4] Cognitive domains may also be differentially affected by pathological decline due to illnesses like dementia.[5,6] For instance, in line with previous research, Mistridis et al found that for subjects receiving a mild cognitive impairment (MCI) diagnosis at a later point in time, decline in memory functions began earlier than decline in executive and psychomotor functions.[7]

Such changes in cognitive abilities are also reflected in the subjective perception of those affected, and correspond, at least in Western societies, to the general view of aging as being associated with a decline in cognitive performance.[8] This is most obvious for memory functions, where older adults often complain about impairment or decline of their memory.[9] The frequency of complaints in older adults, however, is far from being clear, as studies have yielded quite diverse prevalence rates. While an early review of studies on subjective memory complaints reports prevalence rates between 25% and 50%,[10] other studies found prevalence rates as high as 80%,[11] or even 96%.[12] The reasons for these large variations are probably manifold: studies were carried out in different settings, for example, epidemiological vs clinical,[13] vary with regard to the age range included and use different definitions and methods to assess subjective memory complaints.[14]

A number of studies have investigated the broader concept of subjective cognitive complaints, thereby including not only memory but also other cognitive domains, such as the attention, language, or executive domain. However, in many of the studies these domains were integrated into an overall subjective cognitive complaints construct.[15-21] So far, only few studies have investigated cognitive domains seperately.[22-24]

As fluid cognitive abilities usually decline with increasing age, it seems obvious to expect an increase of memory/cognitive complaints with increasing age. This has been found in several studies.[25-28] Others, however, found no such increase.[24,29-31] It is also largely unknown, whether other sociodemographic (gender, educational attainment) and psychological variables (depressive symptomatology, neuroticism, cognitive performance), which have been identified in previous research as potentially influencing subjective memory/cognitive complaints,[11,24,32] are also relevant for the other cognitive domains.

Over the last 15 to 20 years, cognitive complaints also became a focus of interest in the search for early indicators of developing *MCI* and *Alzheimer's disease*.[10,33,34] Recently, the *Subjective Cognitive Decline Initiative* stressed the importance of focusing on the subjective perception of cognitive *decline* instead of the more general terms subjective cognitive complaint or impairment, because subjective cognitive *decline* refers to the experience of temporal change in cognitive capacity, whereas complaint or impairment may also refer to chronic or stable cognitive states.[35]

Key points

- Subjective cognitive decline (SCD) is a characteristic of normal cognitive aging, but may also be an indicator for dementia risk.
- Previous research has focused on SCD in the memory domain, thus the extent of SCD in other cognitive domains is largely unknown to date.
- This study investigated SCD in five cognitive domains and found the highest prevalence rates for the memory domain, followed by the attention, motor, executive, and language domain.
- In all these domains, SCD prevalence increased with age, and was strongly associated with depressive symptomatology and, to a lesser extent, with emotionality.

We consider *subjective cognitive decline* (SCD) a useful concept not only with regard to research on MCI and Alzheimer's disease, but also for research on cognitive aging in general. Thus, the purpose of this study was to investigate the prevalence of SCD in five domains (attention, memory, language, motor, executive functions) and their relationship to the above mentioned variables age, gender, educational attainment, cognitive performance, emotionality/neuroticism, and depressive symptomatology.

2 | METHODS

2.1 | Participants

The sample consisted of participants of the population-based 1000BRAINS study,[36] which is based on the Heinz Nixdorf Recall (HNR) study[37] and the HNR MultiGeneration study cohort (spouses and offspring of participants of the HNR study). Included were those participants, who completed the *Juelich Questionnaire on Subjective Cognitive Decline* (JQSCD-I) between November 2012 and June 2017. All participants signed a written informed consent. The local ethics committee of the University of Essen approved the study.

2.2 | Procedures

During the 1000BRAINS study, participants completed an extensive neuropsychological assessment, extensive neuroimaging using structural and functional magnetic resonance imaging, and several questionnaires.[36]

Sociodemographic variables used in this analysis include age, gender, and educational attainment, the latter being classified by the *International Standard Classification of Education*.[38,39] The ISCED comprises ordered levels from 1 = *pre-primary level of education* to 11 = *secondary stage of tertiary education* and was divided here for analysis into two main categories: low/medium level and high level of education.[38]

Subjective perception of cognitive decline was recorded with the *Juelich Questionnaire on Subjective Cognitive Decline* (JQSCD-I). The JQSCD-I is a self-administered questionnaire for investigating the severity and onset of SCD with regard to 15 cognitive functions from five cognitive domains (Table S1): *Attention* (selective attention, divided attention, sustained attention), *Memory* (figural memory, verbal episodic memory, motor learning), *Language* functions (naming, conversational skills, textual comprehension), *Motor* functions (speed, mobility, coordination), and *Executive* functions (cognitive flexibility, reasoning, planning). Response categories for the severity assessment range from *not worse at all* over *somewhat worse*, *much worse* to *a lot worse*.

Psychological variables included the BDI score from the *Beck Depression Inventory II* (BDI-II),[40] an "emotionality" score (corresponding to Eysenck's personality dimension of neuroticism) that is included in the *Freiburg Personality Inventory* (Freiburger Persönlichkeitsinventar [FPI-R]),[41] and the *DemTect* score as a measure for global cognitive performance.[42]

2.3 | Statistical analysis

Prevalence of domain-specific subjective cognitive decline was defined as whether or not a cognitive function within each of the five domains has been experienced as declined. That is, SCD in a cognitive domain was present if at least one of the three cognitive functions of that domain had been reported as *somewhat worse*, *much worse* or *a lot worse*. To better identify effects we categorized the independent variables in a way that facilitates interpretation.[43] Age was categorized into six age groups "18-34," "35-44," "45-54," "55-64," "65-74," and "75-85" years, and scores of the psychological variables were split into dichotomous categories. For the BDI-II, participants with BDI scores ≤13 (corresponding to the categories "no" and "minimal" depression) were categorized as "no depression," and those with BDI scores ≥14 (corresponding to the categories "mild," "moderate," and "severe" depression) were grouped into the "indication for depression" category. The DemTect comprises the three categories "adequate cognitive performance" (DemTect scores 13-19), "MCI" (DemTect scores 9-12), and "Suspicion of Dementia" (DemTect scores ≤8). Since there were only three cases in the "Suspicion of Dementia" category, we have excluded this category from our analysis. For emotionality the cutoff value for categorizing participants to one of two emotionality groups ("high" and "low") was based on the age and gender specific mean values of the normative sample.[41]

To estimate effects of each of the psychosocial variables on domain-specific SCD, first separate simple binary logistic regression analyses with domain-specific SCD as dependent and each of the psychosocial variables (age group, gender, educational attainment, depressive symptomatology, emotionality, global cognitive performance) as independent variables. Then all psychosocial variables were entered simultaneously in a multivariable binary logistic regression model to estimate their unique explanatory contribution for prevalence of domain-specific SCD. Results of the logistic regression analyses are reported as odds ratios along with 95% confidence intervals. Confidence limit ratios (CLR) are provided for comparing precision of estimates.[44]

Statistical analyses were performed with *R*,[45] including the packages *car*,[46] *ggplot2*,[47] *psych*,[48] *reshape2*,[49] *sjPlot*,[50] and *tableone*.[51]

3 | RESULTS

A total of 807 subjects in the age range 18 to 85 years (M = 57.8 years, SD = 14.3 years) completed the study. Table 1 displays the sociodemographic and psychological sample characteristics.

Overall SCD prevalence rates for the five cognitive domains as well as the intercorrelations of SCD prevalence in cognitive domains are presented in Table 2. SCD prevalence rates for the five domains clearly differ (except for Attention and Motor), as the nonoverlapping confidence intervals show. Pearson correlations between SCD prevalence rates of cognitive domains were all positive and in the range of 0.22 to 0.47.

Figure 1 shows that SCD prevalence rates increased with age in all cognitive domains, albeit to varying degrees (see also Table S2).

The upper row of Figure 2 (see also Table S3) mirrors these patterns, showing odds ratios resulting from simple binary logistic regression analyses with domain-specific SCD prevalence as dependent and age group as independent variable. Here, the youngest age group (18-34 years) served as the reference group against which the odds ratios of the other age groups were estimated. Age group effects were largest for the Executive, the Memory and the Motor domain, with odds ratios above 10 for the oldest age group. Age group effects were somewhat smaller for the Attention domain and markedly smaller for the Language domain.

The second and third row of Figure 2 (see also Table S3) shows the respective results from simple binary logistic regression analyses for the other psychosocial variables (depressive symptomatology, global cognitive performance, emotionality, educational attainment, gender). Large effects were found for depressive symptomatology (compared to no depressive symptomatology), in particular for the Attention, Executive and Language domain.

Low to medium size odds ratios were found for MCI (reference group: adequate cognitive performance) and high emotionality (reference group: low emotionality). For low/medium educational attainment (reference group: high educational attainment) and female gender (reference group: male) odds ratios were all close to one.

Using a multivariable binary logistic regression analysis for estimating the unique association between domain-specific prevalence of SCD and sociodemographic and psychological variables did change little with regard to the odds ratio estimates (Figure 3 and Table S4). For all cognitive domains, odds ratios for the age groups were slightly higher, in particular for the older age groups, while odds ratios for depressive symptomatology were lower. However, these changes were well within the 95% confidence intervals of the original simple binary logistic

TABLE 1 Sociodemographic and psychological sample characteristics

		Age group					
	Overall	18-34	35-44	45-54	55-64	65-74	75-85
N	807	73	80	131	225	217	81
Female (%)	43.1	35.6	45.0	50.4	42.7	43.8	35.8
Education low/medium (%)	51.8	41.1	37.5	42.7	53.3	58.1	69.1
FPI-EM score (SD)	3.95 (3.33)	5.26 (3.62)	3.90 (3.05)	4.15 (3.23)	4.16 (3.61)	3.24 (3.06)	3.81 (2.96)
Emotionality high (%)	31.5	47.9	28.7	35.9	29.8	25.8	32.1
BDI score (SD)	5.20 (5.65)	4.23 (4.54)	4.21 (4.44)	5.65 (6.55)	5.64 (6.72)	4.88 (4.98)	5.94 (4.07)
Depressive symptomatology (%)	7.1	5.5	5.0	8.4	9.8	6.5	2.5
DemTect score (SD)	15.16 (2.39)	16.19 (2.04)	15.95 (2.52)	15.44 (2.36)	15.24 (2.28)	14.78 (2.32)	13.75 (2.26)
Mild cognitive impairment (%)	14.6	4.1	11.2	14.5	12.4	16.6	28.4

Abbreviations: BDI, Beck Depression Inventory II; FPI-EM, emotionality scale of the Freiburg Personality Inventory (Freiburger Persönlichkeitsinventar [FPI-R]).

	Prevalence (%)	Memory	Attention	Motor	Executive	Language
Memory	65.9 [62.6-69.2]	1	0.47	0.35	0.40	0.37
Attention	54.6 [51.2-58.0]	0.47	1	0.28	0.42	0.40
Motor	52.9 [49.5-56.3]	0.35	0.28	1	0.31	0.22
Executive	39.7 [36.3-43.1]	0.40	0.42	0.31	1	0.39
Language	31.5 [28.3-34.7]	0.37	0.40	0.22	0.39	1

Abbreviation: SCD, subjective cognitive decline.

TABLE 2 Prevalence of SCD (with 95% confidence intervals) in cognitive domains and Pearson's correlations of SCD prevalence between cognitive domains

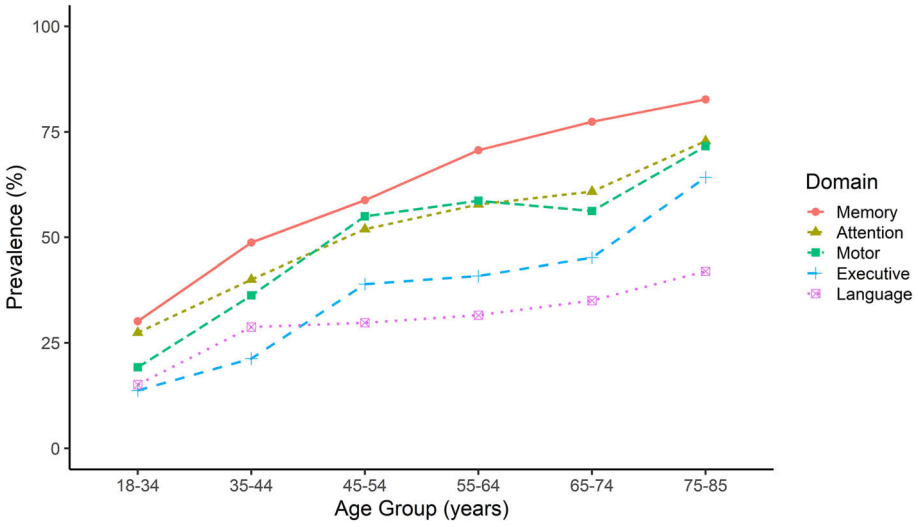

FIGURE 1 Prevalence of subjective cognitive decline in cognitive domains by age groups [Colour figure can be viewed at wileyonlinelibrary.com]

regression analyses, and the confidence intervals from the multivariable binary logistic regression analyses were even wider (with CLR mostly ≥4). Odds ratio estimates for high emotionality, MCI, female gender, and low/medium educational attainment remained about the same as from the simple binary logistic regression analyses, or were slightly lower.

4 | DISCUSSION

This study explored the prevalence of SCD in five cognitive domains in a population-based sample of 807 adults in the age range 18 to 85 years. The highest SCD prevalence rate (65.9%) was obtained for the Memory domain, which falls within the wide range of prevalence estimates reported in previous studies.[10-12] Lower, but still substantial prevalence rates were found for the other four cognitive domains addressed in this study (Attention, Motor, Executive, Language), which had not previously been studied with regard to SCD. The low to medium size correlations between SCD prevalence in the five cognitive domains indicate that these domains should be kept separate and not be collapsed into one overall measure of SCD. This point is even more stressed when considering the association of SCD prevalence with age.

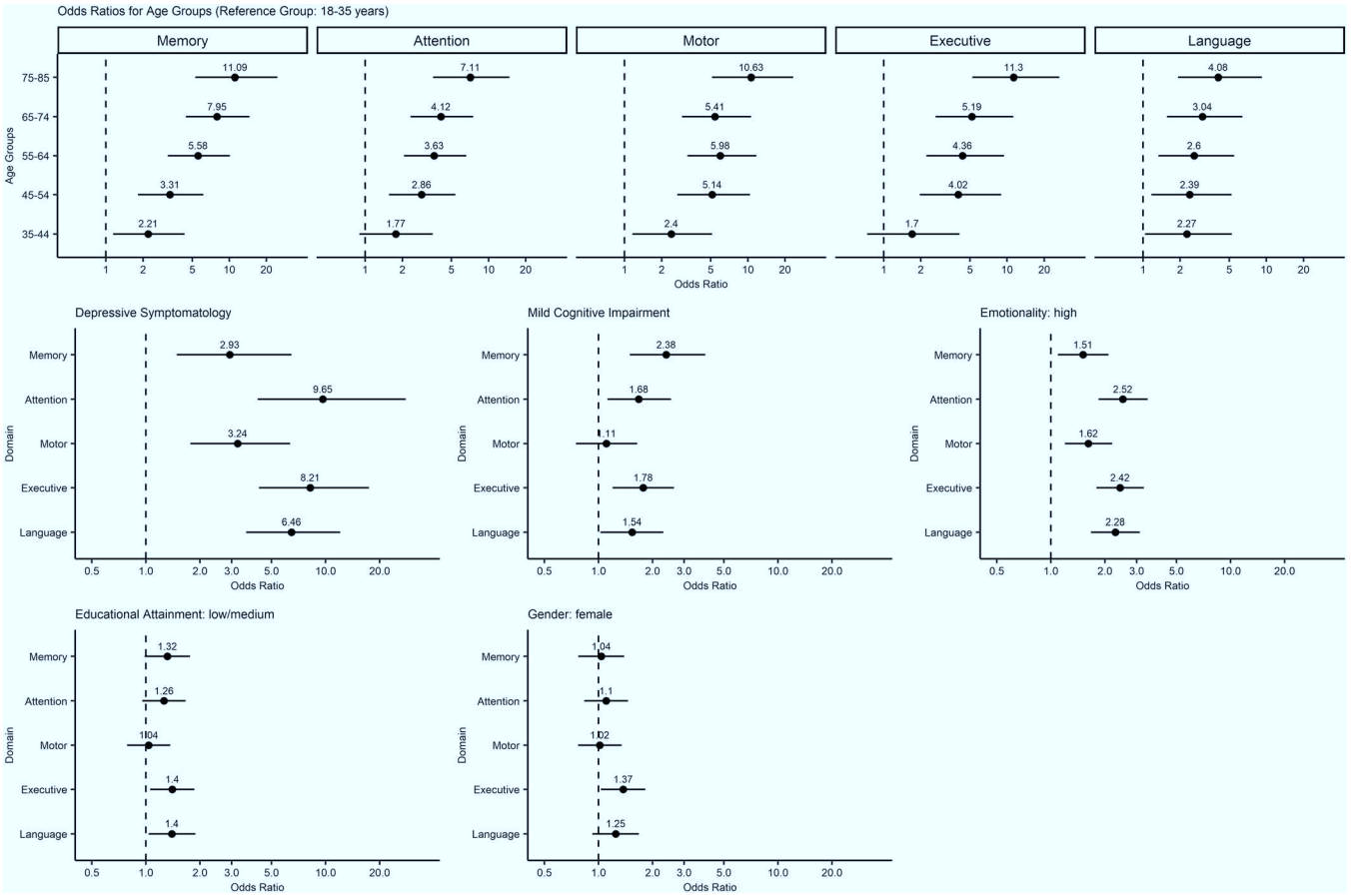

FIGURE 2 Odds ratios (with 95% CIs) from simple binary logistic regression of domain-specific subjective cognitive decline on psychosocial variables

In this regard, two results are worth noting. First, even in the youngest age group (18-34 years), prevalence of SCD in the Memory domain was already 30.1%. This is certainly a surprisingly high rate for young people; however, similarly high prevalence rates for subjective memory complaints (forgetfulness) have been found for young and middle-aged groups in an early study by Commissaris et al.[25] In this study, participants were also asked to give reasons for their forgetfulness (from a pre-structured nine-item list). While the older age groups mainly mentioned internal causes such as age or health problems, the younger people more often referred to external causes, such as stress or concentration problems. Second, while SCD prevalence rates for the other cognitive domains were already lower than for the Memory domain (from 27.4% for Attention down to 13.7% for Executive) in the youngest age group, the differences between the cognitive domains diverged with increasing age. While both Memory and Attention SCD prevalence increased monotonically from the youngest to the oldest age group, Motor and Executive SCD prevalence increased up to the "45-54" age group (though at different levels), then remained almost stable at that level, before increasing again for the oldest age group. Language SCD prevalence increased from the youngest age group (18-34 years) to the next, but then remained about the same up to age group "65-74," before finally increasing again at the oldest age group (75-85 years). These patterns of age-related SCD prevalence are reminiscent in shape of the age-related profiles of cognitive performance, where fluid cognitive abilities (Memory, Attention, Motor, Executive) have been found to decrease with advancing age, while crystallized cognitive abilities (Language) remain almost stable until very old age.[2,3]

Given this resemblance, one could expect an at least moderate association between domain-specific SCD and objective cognitive performance. However, the association between domain-specific SCD and cognitive performance, measured as normal cognitive performance vs MCI, turned out to be low, with odds ratios below two for the Attention, Motor, Executive, and Language domains. Only for Memory an odds ratio above two (OR = 2.38) was found. The associations between domain-specific SCD and objective cognitive performance, however, became even smaller in the multivariable analysis. The odds ratios were now all close to one with 95% CIs including one, except for Memory (OR = 1.76). A plausible explanation for the stronger memory related association is that the DemTect test focusses on memory related abilities. The low association between memory specific SCD and objective cognitive performance is by no means characteristic of this study alone. Previous research showed quite mixed results. Some studies found associations[52,53] and others not.[54-56] Summarizing the heterogeneous research on this topic, recent meta-analyses found only a small overall association between subjective memory complaints and objective memory performance.[57-59]

Several studies found depressive symptomatology to be closer associated with subjective memory complaints than objective memory

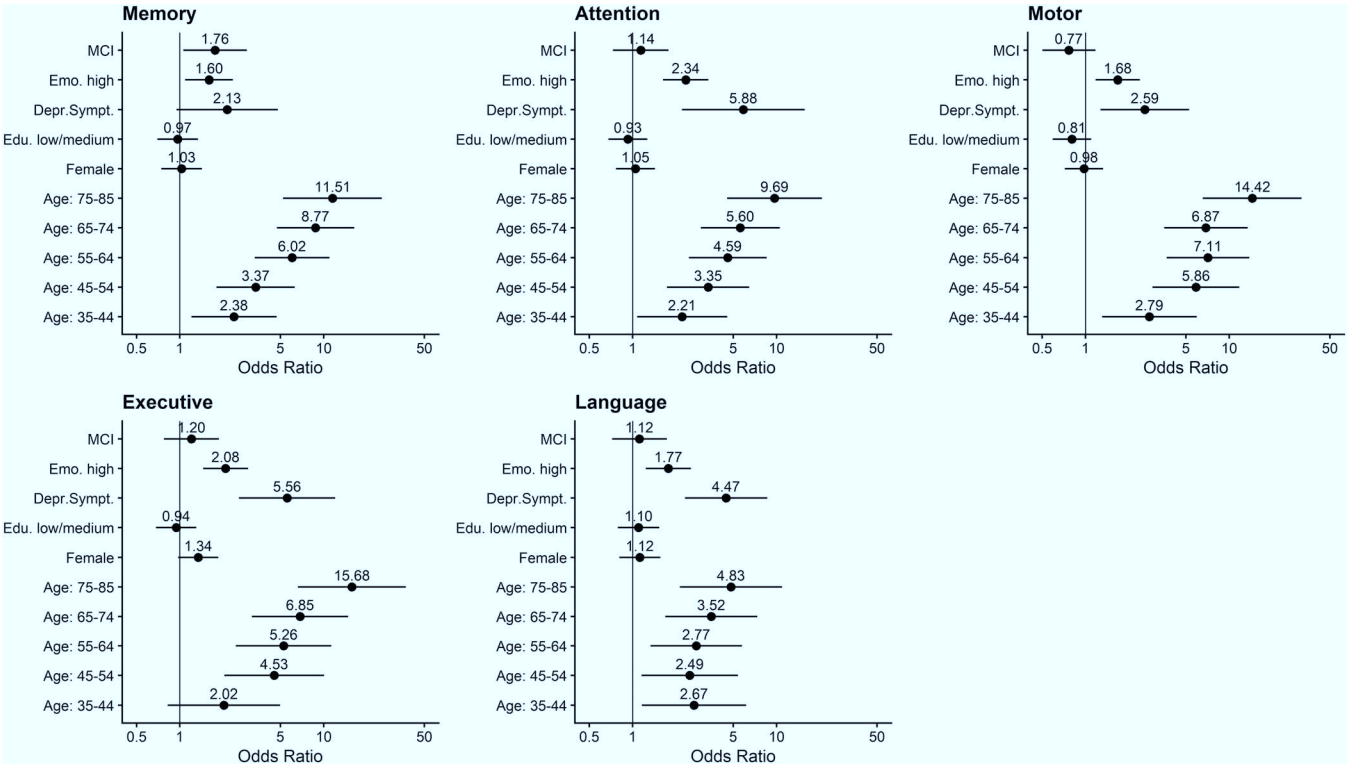

FIGURE 3 Odds ratios (with 95% CIs) from multivariable binary logistic regression of domain-specific subjective cognitive decline on psychosocial variables

performance.[60-62] Moreover, in a recent systematic review Hill et al concluded that subjective memory complaint was consistently related to depressive symptomatology.[63] The findings of our study are only partly consistent with these results. While the bivariate association between depressive symptomatology and memory specific SCD prevalence was substantial (OR = 2.93) with 95% CI clearly excluding one, the odds ratio dropped to OR = 2.13 in the multivariable logistic regression analysis, now with the 95% CI including one. However, we not only investigated the association of depressive symptomatology with memory specific SCD, but also with Attention, Motor, Executive, and Language specific SCD. For these cognitive domains, even stronger associations with depressive symptomatology were obtained in the bivariate analyses, in particular for the Attention, Executive, and Language domains with odds ratios ranging from 6 to almost 10. The odds ratios also decreased in the multivariable logistic regression analyses, but with 95% CIs still clearly excluding one. The odds ratio estimates in both simple and multivariable logistic regression analyses were associated with large uncertainties, as indicated by the wide 95% CIs and large confidence limit ratios (between 4 and 7). Despite these uncertainties, it is clear that the association between depressive symptomatology and domain-specific SCD was—at least for the Attention, Executive, and Language domains—on the order of age-related effect sizes for SCD prevalence. One explanation for the association between depressive symptomatology and SCD discussed in the literature is that people with a depressive symptomatology "may pay more attention to or monitor their state more closely for negative or problematic symptoms" (p. 1040).[64]

This sensitivity to negative changes in personal health states might also be typical for people high on the personality trait of emotionality/neuroticism.[65] Quite a number of studies have investigated the relationship between this personality characteristic and subjective cognitive complaint, consistently finding low to moderate positive associations between both.[15-17,66-71] One may wonder whether the association between subjective cognitive complaint on the one hand and depressive symptomatology and emotionality/neuroticism on the other hand is actually due to both referring to the same underlying psychological state.[72] However, a recent study by Pearman et al found that both depression and emotionality/neuroticism independently contribute to explaining subjective cognitive complaint.[73] The same holds for the present study, which also found low to medium positive associations between SCD and emotionality in the simple logistic regression analysis. These remained about the same size in the multivariable analysis, which included depressive symptomatology as another predictor. This supports the notion that both emotionality/neuroticism and depressive symptomatology are both independently associated with SCD.

Previous studies investigating gender and subjective memory decline found only weak (both positive and negative) associations.[32,69,74-76] The results of the present study point in the same direction: the odds ratios between domain-specific SCD and gender were close to one, with their 95% confidence intervals including one.

Educational attainment is often taken as a proxy for cognitive reserve, which in turn is considered a protective factor against age-related cognitive decline.[77,78] This suggests that lower educational

attainment, as a marker for less cognitive reserve, should be associated with more SCD, since those with low cognitive reserve would experience stronger cognitive decline. In fact, previous studies investigating the association between educational attainment and subjective memory decline almost consistently found this negative association, although the associations were weak.[69,74,75,79] In the present study, bivariate associations between educational attainment and SCD were weak for all cognitive domains, with odds ratios all below 1.5. Even lower and almost indistinguishable from one were the odds ratios found in the multivariable logistic regression analyses. A reason for these low associations between educational attainment and SCD could be that SCD is actually only weakly related to actual decline in cognitive performance (as the results reported above indicate). Thus, even if educational attainment does affect (via cognitive reserve) cognitive decline, this would have no effect on SCD. However, from a psychological point of view, the reverse association is also plausible. In a study on subjective memory complaints and the risk of stroke, Sajjad et al found a positive association between higher educational attainment and subjective memory complaints.[80] They also found that the association between subjective memory complaints and stroke was strongest in highly educated subjects. Van Oijen et al obtained a similar results for the association between subjective memory complaints and Alzheimer's disease, which also was strongest in persons with higher educational attainment.[81] Both speculated that people with higher educational attainment might be more likely to notice subtle changes in their memory performance. A reason for these conflicting results between these two studies and our study might be that Sajjad et al as well as Van Oijen et al asked for subjective memory *complaints*, whereas our study and the other studies cited above asked for subjective memory *decline*. As noted in the introduction, asking for subjective memory decline focuses on the experience of temporal change in cognitive capacity, whereas asking for subjective memory complaints refers to a more general assessment of one's memory, which also may be chronic or stable cognitive state. It may well be that this difference triggers different cognitive processes, which result in different evaluations.

4.1 | Study limitations

This study has limitations, which should be considered when drawing conclusions. Prospective study participants were informed in advance of the intensive study procedures, including time demands. This might result in an overrepresentation of mentally and physically more healthy participants particularly in the older age groups. This may have affected the prevalence of SCD in the study sample as well as the strength of associations between SCD prevalence and the psychosocial variables, in particular cognitive performance. Specifically with regard to cognitive performance, a second limitation needs to be noted. SCD refers to the subjective perception of *change* in cognitive performance. To investigate the relationship between SCD and objective cognitive performance, one would therefore better look at change in objective cognitive performance over time in a longitudinal study design, rather than at a one-time assessment of cognitive performance, and relate this change to SCD.

5 | CONCLUSION

Our study results could demonstrate that SCD is not limited to the cognitive domain of memory, but is substantial also for the attention, motor, executive, and language domains. In all domains, SCD prevalence increased with advancing age, though at different rates. Together with the low to medium size correlations between SCD prevalence in the five cognitive domains, this suggests that SCD in these domains should be considered separately and not be collapsed into one overall score of SCD.

Knowledge of domain-specific SCD is required not only for a comprehensive characterization of cognitive aging, but might also be useful for the differential diagnosis of diseases, for example, in early detection of different types of dementia. For instance, frontotemporal dementia might be detected at an early stage by decline in the attention or executive domain, while decline in the language domain might be indicative for future semantic dementia.

Our results also suggest that the suspicion from previous research, that subjective memory decline might be more strongly associated with depressive symptomatology and emotionality/neuroticism than with actual decline of cognitive performance, might also apply to the attention, motor, executive, and language domain. However, substantiating this suspicion requires further investigations using neuropsychological testing for specific cognitive functions and longitudinal designs.

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CONFLICT OF INTEREST

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

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

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