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Research paper

Depressive symptom factors and their differential association with psychotherapy outcomes in late-life depression: Results of the CBTlate study

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ABSTRACT

Objective: Depression is characterized by heterogeneous symptom patterns. We investigated different facets of depressive symptoms and their role in predicting the longitudinal outcome of psychotherapy in late-life depression (LLD).
Methods: This is a secondary analysis of a multicenter, randomized clinical trial in 229 LLD patients. The factor structure of the Geriatric Depression Scale (GDS) was examined. The association between these identified GDS factors and longitudinal psychotherapy outcomes (remission, response, GDS change scores) was analysed using logistic and linear regression.
Results: Five GDS factors were identified at baseline ("worries and tension", "hopelessness and worthlessness", "positivity and appreciation of life", "cognitive and performance-related disturbances", "social withdrawal"). Higher factor scores in "positivity and appreciation of life" and "social withdrawal" were associated with better psychotherapy outcomes. More specifically, "positivity and appreciation of life" predicted remission at the end of treatment (e.g., OR, 1.95 [95%CI, 1.18–3.22]; $p = .009$). "Social withdrawal" predicted remission at follow-up (e.g., OR, 1.86 [95%CI, 1.17–2.95]; $p = .009$) and response at the end of treatment (e.g., OR, 1.80 [95%CI, 1.17–2.76]; $p = .008$) and follow-up (e.g., OR, 1.93 [95%CI, 1.22–3.04]; $p = .005$).
Conclusions: Resilience factors were associated with better outcomes at the end of treatment. Social withdrawal might have been reduced by high-frequent psychotherapy sessions. Positive associations between social withdrawal and better psychotherapy outcomes remained not only at the end of treatment, but also in the long-term at follow-up. Our results might assist in treatment decision-making and improve treatment efficacy in LLD patients by developing targeted, personalized interventions.

1. Background

The depressive syndrome is characterized by a wide variety of symptoms, which are not uniformly present in all depressed patients (e.g., van Loo et al., 2012; Beijers et al., 2019). Different subtypes of depression have been characterized such as the melancholic subtype

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with a specific symptom profile including psychomotor disturbances and pathological guilt (e.g., Orsel et al., 2010). Recently, subtypes of depression and anxiety have been identified by others (Tozzi et al., 2024), partly to tailor specific treatment and apply precision medicine. However, an earlier systematic review found conflicting results for major depression (van Loo et al., 2012) and precision medicine in depression has not been achieved yet (e.g., Simon and Perlis, 2010; Miller and O'Callaghan, 2013; Trivedi, 2016).

Depression in late life is more frequently associated with physical symptoms as well as memory and concentration deficits than depression at younger age and LLD often remains undetected and untreated (Alexopoulos et al., 1989; Zenebe et al., 2021; Alexopoulos, 2005). Additionally, life circumstances that are frequently associated with old age (i.e., loss of beloved ones, somatic illnesses and disability, loss of structure due to retirement, reduced mobility) can facilitate the development of depressive symptoms (e.g., Bruce, 2001; Alexopoulos, 2005). The geriatric depression scale (GDS) was designed to assess depressive symptoms considering specific aspects of depression in late-life, such as somatic and age-related characteristics (e.g., Yesavage et al., 1983; Kim et al., 2013). Factor analyses of the GDS support the symptom heterogeneity in late-life depression (LLD). Sheikh et al. (1991) found a structure of five factors, i.e., "sad mood", "lack of energy", "positive mood", "agitation", and "social withdrawal". Imai et al. (2014) found three reproducible factors of the GDS short version, i.e. "energy loss and pessimistic outlook", "positive mental status" and "empty feeling", that correlated with different external criteria such as quality of life and activities of daily living. In a meta-analysis, Kim et al. (2013) identified "dysphoria", "social withdrawal-apathy-cognitive impairment" and "positive mood" as rather consistent factors of the GDS across different languages. Overall, four to six factors were found for the 30-item version of the GDS (Kim et al., 2013). Despite some deviating findings, "positive mood", "negative mood", and "social withdrawal" were repeatedly reported factors of the GDS indicating some consistency of the structure of depressive symptoms.

With regard to the treatment of LLD, cognitive behavioural therapy (e.g., Cuijpers et al., 2006, 2020; Pinquart et al., 2007; Huang et al., 2015) as well as unspecific supportive psychotherapeutic interventions (SUI; e.g., Dafsari et al., 2023), have been proven to be effective in the treatment of depressed older adults. Nevertheless, different facets of depressive symptomatology might be associated with different psychotherapy treatment outcomes in LLD patients. Evidence suggests that, among others, low perceived social support, high neuroticism scores, low treatment expectancy, low perception of the therapist as accepting, and low perceived physical health are important predictors for non-response to psychotherapy in late-life depression patients (e.g., Solomonov et al., 2021; Laird et al., 2019; Dafsari et al., 2024). However, studies assessing the relationship between different depressive symptom factors at baseline and treatment outcome, response and remission in LLD are missing.

We aimed to investigate 1. the factor structure of the German 30-item GDS at baseline and 2. the association between these different GDS factors at baseline with response, remission and the change in the GDS score from baseline to week 5, to the end of psychotherapeutic treatment and to a 6-months follow-up assessment in a large sample of LLD patients.

We used data from the multicentre, randomized, controlled psychotherapy study CBTlate (Dafsari et al., 2019, 2023) in order to examine the factor structure of the 30 item GDS. Clarifying this association between depressive symptom factors pre-treatment and psychotherapy outcome is of particular importance, as it might not only help to understand the factors that are associated with response to psychotherapy but also assist in treatment decision-making and improve treatment efficacy in LLD patients by developing targeted, personalized interventions.

2. Method

2.1. Study design and participants

A total of 251 participants with LLD was recruited at seven trial sites in Germany for the study "Cognitive behavioural therapy for the treatment of late life depression – a multicentre, randomized, observer blinded controlled trial (CBTlate)". Details on the study design and the trial protocol have been published previously (Dafsari et al., 2019, 2024). All participants provided written informed consent. Patients who met eligibility criteria at baseline were randomly assigned (1:1 randomization) to either a late-life depression specific cognitive behavioural therapy (LLD-CBT) or a supportive unspecific intervention (SUI). The interventions included 15 twice-weekly sessions during 8 weeks of manual-based, individual, outpatient treatment (LLD-CBT: 6 late-life specific modules; SUI: active control intervention with supportive, but non-specific interventions). All therapists were trained in both interventions and delivered either one according to individual randomization. Adherence was ensured by continuous supervision of all therapists and by recording of all therapy sessions with central adherence assessment on randomly selected recordings. Clinical interviews and outcome assessments were conducted by trained raters who were blinded to the treatment allocation. The study was approved by the University of Cologne Institutional Review Board/Institutional Ethical Committee and by all other local institutional review boards or institutional ethical committees at the sites before initiation of the trial.

Participants were aged at least 60 years and met diagnostic criteria for moderate to severe major depressive disorder assessed by raters using the validated standard clinical Mini-International Neuropsychiatric Interview for *Diagnostic and Statistical Manual of Mental Disorders* (Fifth Edition), version 7.0.2 (Sheehan et al., 1998). Participants with a 30-item Geriatric Depression Scale (GDS; Yesavage et al., 1983) score above 10 (higher scores indicating more severe symptoms), Quick Inventory of Depressive Symptomatology-Clinician Rating (Rush et al., 2003) score above 10, and Mini-Mental-Status-Test (Kessler et al., 1990) score above 25 were considered for study inclusion. Details on the inclusion and exclusion criteria can be found in the previously published study protocol (Dafsari et al., 2019).

2.2. Outcome measures

Depressive symptoms were measured using the 30-item GDS version (range 0–30, higher scores indicating more severe symptoms), a widely established, self-report measure of depressive symptoms in older subjects (Yesavage et al., 1983; Gauggel and Birkner, 1999). The assessments of the GDS was conducted at baseline, during treatment in week 5 (T1), at the end of treatment (EOT; T2) in week 10, and at follow-up (T3) 6 months after randomization.

We assessed remission at the end of treatment/follow-up, response at the end of treatment/follow-up, and the change in GDS scores from baseline to T1, T2, or T3 as relevant outcome measures of psychotherapy. Remission was defined as a GDS score of 10 or lower, response was defined as a reduction of the GDS score of at least 50 % from baseline to the respective timepoint. Regarding the change in the GDS scores, negative scores represent improvement, i.e. symptom reduction.

2.3. Statistical analysis

We conducted an exploratory factor analysis using Mplus version 7.3 (Muthén and Muthén, 1998-2015) to identify the factor structure of the 30-item German GDS version assessed at baseline (T0) in the intention-to-treat (ITT) sample. As a previous meta-analysis reported four to six factors of the GDS (Kim et al., 2013), we allowed one to seven possible factors in our analysis. The oblique GEOMIN technique was chosen as rotation method to account for possible correlations between the factors. Weighted Least Squares Mean and Variance adjusted (WLSMV) was

chosen as estimation procedure for the dichotomous GDS items. Significant improvement of model fit was found from the 2-factor- (χ^2 = 99.565, $p < .001$) until the 5-factor-model ($\chi^2 = 40.838$, $p = .0322$), but not for the 6-factor- ($\chi^2 = 33.822$, $p = .1118$) and 7-factor-models (χ^2 = 32.303, $p = .1196$). As the 5-factor-model also fulfilled RMSEA = 0.022 and CFI = 0.950, it was chosen for further analyses. Factor scores of Mplus were estimated using the default Maximum A Posteriori approach and imported into SPSS for further analyses.

Further, we used logistic and linear regression analyses in SPSS (version 27, www.ibm.com/products/spss-statistics) to identify the association between the identified GDS factors and the above reported psychotherapy outcome measures in the intention-to-treat sample (n = 229).

Driessen et al. (2010) found that psychological treatment had higher efficacy in more severe depression, although others found opposite results (Tunvirachaisakul et al., 2018; Solomonov et al., 2021). Nonetheless, depression severity at baseline was included as covariate.

Bonferroni correction was applied to the regression models ($p = .05$ / number of identified factors), resulting in an adjusted level of significance of $p = .01$. We added covariates stepwise in the adjusted models as follows: 1. study center and treatment group (i.e., LLD-CBT or SUI) and 2. depression severity represented by categorized GDS baseline scores (moderate = scores above 10 and below 20; severe = scores of at least 20), 3. age (in years) and sex (male = 1, female = 2). Additional analyses were conducted for the LLD-CBT and SUI groups, respectively (results presented in the supplementary materials section).

3. Results

Sample characteristics are given in Table 1.

Table 2 presents the five identified factors and item loadings of the GDS at baseline. According to the pattern of factor loadings, we named the five factors as follows: 1. worries and tension, 2. hopelessness and worthlessness, 3. positivity and appreciation of life, 4. cognitive and performance-related disturbances, 5. social withdrawal.

The third factor score ("positivity and appreciation of life") predicted remission at the end of treatment in the second adjusted model (see model 3 in Table 3); i.e., a higher third factor score predicted a higher likelihood of remission at the end of treatment controlling for study site, treatment condition, and symptom severity at baseline (OR = 1.95, 95 % CI = 1.18–3.22, $p = .009$; after additional control for age and sex, the Bonferroni-corrected significance was lost: OR = 1.90, 95 % CI = 1.15–3.14, $p = .013$). A higher factor score 5 ("social withdrawal") predicted remission at follow-up in the crude (OR = 1.86, 95 % CI = 1.17–2.94, $p = .008$) and partly adjusted model (OR = 1.86, 95 % CI = 1.17–2.95, $p = .009$), whereas significance was lost after controlling for baseline symptom severity and age / sex after Bonferroni correction in model 3 (OR = 1.80, 95 % CI = 1.13–2.87, $p = .013$) and in model 4 (OR = 1.75, 95 % CI = 1.09–2.80, $p = .020$; see Table 3).

The factor score 5 ("social withdrawal") predicted response at the end of treatment and response at follow-up in crude and adjusted models (see Table 4). More specifically, a higher factor 5 score was associated with a higher likelihood of response at the end of treatment (unadjusted model: OR = 1.82, 95 % CI = 1.18–2.79, $p = .006$) and at follow-up (unadjusted model: OR = 1.93, 95 % CI = 1.23–3.04, $p = .005$). However, significance was lost after controlling for age and sex and Bonferroni-correction (response at EOT: OR = 1.70, 95 % CI = 1.10–2.63, $p = .017$; response FUP: OR = 1.82, 95 % CI = 1.15–2.89, $p = .011$).

The factor score 5 ("social withdrawal") also predicted stronger improvement from baseline to the end of treatment (T2) and from baseline to follow-up (T3) in crude and adjusted linear regression models (see Table 5), although Bonferroni-corrected significance was lost after adjusting for age and sex in model 4. Regarding change from baseline to week 5 (T1), a higher factor score 3 ("positivity and appreciation of life") was associated with less improvement in the crude model, but associations disappeared after covariate adjustment.

Table 1
Sample characteristics of relevant covariates and outcome measures in the intention-to-treat sample.

	n = 229
GDS baseline score (M (SD))	20.75 (4.285)
GDS factor score 1 (baseline) (M (SD))	−0.06277 (0.756172)
GDS factor score 2 (baseline) (M (SD))	−0.03717 (0.782150)
GDS factor score 3 (baseline) (M (SD))	0.08275 (0.716710)
GDS factor score 4 (baseline) (M (SD))	−0.04533 (0.732601)
GDS factor score 5 (baseline) (M (SD))	0.01758 (0.684187)
Treatment (n (%))	
LLD-CBT (n (%))	115 (50.2)
SUI (n (%))	114 (49.8)
GDS symptom severity at baseline (n (%))	
Moderate, GDS score 10–19 (n (%))	87 (38.0)
Severe, GDS score 20–30 (n (%))	142 (62.0)
Age in years (M (SD))	70.16 (7.108)
Sex (n (%))	
Female (n (%))	151 (65.9)
Male (n (%))	78 (34.1)
Remission at EOT (n (%))	
No (n (%))	145 (63.3)
Yes (n (%))	74 (32.3)
Missing (n (%))	10 (4.4)
Remission at FUP (n (%))	
No (n (%))	145 (63.3)
Yes (n (%))	61 (26.6)
Missing (n (%))	23 (10.0)
Response at EOT (n (%))	
No (n (%))	135 (59.0)
Yes (n (%))	84 (36.7)
Missing (n (%))	10 (4.4)
Response at FUP (n (%))	
No (n (%))	140 (61.1)
Yes (n (%))	66 (28.8)
Missing (n (%))	23 (10.0)
Change in GDS score from baseline to T1 (M (SD))	−4.4222 (5.61045)
Missing (n (%))	4 (1.7)
Change in GDS score from baseline to T2 (M (SD))	−6.8676 (7.33696)
Missing (n (%))	10 (4.4)
Change in GDS score from baseline to T3 (M (SD))	−6.1553 (7.41752)
Missing (n (%))	23 (10.0)

Note. GDS = Geriatric Depression Scale, M = mean, SD = standard deviation, LLD-CBT = late-life depression specific cognitive behavioural therapy, SUI = supportive unspecific intervention, EOT = end of treatment, FUP = follow-up, T1 = week 5, T2 = end of treatment, T3 = follow-up.

Applying Bonferroni correction, factor scores were not significantly associated with remission at the end of treatment or at follow-up in the LLD-CBT and in the SUI group (see supplementary tables 1a and 1b). A higher factor score 5 predicted response at the end of treatment in the crude and partly adjusted models in the LLD-CBT group, but not at follow-up (see supplementary table 2a). The factor score 5 did not predict response at the end of treatment and at follow-up in the SUI group (see supplementary table 2b). A higher factor score 1 ("worries and tension") was associated with greater improvement from baseline to the end of treatment in the SUI group, whereas no associations were found for changes from baseline to week 5 and from baseline to the follow-up in the SUI group (see supplementary table 3b).

4. Discussion

We investigated the association of depressive symptom factors measured with the GDS before psychotherapy with treatment outcome, response and remission in patients with late-life depression. To the best of our knowledge, this is the first study investigating the factor structure of the German 30-item GDS in a large sample of LLD patients. In our analyses of data from the randomized controlled CBTlate trial, we assessed whether the factors are consistent with factors that have been described in previous studies. We identified a five-factor-structure of the German 30-item GDS version, i.e., „worries and tension", „hopelessness

Table 2
Five factor model of GDS items at baseline ($n = 229$).

		1 worries and tension	2 hopelessness and worthlessness	3 positivity and appreciation of life	4 cognitive and performance-related disturbances	5 social withdrawal
1	*Are you basically satisfied with your life?* (**−R-**)	−0.093	**−0.562***	0.038	0.002	**0.420***
2	*Have you dropped many of your activities and interests?*	0.056	0.180	**−0.424***	−0.036	**0.375***
3	*Do you feel that your life is empty?*	−0.086	**0.786***	0.001	−0.166	0.156
4	*Do you often get bored?*	0.153	0.176	−0.185	−0.157	0.181
5	*Are you hopeful about the future?* (**−R-**)	−0.188	**−0.536***	0.059	−0.007	0.354
6	*Are you bothered by thoughts you can't get out of your head?*	**0.567***	0.092	0.241	−0.043	0.061
7	*Are you in good spirits most of the time?* (**−R-**)	−0.199	−0.161	**0.307***	0.001	0.304
8	*Are you afraid that something bad is going to happen to you?*	**0.750***	−0.028	0.006	0.014	0.264
9	*Do you feel happy most of the time?* (**−R-**)	0.075	−0.216	**0.589***	−0.009	0.314
10	*Do you often feel helpless?*	**0.416***	0.201	−0.017	0.177	−0.072
11	*Do you often get restless and fidgety?*	**0.381***	0.053	0.182	**0.288***	0.103
12	*Do you prefer to stay at home, rather than going out and doing new things?*	−0.011	−0.014	**−0.600***	−0.019	**0.613***
13	*Do you frequently worry about the future?*	**0.922***	−0.046	−0.034	−0.038	−0.083
14	*Do you feel you have more problems with memory than previously?*	−0.091	0.009	−0.031	**0.775***	0.071
15	*Do you think it is wonderful to be alive now?* (**−R-**)	−0.030	−0.139	0.159	−0.165	0.145
16	*Do you often feel downhearted and blue?*	**0.505***	**0.557***	0.007	**−0.381***	−0.017
17	*Do you feel pretty worthless the way you are now?*	−0.064	**0.767***	0.006	0.203	0.387
18	*Do you worry a lot about the past?*	**0.314***	0.055	0.012	0.059	0.040
19	*Do you find life very exciting?* (**−R-**)	0.218	**−0.255***	**0.325***	0.205	0.035
20	*Is it hard for you to get started on new projects?*	−0.066	−0.048	**−0.300***	**0.569***	0.027
21	*Do you feel full of energy?* (**−R-**)	0.075	−0.010	**0.820***	0.012	−0.011
22	*Do you feel that your situation is hopeless?*	0.240	**0.686***	0.050	0.140	−0.087
23	*Do you think that most people are better off than you are?*	0.067	**0.484***	−0.106	0.003	0.136
24	*Do you frequently get upset over little things?*	**0.246***	0.009	0.031	−0.043	0.186
25	*Do you frequently feel like crying?*	**0.222***	**0.294***	−0.004	0.010	0.087
26	*Do you have trouble concentrating?*	0.051	0.052	0.033	**0.872***	−0.066
27	*Do you enjoy getting up in the morning?* (**−R-**)	0.037	−0.006	**0.451***	0.012	0.246
28	*Do you prefer to avoid social gatherings?*	0.140	0.011	**−0.569***	0.157	**0.516***
29	*Is it easy for you to make decisions?* (**−R-**)	**−0.310***	0.222	**0.440***	**−0.269***	0.001
30	*Is your mind as clear as it used to be?* (**−R-**)	−0.133	−0.273*	0.099	**−0.363***	0.035

Significance at 5% level is indicated by bold type and asterisk.
Note. GDS = Geriatric Depression Scale, CBT-late = name of the presented study. (**−R-**) = inversely coded in GDS sum score (original scores used for factor analysis).

and worthlessness“, „positivity and appreciation of life“, „cognitive and performance-related disturbances“, and „social withdrawal“. The number of factors is in accordance with Sheikh et al. (1991), who identified five factors, and with the meta-analysis by Kim et al. (2013), who reported that four to six factors were most common. Our factors also correspond to the results of the meta-analysis by Kim et al. (2013), who identified „dysphoria“, „social withdrawal-apathy-cognitive impairment“, and „positive mood“ as rather stable factors of the GDS across different languages. However, some individual factor loadings showed differences. For example, item 8 related to the factor „dysphoria“ in Asian studies and to „social withdrawal-apathy-cognitive impairment“ in English studies, whereas it loaded on the factor „worries and tension“ in our sample. Sheikh et al. (1991) found a structure of five factors, i.e., “sad mood“, “lack of energy“, “positive mood“, “agitation“, and “social withdrawal“. Although the factor scores show some compatibility with our results, there are discrepancies regarding individual factor loadings (e.g., item 1 showed no particular factor association in the study by Sheikh et al. (1991), whereas item 1 significantly loaded on factor 2 and factor 5 in our study). Kim et al. (2013) proposed language differences in the GDS factor structure that might account for some discrepancies. Hence, although our results generally replicate the findings of other studies, there are also differences which might be caused by language or sample characteristics. Nonetheless, we consider the results as sufficiently stable to further explore the association of the factor scores with the treatment outcomes of psychotherapy.

We found a better outcome at the end of treatment and at follow-up for patients reporting more social withdrawal (factor 5) at baseline and a better outcome at the end of treatment for those patients reporting more positivity and appreciation of life (factor 3) at baseline. It bears mentioning that these predictive associations were independent of the overall symptom level at baseline, and therefore the predictive factors might be considered as qualitative profiles or subtypes of depressive symptoms in these patients.

Contrary to our expectations, factors representing negative affect, negative thinking and “cognitive and performance-related disturbances” were not significantly associated with a poorer treatment outcome in general. As expected, social withdrawal and positivity / appreciation of life were positively associated with a better treatment outcome. As we controlled for symptom severity in the adjusted models, the associations cannot be explained only by depression severity. The effect of social withdrawal might have been facilitated by the compulsory appointments twice a week for 8 weeks during both psychotherapeutic treatments as the therapeutic relationship is known as a common factor of psychotherapy. Remarkably, associations were not only short-term, but persisted until the follow-up assessment. Possibly, building and rebuilding of social contacts have been explicitly addressed in psychotherapy via Lewinsohn's loss of positive reinforcement theory in CBT or via reflecting associated emotions in SUI. Moreover, the “social withdrawal” factor also contained an affirmation of “being satisfied with life”, despite depression and social withdrawal, which might also indicate self-sufficient social withdrawal or social withdrawal with available social relationships. Social relationships can be divided into structural

Table 3
Longitudinal prediction of remission at the end of treatment (EOT) and at follow-up (FUP) by GDS factor scores at baseline in the intention-to-treat sample.

	remission at end of treatment (EOT): n = 229 (*n* = 10 missings)												remission at follow-up (FUP): *n* = 229 (*n* = 23 missings)											
	Model 1 (unadjusted)			Model 2 (adjusted)			Model 3 (adjusted)			Model 4 (adjusted)			Model 1 (unadjusted)			Model 2 (adjusted)			Model 3 (adjusted)			Model 4 (adjusted)		
	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*
FS1 (worries and tension)	0.77	0.50–1.19	0.242	0.77	0.50–1.20	0.252	0.73	0.45–1.19	0.206	0.73	0.45–1.19	0.205	0.96	0.61–1.52	0.865	0.95	0.59–1.53	0.830	0.82	0.48–1.40	0.471	0.81	0.48–1.39	0.448
FS2 (negative affect)	0.74	0.47–1.15	0.182	0.76	0.48–1.20	0.233	0.71	0.43–1.18	0.190	0.70	0.42–1.18	0.180	0.76	0.47–1.22	0.250	0.78	0.48–1.27	0.326	0.68	0.40–1.17	0.162	0.68	0.39–1.17	0.163
FS3 positivity and appreciation of life	1.75	1.11–2.77	0.017	1.86	1.16–2.98	0.010	**1.95**	**1.18–3.22**	**0.009**	1.90	1.15–3.14	0.013	1.19	0.74–1.91	0.484	1.30	0.79–2.12	0.305	1.46	0.86–2.50	0.165	1.43	0.83–2.44	0.196
FS4 (cognitive and performance-related disturbances)	1.07	0.71–1.62	0.750	1.07	0.71–1.63	0.745	1.04	0.67–1.60	0.867	1.01	0.65–1.56	0.981	1.35	0.86–2.10	0.190	1.37	0.87–2.15	0.179	1.27	0.79–2.03	0.321	1.25	0.78–2.01	0.352
FS5 (social withdrawal)	1.51	0.98–2.32	0.062	1.49	0.97–2.30	0.070	1.47	0.95–2.27	0.083	1.39	0.89–2.16	0.148	**1.86**	**1.17–2.94**	**0.008**	**1.86**	**1.17–2.95**	**0.009**	1.80	1.13–2.87	0.013	1.75	1.09–2.80	0.020
Study site				0.90	0.74–1.10	0.296	0.90	0.74–1.10	0.294	0.91	0.75–1.11	0.368				0.88	0.71–1.08	0.210	0.87	0.71–1.08	0.203	0.88	0.72–1.09	0.238
Treatment assignment				0.74	0.40–1.35	0.323	0.76	0.41–1.39	0.370	0.77	0.41–1.45	0.424				0.56	0.29–1.06	0.075	0.59	0.31–1.13	0.111	0.58	0.30–1.13	0.109
Symptom severity at baseline							1.30	0.51–3.28	0.584	1.15	0.45–2.94	0.763							1.86	0.67–5.17	0.233	1.72	0.62–4.75	0.299
Age (years)										0.96	0.91–1.00	0.53										0.97	0.92–1.02	0.212
Sex										1.07	0.56–2.05	0.848										0.88	0.44–1.77	0.719
Chi^2	22.229			24.170			24.472			28.418			15.125			19.528			20.990			23.021		
df	5			7			8			10			5			7			8			10		
p	<0.001			0.001			0.002			0.002			0.010			0.007			0.007			0.011		
Nagelkerkes R^2	0.134			0.145			0.146			0.169			0.101			0.129			0.138			0.150		

Note. Remission = GDS score of 10 or below, EOT = end of treatment, FUP = follow-up, GDS = Geriatric Depression Scale score, OR = odds ratio, CI = confidence interval, FS = factor score. Treatment assignment = LLD-CBT as reference; symptom severity at baseline = moderate symptoms as reference.

Table 4
Longitudinal prediction of response at the end of treatment (EOT) and at follow-up (FUP) by GDS factor scores at baseline in the intention-to-treat sample.

	response at end of treatment (EOT): n = 229 (n = 10 missings)												response at follow-up (FUP): n = 229 (n = 23 missings)											
	Model 1 (unadjusted)			Model 2 (adjusted)			Model 3 (adjusted)			Model 4 (adjusted)			Model 1 (unadjusted)			Model 2 (adjusted)			Model 3 (adjusted)			Model 4 (adjusted)		
	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*	OR	95 % CI	*p*
FS1 (worries and tension)	0.86	0.57–1.30	0.472	0.86	0.57–1.32	0.490	0.83	0.53–1.32	0.438	0.84	0.53–1.33	0.456	0.98	0.63–1.53	0.929	0.97	0.62–1.53	0.901	0.87	0.53–1.46	0.606	0.87	0.52–1.45	0.580
FS2 (negative affect)	0.85	0.55–1.31	0.457	0.87	0.56–1.35	0.534	0.84	0.52–1.36	0.475	0.81	0.50–1.32	0.403	0.93	0.59–1.48	0.763	0.96	0.60–1.53	0.854	0.87	0.52–1.45	0.585	0.85	0.51–1.43	0.545
FS3 positivity and appreciation of life	1.44	0.93–2.24	0.105	1.52	0.97–2.39	0.071	1.56	0.97–2.52	0.068	1.53	0.95–2.47	0.084	1.09	0.68–1.74	0.729	1.15	0.71–1.87	0.559	1.26	0.75–2.11	0.385	1.24	0.74–2.07	0.422
FS4 (cognitive and performance-related disturbances)	1.20	0.80–1.81	0.369	1.21	0.80–1.82	0.367	1.18	0.78–1.80	0.432	1.16	0.76–1.77	0.507	1.36	0.88–2.09	0.170	1.37	0.88–2.12	0.164	1.30	0.82–2.04	0.264	1.28	0.81–2.02	0.290
FS5 (social withdrawal)	**1.82**	**1.18–2.79**	**0.006**	**1.80**	**1.17–2.76**	**0.008**	**1.78**	**1.16–2.75**	**0.009**	1.70	1.10–2.63	0.017	**1.93**	**1.23–3.04**	**0.005**	**1.93**	**1.22–3.04**	**0.005**	**1.89**	**1.19–2.99**	**0.007**	1.82	1.15–2.89	0.011
Study site				0.90	0.74–1.08	0.251	0.89	0.74–1.08	0.249		0.90	0.75–1.09	0.290			0.90	0.74–1.10	0.301	0.90	0.74–1.10	0.294	0.91	0.74–1.11	0.334
Treatment assignment				0.78	0.43–1.39	0.392	0.79	0.44–1.41	0.422		0.84	0.46–1.53	0.562			0.67	0.36–1.25	0.208	0.70	0.37–1.31	0.261	0.72	0.38–1.36	0.304
Symptom severity at baseline							1.18	0.48–2.86	0.720	1.10	0.45–2.70	0.831							1.57	0.60–4.15	0.360	1.50	0.57–3.97	0.413
Age (years)										0.96	0.92–1.01	0.095										0.97	0.92–1.02	0.186
Sex										1.32	0.70–2.49	0.391										1.09	0.55–2.15	0.807
Chi^2	17.428			19.374			19.504			22.633			12.666			15.111			15.961			17.755		
df	5			7			8			10			5			7			8			10		
p	0.004			0.007			0.012			0.012			0.027			0.035			0.043			0.059		
Nagelkerkes R^2	0.104			0.115			0.116			0.133			0.083			0.099			0.104			0.116		

Note. Response = a reduction of at least 50 % in the GDS score from baseline to the timepoint, GDS = Geriatric Depression Scale score, OR = odds ratio, CI = confidence interval, FS = factor score. Treatment assignment = LLD-CBT as reference; symptom severity at baseline = moderate symptoms as reference.

Table 5
Linear regression models with GDS factor scores at baseline and covariates predicting change in GDS total score from baseline to different timepoints in the intention-to-treat sample.

	change from baseline to week 5 (T1)								change from baseline to end of treatment (T2)								change from baseline to follow-up (T3)							
	Model 1 (unadjusted)		Model 2 (adjusted)		Model 3 (adjusted)		Model 4 (adjusted)		Model 1 (unadjusted)		Model 2 (adjusted)		Model 3 (adjusted)		Model 4 (adjusted)		Model 1 (unadjusted)		Model 2 (adjusted)		Model 3 (adjusted)		Model 4 (adjusted)	
	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*	ß	*p*
FS1 (worries and tension)	−0.088	0.219	−0.082	0.249	0.032	0.672	0.031	0.682	−0.135	0.064	−0.132	0.070	−0.032	0.682	−0.036	0.645	−0.132	0.066	−0.126	0.079	0.008	0.922	0.012	0.871
FS2 (negative affect)	0.015	0.845	−0.001	0.992	0.126	0.123	0.131	0.114	−0.066	0.400	−0.075	0.338	0.027	0.750	0.042	0.618	−0.083	0.285	−0.090	0.245	0.031	0.702	0.047	0.559
FS3 positivity and appreciation of life	**0.193**	**0.008**	0.168	0.023	0.083	0.267	0.085	0.258	0.103	0.161	0.087	0.241	0.011	0.884	0.017	0.820	0.148	0.046	0.132	0.079	0.028	0.717	0.038	0.613
FS4 (cognitive and performance-related disturbances)	−0.090	0.185	−0.095	0.163	−0.033	0.630	−0.030	0.654	−0.096	0.157	−0.098	0.153	−0.044	0.523	−0.034	0.625	−0.148	0.030	−0.148	0.030	−0.077	0.260	−0.061	0.363
FS5 (social withdrawal)	−0.168	0.012	−0.164	0.013	−0.136	0.035	−0.131	0.046	**−0.188**	**0.005**	**−0.184**	**0.007**	−0.163	0.014	−0.147	0.027	**−0.211**	**0.002**	**−0.209**	**0.002**	**−0.181**	**0.007**	−0.151	0.021
Study site			0.035	0.591	0.046	0.466	0.045	0.477			0.047	0.476	0.053	0.411	0.050	0.439			0.044	0.509	0.053	0.411	0.041	0.519
Treatment assignment			0.145	0.026	0.121	0.057	0.115	0.076			0.072	0.276	0.049	0.455	0.027	0.679			0.085	0.205	0.053	0.415	0.036	0.581
Symptom severity at baseline					−0.352	<0.001	−0.349	<0.001					−0.298	0.002	−0.290	0.003					−0.367	<0.001	−0.349	<0.001
Age (years)							0.030	0.651							0.106	0.117							0.217	0.001
Sex							−0.023	0.718							−0.096	0.150							−0.057	0.381

Note. GDS = Geriatric Depression Scale score, ß = Standardized beta, FS = factor score. Treatment assignment = LLD-CBT as reference; symptom severity at baseline = moderate symptoms as reference. Negative values indicate stronger improvement of depressive symptoms.

characteristics (e.g., social network size) and functional characteristics (e.g. social support) and qualitative aspects might be more relevant than quantitative aspects regarding depressive symptoms (Schwarzbach et al., 2014). Post hoc analyses in the present CBTlate data showed that the GDS factor score "social withdrawal" did not correlate with difficulties interacting with family members but significantly correlated with difficulties interacting with friends and with preferring to be left alone measured at baseline by the patient-reported outcome measure PRO-MDD to assess symptoms of depression (Lasch et al., 2012). No significant correlations were found between the GDS factor score "social withdrawal" at baseline and a later assessment of loneliness with UCLA Loneliness Scale in a subsample of the CBTlate patients (Döring and Bortz, 1993).

Positivity / appreciation of life was associated with better treatment outcome at the end of treatment, but unexpectedly was not associated with psychotherapy outcomes at follow-up. One explanation might be that positivity / appreciation of life can be seen as a given trait-like resource, but one that might be less associated with intended change in psychotherapy because it is not attended by psychological strain and stress, which can create a motivation to change in itself. Hence, more positivity / appreciation of life might facilitate positive short-term change, but change might be less focussed or less directly related to behaviour, and might stimulate less long-term and self-initiated positive change after psychotherapy. Another explanation might be that individuals with more positivity / appreciation of life might have been more amenable to the strategies used in therapy, but for some reason this only held while the therapy was ongoing. Future studies might explore, if positivity / appreciation of life is associated with positive expectations regarding psychotherapy, its outcomes, and the psychotherapeutic relationship or attachment styles. With regard to "cognitive and performance-related disturbances", therapists might try to take the cognitive status of patients into account and tailor their interventions accordingly. For example, Bewernick et al. (under revision) found in their analyses of the CBTlate data that worse cognitive performance did not negatively predict psychotherapy outcome per se. This might explain the lack of an association between "cognitive and performance-related disturbances" and outcome measures in our study.

4.1. Strengths and limitations

The main strength of our study is the multicenter design with a large number of patients, randomization, adherence-to-manual monitoring, rater-blinding and post-treatment follow-up. All therapists and raters were trained and both treatments were manual-based. Treatment adherence was assessed with recorded sessions and continuous central and local supervision (Dafsari et al., 2019, 2023). However, the current findings should be considered in the context of several limitations. First, this is a post hoc analysis of the CBTlate trial and the results from these secondary analyses are exploratory. As such, they are hypothesis-generating, but not confirmatory. Second, the items of the GDS are dichotomous, so that the factor analysis had to be conducted with a statistic program that can deal with this constraint. Third, we used data of the GDS, which is a self-report measure with all associated advantages and disadvantages of these questionnaires. Fourth, we assessed the effectiveness of only two forms of psychotherapy (LLD-CBT and SUI), so that we cannot generalize our findings to all types of psychotherapeutic treatments for LLD patients. Fifth, the severity of depression and regression to the mean might have had an impact on our results. We attempted to mitigate such an effect by including a categorized variable higher vs. lower baseline symptom severity as a covariate in the adjusted models. It should also be critically mentioned that predictors, outcomes and the covariate "severity of depression" were measured by GDS scores.

Thus, further randomized controlled trials (RCTs) are needed to confirm these results and evaluate the association between depressive symptom factors and treatment outcome, response and remission in different psychotherapies for LLD. Future studies that examine therapeutic processes can help to understand the mechanisms underlying the association between the GDS factors and positive psychotherapy outcomes.

Drawing preliminary conclusions of this finding, it might be relevant for prognosis to take self-reported resilience factors of depressed patients in late-life into account. Others also highlighted positive concepts such as wisdom, resilience, and meaning in life to prevent mental disorders, but also recommended to strengthen well-being, resilience, optimism, and self-efficacy/personal mastery in persons e.g. with LLD (Reynolds 3rd et al., 2022). As factors representing negative affect and thinking were largely not significantly associated with psychotherapy outcome, people with negative depressive affect and cognition but also with access to their resources, may still show symptom improvement. In order to develop our findings further in future studies, it would be interesting to know more about psychotherapeutic processes, for example, whether people changed their behaviour and initiated more social contacts as a result of psychotherapy, or whether they were able to cope better with their social withdrawal, either through acceptance or through new activities alone. Considering individual differences in the GDS factors "positivity and appreciation of life" and "social withdrawal" at baseline before treatment might significantly improve treatment effectiveness for this patient group when selecting a therapeutic modality for LLD patients. The assessment of these GDS factors might also assist in treatment decision-making and improve treatment efficacy in LLD patients by developing targeted, personalized interventions.

CRediT authorship contribution statement

Kathrin Heser: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Forugh S. Dafsari:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Luca Kleineidam:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Katarina Kuss-Gondorf:** Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Melanie Luppa:** Supervision, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Oliver Peters:** Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Lutz Froelich:** Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Steffi Riedel-Heller:** Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Elisabeth Schramm:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Martin Hautzinger:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Michael Wagner:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Frank Jessen:** Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Bettina Bewernick:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization.

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Role of the funder/sponsor

The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and the decision to submit the manuscript for publication.

Declaration of competing interest

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Appendix A. Supplementary data

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