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# **Depressive Symptomatology from a Network Perspective: Differences in the Experience of Symptoms Involved in the Self-Recognition of Depression and the Diagnosis Process by Social Position**

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## Introduction

Depression has been shown to be disproportionately distributed among individuals in a low socioeconomic situation (SES) (Lorant et al., 2003). At the same time, socially disadvantaged groups may face greater challenges in access to care, accurate detection, and management of depression. For example, studies have shown that these groups make initial contact with the healthcare system at later stages of the course of symptoms (Wang et al., 2005) and have longer diagnosis delays (Huerta-Ramírez et al., 2013). This situation may affect prognosis, considering that late antidepressant treatment has been associated with worse depression outcomes (Bukh et al., 2013; Ghio et al., 2015). Other factors, such as perceived stigma and financial and structural barriers, may account for these difficulties in depression care. Importantly, socially disadvantaged groups may intentionally or unintentionally conceal their symptoms for long periods or simply do not perceive the need for help. In any case, depression inequities are complex and multidimensional, involving individual, social, and provider factors. Notably, research is scarce on individual-level factors, such as the experience of symptoms influencing the self-recognition of depression and the diagnosis process across social positions.

Some empirical evidence has shown that socially disadvantaged groups lack insight (Fahmi et al., 2022) and underestimate their depressive symptoms (Rondet et al., 2015). Yet, self-perception of depressive symptoms can be considered the first stage of a complex decision-making process that leads to seeking help (Möller-Leimkühler, 2002). This starting point encompasses internal factors (i.e., somatic and emotional elements) and external factors (i.e., sociocultural context) (Möller-Leimkühler, 2002). Whether one appraises depressive manifestations as morbid and recognizes the need for help depends largely on his/her multiple subjective and collective past experiences. On this basis, social positions captured by indicators such as education, occupation, and income not only affect mental health at the exposure level but also have relatively unique formative effects on the experience of depression. Social position shapes one's perception of symptoms, self-recognition, and help-seeking behavior; indeed, the field of sociology of health and illness has consistently pointed out a socially

differentiated relationship with health, body, and symptom perception, with groups at the top of the social hierarchy having more resources (socially and materially speaking) to navigate these issues (Williams, 1995; Cockerham, 2020).

When a person decides to seek help, clinicians' ability to identify depression depends on several factors, such as symptom presentation, which can be heterogeneous or masked by somatic complaints (Heinz et al., 2021), and the quality of the communication established with the patient. Good patient-clinician communication is crucial to enable the disclosure of patients' concerns; more specifically, disclosing emotional distress or depressive symptoms requires patient-clinician interactions to be reassuring, with a certain degree of partnership from the clinician (Buszewicz et al., 2006; Parker et al., 2020). A systematic review found, however, that these interactions (not exclusively in mental health concerns) can be affected when patient-clinician social distance is discordant, affecting the quality of communication and, therefore, received care for disadvantaged groups (Verlinde et al., 2012).

Past research on depressive symptomatology across social positions has mostly adopted a linear perspective (i.e., measured as a continuous dependent variable that increases/decreases as a function of the rank of the social indicator). Nevertheless, recent evidence has shown that depressive symptoms involve different mechanisms, structures, and etiology (Fried & Nesse, 2015). Thus, it is important not to homogenize them as a single construct. The psychometric network approach addresses this point well. Accordingly, depression is understood as a complex dynamic system of interacting symptoms (Cramer, 2016). Distinguishing which depressive symptoms are involved in self-recognition and the diagnosis process has not been done yet from a dynamic approach, which could help improve depression care among socially disadvantaged groups. Clinicians could use the information about symptoms that concern patients to substantiate their diagnosis, increasing the quality of their relationship and reinforcing the therapeutic alliance. Also, public health campaigns targeting negative attitudes toward depression symptoms could be used as leverage to reach people who are coping and remain unattended. This work uses occupation, educational level, and financial difficulties as social indicators likely to demonstrate different underlying symptom mechanisms. This paper proposes such



an approach, describing and comparing which depressive symptoms are associated with a previous diagnosis of depression and a self-recognition of limitations due to depression. Both associations are analyzed according to social position and are applied to a French general population-based sample.

## Methods

### Participants

We used baseline data from 'Constances' (Zins & Goldberg, 2015), a population-based cohort of adults living in Metropolitan France. The inclusion period went from February 2012 to September 2021, in which more than 200,000 volunteers aged 18-69 were enrolled. At inception, volunteers self-administered a questionnaire covering socio-demographic characteristics and health data. They ran medical examinations and paraclinical tests in one participating Health Screening Center (HSC). For this study, we included volunteers who were enrolled between 2012 and 2019 and excluded those enrolled during 2020 and 2021 because, as is well known, mental health was heavily impacted by the Covid-19 pandemic.

### Measures

#### *Depressive symptomatology*

At baseline, participants self-administered the French 20-item version of the Center for Epidemiologic Studies Depression Scale (CES-D) based on the frequency with which they experienced each symptom over the last week. The scale has four subscales: three represent the 'negative' affect (depressive affect, somatic, and interpersonal), and the fourth represents the 'positive' affect. Items belonging to the latter are positively worded and were reverse coded before analysis. Items are presented on a Likert-type with four options (0-3). A final score can be obtained by adding the subscale scores, with a higher score indicating worse symptomatology. A cut-off point of 19 was used for identifying participants at risk of depression (Morin et al., 2011).

### *Clinical depression*

Participants responded to a medical questionnaire during their visit to an HSC covering personal and family medical history, including 'Personal history of Treated Depression' (yes or no, and age at diagnosis). We renamed this variable as 'Clinical Depression', signifying that participants were diagnosed with depression by a clinician in the past.

### *Limitations due to depression*

At baseline, participants self-responded to a question regarding the global activity limitation indicator (GALI) in the past six months with four options (from strongly limited to not limited). In case of limitation, they were asked for the reasons. We recoded this variable as 'Limitations due to depression' if participants answered Yes (whatever the intensity) and selected 'Depressive state' as a reason. We used this variable as a proxy of self-recognition of a depressive episode because self-reporting allowed a direct assessment of participants' acceptance and for its limited time scope.

### *Social position indicators*

At baseline, participants self-reported their self-perceived economic situation, educational attainment, and occupational job. Financial difficulties were assessed by asking participants if they have ever experienced financial challenges to meet month's ends (yes or no). Educational level was assessed by asking participants what their highest level of education had been achieved to date. We grouped participants with up-to-completed baccalaureate education (French secondary examination or equivalent) vs. completed post-baccalaureate education. The occupational job was assessed with the Socio-professional classification, an official ranking of occupation fields that categorizes the working population into Farm Workers, Craft and Sales Workers, Company Managers Executives and Higher Intellectual Professions, Intermediate Employees, Employees, Manual workers, Never worked before, and Another Situation. We focused our analysis on high-skilled vs low-skilled occupations by

considering, on the one hand, Executives and higher Intellectual Professions along with Intermediate Professions, and on the other hand, Employees and Manual workers.

## Statistical Analysis

### *Estimating Networks based on the Gaussian Graphical Model (GGM)*

Two network models were estimated, both from the 20 CES-D items and an external node corresponding to 'Clinical depression' (indicating the presence versus absence of a history of diagnosis) for one and to the presence vs. absence of 'Limitations due to depression in the past six months' for the other one. Both models were estimated in 12 subpopulations defined by each of the three social position indicators, having two modalities each: the disadvantaged group and the advantaged and stratifying by sex. We balanced sample sizes for each social indicator by randomly reducing the largest group's size to match that of the smallest group. Edges represented weighted undirected connections between two nodes (Epskamp et al., 2018). Considering the non-normal distribution of the items, we used Spearman's Rank Correlation matrices, computed on complete pairwise observation, as the inputs of our models as a robust compromise (Epskamp & Fried, 2018). We used the graphical least absolute shrinkage and selection operator (gLasso) as a regularization technique and the Extended Bayesian Information Criterion for model selection (Epskamp & Fried, 2018).

The accuracy of the edge weights was assessed by computing bootstrapped confidence intervals (BCI). For visualization, we estimated the two network models in men and women separately to compute the original layouts regardless of the social background, which were then used across the 12 subpopulations. The original layouts were based on the Fruchterman and Reingold algorithm, which places nodes with higher centrality towards the center. The Network Comparison Test (van Borkulo et al., 2022), a non-parametric method based on a permutation test, was used to compare networks' global and local characteristics by social position. Firstly, socially disadvantaged networks were compared to socially advantaged in their global strength; under the null hypothesis, both networks have the same level of connectivity (i.e., the absolute sum of all edge weights is equal). A significantly

higher global strength underlies a possible risk factor for that particular population (Isvoranu et al., 2022). Therefore, this test informs us whether or not a membership in a specific social group represents an increased risk for the activation of the depressive network. Secondly, we tested the invariance of network structures, meaning that each pair of edges in the advantaged and disadvantaged groups is equal under the null hypothesis. Lastly, we ran specific edge invariance tests to compare symptom connections to the 21st node (Clinical depression and Limitations, respectively) by social position. Holm-Bonferroni correction was applied.

We used three R packages: bootnet version 1.5 (Epskamp et al., 2018), qgraph version 1.9.4 (Epskamp et al., 2012), and the NCT version 2.2.2 (van Borkulo et al., 2022) to estimate, plot and compare the networks respectively.

## **Ethics**

Data from the Constances cohort obtained authorization from the French National Commission for Information Technology and Liberties (CNIL) and the National Institute for Medical Research (Inserm) institutional review board. All studies using the Constances cohort data have received approval from a scientific committee. All participants have given written consent to use their data for scientific research.

## **Results**

### **Sample Characteristics**

Overall, 201,952 volunteers of 'Constances' were eligible and included in the present study. Table 1 shows the sample's main characteristics related to depression. Participants who were less educated, occupied low-skilled jobs, and had financial difficulties had systematically higher rates of depressive-related variables. For instance, women with financial difficulties were more likely to declare Limitations due to a depressive episode than women who never experienced this challenge (11% vs.

4%). Likewise, low-educated men were more likely to have a History of clinical Depression than higher-educated men (12% vs. 9%).

**Table 1.** Characteristics of participants by socioeconomic factor and stratified by sex

	Occupation				Financial difficulties				Education level			
	Women, N = 108,391 <sup>1</sup>		Men, N = 93,561 <sup>1</sup>		Women, N = 108,391 <sup>1</sup>		Men, N = 85,441 <sup>1</sup>		Women, N = 108,391 <sup>1</sup>		Men, N = 93,561 <sup>1</sup>	
	High-skilled (n = 55,992)	Low-skilled (n=37,566)	High-skilled (n=54,884)	Low-skilled (n=25,753)	No (n= 92,746)	Yes (n=13,122)	No (n=82,099)	Yes (n= 9,573)	Higher (n=65,506)	Bac, less <sup>2</sup> (n=41,288)	Higher (n= 51,849)	Bac, less (n = 40,140)
Age group												
18-34	11,037 (20%)	8,810 (23%)	9,883 (18%)	6,002 (23%)	20,552 (22%)	3,699 (28%)	17,095 (21%)	2,147 (22%)	17,425 (27%)	7,143 (17%)	13,220 (25%)	6,145 (15%)
35-49	21,306 (38%)	12,324 (33%)	19,602 (36%)	8,780 (34%)	31,173 (34%)	5,240 (40%)	27,213 (33%)	3,944 (41%)	26,516 (40%)	10,057 (24%)	20,324 (39%)	10,894 (27%)
50 +	23,649 (42%)	16,432 (44%)	25,399 (46%)	10,971 (43%)	41,021 (44%)	4,183 (32%)	37,791 (46%)	3,482 (36%)	21,565 (33%)	24,088 (58%)	18,305 (35%)	23,101 (58%)
At risk of depression												
No	45,362 (85%)	26,358 (75%)	48,201 (91%)	20,171 (84%)	73,571 (83%)	7,196 (58%)	71,362 (91%)	6,220 (69%)	52,734 (83%)	28,470 (75%)	45,442 (90%)	32,233 (86%)
Yes	8,320 (15%)	8,569 (25%)	4,815 (9%)	3,744 (16%)	14,597 (17%)	5,108 (42%)	7,417 (9%)	2,736 (31%)	10,560 (17%)	9,383 (25%)	4,994 (9.9%)	5,229 (14%)
Limitations <sup>3</sup>												
No	53,917 (96%)	35,362 (94%)	53,571 (98%)	24,674 (96%)	89,265 (96%)	11,621 (89%)	80,079 (98%)	8,682 (91%)	62,939 (96%)	38,801 (94%)	50,467 (97%)	38,586 (96%)
Yes	2,075 (4%)	2,204 (6%)	1,313 (3%)	1,079 (4%)	3,481 (4%)	1,501 (11%)	2,020 (2%)	891 (9%)	2,567 (3.9%)	2,487 (6%)	1,382 (3%)	1,554 (4%)
History of Clinical Depression												
No	44,795 (82%)	28,223 (78%)	48,475 (90%)	21,801 (88%)	73,939 (82%)	8,888 (70%)	72,367 (90%)	7,420 (81%)	52,831 (83%)	30,658 (77%)	46,052 (91%)	33,972 (88%)
Yes	9,917 (18%)	8,083 (22%)	5,252 (10%)	3,069 (12%)	16,336 (18%)	3,757 (30%)	7,708 (10%)	1,754 (19%)	11,065 (17%)	9,238 (23%)	4,680 (3%)	4,822 (12%)

<sup>1</sup> All Pearson's Chi-squared tests were significant at  $p < 0.001$ . <sup>2</sup>Baccalaureat or less (French high-school achievement diploma). <sup>3</sup>"Functional Limitations due to depression".

## **Descriptive features of estimated networks**

In general, the edge weights of the 24 estimated networks were somewhat accurate with narrow BCI (not shown). Globally, ten symptoms were connected to 'Clinical depression' and ten to 'Limitations'. These connections were all positive, meaning that experiencing these symptoms likely activates the presence of the external node or vice-versa. Figures 1, 2, 3, and 4 display networks highlighting symptoms connected to 'Clinical Depression' and 'Limitations' across all social positions in women and men separately (full networks available in Supplemental materials).

## **Network Comparisons results**

Table 2 details the NCT results for both analyses. Overall, the global strength invariance tests were significant, with socially disadvantaged participants having systematically denser networks than their advantaged counterparts. Networks including 'Clinical depression' had significantly different structures by occupation and educational level in men and women separately. Networks including 'Limitations' had non-invariant structures by educational level and occupation, and in men, by financial difficulties.

In networks including 'Clinical depression', three edges were non-invariant between symptoms and this node by educational level. Low-educated men had stronger connections between this external node and 'Felt depressed' and 'Could not get going'. Likewise, low-educated women had a stronger connection between 'Could not get going' and 'Clinical depression' than higher-educated women. Considering networks including 'Limitations', women having financial difficulties had a stronger connection between 'Could not get going' and this node than their better-off counterparts. Similarly, men with financial difficulties and those low-educated had stronger connections between 'felt depressed' and 'Limitations' than their advantaged counterparts.

**Table 2.** Results of the Network Comparison Test (NCT) in networks models including Clinical Depression (above) and Limitations (below) by socioeconomic indicator

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	Occupation						Financial difficulties						Educational level					
	Women			Men			Women			Men			Women			Men		
	Low-skilled (n=37,566)	High-skilled (n=37,566)	<i>p</i>	Low-skilled (n=25,753)	High-skilled (n=25,753)	<i>p</i>	Yes (n=13,122)	No (n=13,122)	<i>p</i>	Yes (n=9,573)	No (n=9,573)	<i>p</i>	Baccalaureat or less (n=41,288)	Higher (n=41,288)	<i>p</i>	Baccalaureat or less (n=40,140)	Higher (n=40,140)	<i>p</i>
1. Bothered by things																		
2. Poor appetite																		
3. Could not shake the blues	0.0521	0.0404		0.0708	0.0380		0.0488	0.0475		0.0675		0.0540	0.0413		0.0661	0.0468		
4. Felt as good as others																		
5. Trouble keeping mind on task																		
6. Felt depressed	0.0520	0.0519		0.0626	0.0614		0.0577		0.0562	0.0556		0.0606	0.0433		0.0754	0.0406	**	
7. Everything was an effort	0.0603	0.0461		0.0410	0.0455		0.0457	0.0462				0.0548	0.0473		0.0390	0.0346		
8. Felt hopeful		0.0254																
9. Life was a failure	0.0424	0.0532		0.0269	0.0567			0.0564		0.0451	0.0501	0.0363	0.0531		0.0311	0.0538		
10. Felt fearful		0.0294											0.0313					
11. Restless sleep	0.0393	0.0380										0.0332	0.0367		0.0247			
12. Happy	0.0334	0.0319						0.0476				0.0327	0.0401			0.0245		
13. Talked less																		
14. Felt lonely																		
15. People unfriendly																		
16. Enjoyed life																		
17. Crying spells				0.0431						0.0535					0.0373	0.0386		
18. Felt sad																		
19. People disliked me																		
20. Could not get going	0.0309						0.0571					0.0440	**	0.0346		**		
<b>Global tests</b>																		
Global invariance	8.760	8.382	***	8.534	7.993	***	8.513	8.084	**	7.962	7.374	**	8.875	8.555	***	8.733	8.202	***
Structure invariance			***			***			NS			NS			***		***	
1. Bothered by things																		
2. Poor appetite				0.0405											0.0340	0.0335		
3. Could not shake the blues	0.1334	0.1293		0.1532	0.1437		0.1320	0.1252		0.1277	0.1455	0.1476	0.1260		0.1496	0.1364		
4. Felt as good as others	0.0254	0.0227										0.0209	0.0230			0.0232		
5. Had trouble keeping mind on task																		
6. Felt depressed	0.0476	0.0378		0.0592	0.0456		0.0661	0.0336		0.0919	**	0.0449	0.0344		0.0683	0.0395	**	
7. Everything was an effort	0.0746	0.0597		0.0574	0.0585		0.0765	0.0641		0.0549	0.0549	0.0685	0.0610		0.0597	0.0580		
8. Felt hopeful																		
9. Life was a failure	0.0544	0.0748		0.0292	0.0634		0.0340	0.0590			0.0628	0.0485	0.0732		0.0441	0.0564		
10. Felt fearful				0.0494	0.0364					0.0444		0.0231			0.0426	0.0296		
11. Restless sleep																		
12. Happy																		
13. Talked less																		
14. Felt lonely																		
15. People unfriendly																		
16. Enjoyed life																		
17. Crying spells				0.0650	0.0724					0.0795	0.0734				0.0683	0.0688		
18. Felt sad																		
19. People disliked me	0.0342			0.0334	0.0328		0.0433			0.0401		0.0400			0.0240	0.0434		
20. Could not get going	0.0260	0.0205		0.0258			0.0649		**			0.0280	0.0191					
<b>Global tests</b>																		
Global invariance	8.857	8.413	***	8.696	8.207	***	8.628	8.135	***	8.172	7.476	***	8.926	8.568	***	8.842	8.385	***
Structure invariance			***			**			NS			**		***		***		

NS= Not Significant ; \*\*\* = p-value <0.001; \*\*=p-value <0.01



## **Other noteworthy findings**

Seven symptoms were consistently found to be connected to both external nodes, with four being almost systematically connected across all networks, irrespective of sex: 'Could not shake the blues', 'Felt depressed', 'Everything was an effort', and 'Life was a failure'. Additionally, seven other symptoms were found to never be connected to external nodes ('Bothered about things', 'Had trouble keeping mind on task', 'Talked less', 'Felt lonely', 'People was unfriendly', '(not) Enjoyed life', 'Felt sad').

Moreover, 'Crying spells' was connected to 'Clinical depression' in four men's networks out of six and in all men's networks with 'Limitations'. At the same time, these connections were absent across all women's networks. Lastly, 'Life was a failure' was connected systematically to both external nodes in all socially advantaged networks. When this connection was present in disadvantaged groups, it tended to be stronger in advantaged groups, inverting the social pattern.

## **Discussion**

### **Summary of key findings**

In this study, socially disadvantaged groups had denser depressive networks, which, clinically, might translate into more severe and active symptomatology. To our knowledge, this study is the first to investigate the relationships between depressive symptoms with a previous diagnosis of depression and depressive symptoms with the self-recognition of limitations due to depression from a network perspective. Some of the connections were socially differentiated and gendered. Our novel strategy allowed us to distinguish four symptoms - 'Could not shake the blues', 'Felt depressed', 'Everything was an effort', and 'Life was a failure' - which are likely to play a key role in the experience of depression, as they were involved in both the self-recognition of depression and the diagnosis process.

### **Comparison with the literature**

Our sample is consistent with the international literature in that depression and other related variables were disproportionately distributed among participants in socially disadvantaged positions

(Lorant et al., 2003). However, comparisons with our main results are difficult to determine because, to our knowledge, no other published studies applied comparable methods and measures. In one master thesis, the author studied depressive networks measured by the PHQ-9 and included gradual nodes referring to SES (composite and disaggregated measures) and stressors (i.e., subjective integration into Dutch society, struggle with sexual orientation, etc.) among a Dutch student sample (Platania, 2023). This work highlighted negative interrelationships between SES positions and distinct depressive symptoms and suggested that diverse aspects of SES could impact the manifestation of depression differently. Specifically, the author found that subjective social status had more associations with depressive symptoms than other objective indicators. Our results, particularly that occupation and educational level-based models showed non-invariant structures, are partially consistent with this thesis in that social position has varying consequences in the experience of depressive symptoms.

### **Interpretation of our findings**

The fact that four individual symptoms were involved both in the self-recognition of a depressive episode and in the diagnosis process regardless of the social background and sex suggests that these symptoms matter to patients more than others and that they ‘trigger’ clinicians’ judgment when making a diagnosis. These common symptoms of both distinct stages of the help-seeking process could be considered promising information for reinforcing therapeutic alliance because they suggest a continuum between the experience, self-recognition, and diagnosis. On this basis, we suggest that symptoms evoking ‘the blues’, depressed mood, failure, and energy loss (‘could not get going’) should be systematically screened in consultation to improve the detection and management of depression.

Seven symptoms were neither connected to Clinical depression nor Limitations, which raises the question about the relevance of these CES-D items. Surprisingly, ‘Sadness’ was one of the symptoms, suggesting that either clinicians or patients overlook it for the benefit of others. Although the psychometric properties of the CES-D have been previously validated (Morin et al., 2011), this scale

was created in the late 70s (Radloff, 1977) and may no longer translate actual generations' depressive symptoms. More recent qualitative studies have documented many other expressions of depression that are also relevant, such as excessive worry, rumination (Danielsson et al., 2010; Sloan et al., 2021), somatic complaints/pain (Chen et al., 2022; Sowińska & Czachowski, 2018), loss of intimacy/libido and loss of self-care (Poole et al., 2022), feelings of loss of control and self-identity (Cornford et al., 2007) and irritability/anger (Danielsson & Johansson, 2005). Although several of these manifestations are associated features supporting diagnosis (*DSM-V* 2013), as of now, there is not a consensus on whether they constitute core symptoms, predictors/triggers, maintaining factors, symptoms associated with distinct comorbidities, or symptoms evoking subtypes of depression. Consequently, they are not systematically screened or assessed clinically, raising questions about the extent to which clinicians and researchers may be overlooking important depressive symptoms. Further qualitative research may be necessary to better capture depressive symptoms relevant to current generations, enabling their inclusion in updated screening tools or clinical assessments.

Networks including 'Clinical depression' had different structures by occupation and educational level, meaning that there were edges connecting two symptoms (in general, not limited to the 21st node) in socially advantaged vs. socially disadvantaged networks that were not equal. Similarly, in networks estimated including 'Limitations', findings revealed that network structures differed by educational level and occupation in men's and women's models and financial difficulties exclusively in men. Although the details of these edges were not deepened in this study, these findings suggest that depressive symptoms presented different activation mechanisms within each network, and likely, these interrelationships translate into different clinical manifestations. These findings also underscore the need to study depressive symptoms according to different social indicators. Indeed, different social indicators may capture varying forms of the experience of depression that could be addressed with tailored interventions targeting central symptoms.

Depressive networks from socially disadvantaged groups were denser than their better-off counterparts, which confirms that membership in those groups implies an increasing risk that the

depressive network becomes active. This finding may be explained by greater exposure to stressful life events, which has been shown to affect coping abilities (Kim et al., 2017). From a clinical perspective, these results show that socially disadvantaged groups experience depressive symptoms more severely. Yet, these groups also had greater rates of a history of clinical depression compared to advantaged groups, meaning that despite having consulted a clinician and received a diagnosis at least once in their lifetime, they still experienced more intense symptomatology when they responded to the questionnaire. This paradoxical situation could be related to previous findings indicating these groups have worse depression treatment outcomes (Bukh et al., 2013) and longer depression trajectories (Melchior et al., 2013). Other potential explanations are that socially disadvantaged groups may have poorer treatment engagement (Rivero-Santana et al., 2013) or may not be treated as comprehensively or assertively due to clinicians bias and social distance (Garb, 1997; Salmon et al., 2004).

Educational level captured differences in symptoms involved in the diagnosis process when comparing advantaged vs. disadvantaged groups. Specifically, for low-educated women, 'Could not get going' played a more significant role in the diagnosis process (symptom presentation and symmetrically clinicians' judgment), while this symptom did not participate in this process for their better-off counterparts. Likewise, for low-educated men, energy loss and depressed mood accounted for more in this process than for higher-educated men. Although there is no consensus to date on the specific features of different subtypes of depression, this finding suggests that low-educated people may endorse a more melancholic profile, which some have characterized by the presence of pervasive anhedonia and psychomotor slowing (Maj et al., 2020). Importantly, these symptom patterns inform us about clinical profiles among low-educated people that could be addressed with specific treatment choices.

Depressed mood played a role in the self-recognition of depression for men with financial difficulties, which suggests that there might be gender mechanisms interacting with this social indicator. One possible explanation is that men with financial difficulties, besides the stress of hardship, also suffer from 'failing' in their stereotypical expectancy to provide, driven by hegemonic

masculinity ideals (Connell, 1995). This apparent contradiction with their selves could increase and reinforce the depressed mood. Similarly, another interesting clue was that edge weights concerning 'Crying spells' and both external nodes were exclusively present in men's networks. Notably, this connection was present across all men's networks with Limitations, with slight social position and indicator differences. Following the same gender perspective, hegemonic masculinity also drives multiple beliefs and norms about dominant forms of manhood, such as emphasizing emotional restriction and associating crying with weakness. Therefore, if participant men adhere strongly to these norms, crying might reflect a severe symptom (to the point of self-recognizing depression), inducing them into a vicious circle in which their masculine identities are threatened (Möller-Leimkühler, 2002) by stereotypically feminine symptoms and, thus, reinforcing their depression.

In networks estimated from women, the only symptom differently connected to 'Limitations' by social position was 'could not get going' in financial-based models. Insofar as this symptom measures a loss of energy, we believe this strong connection evokes a form of experiencing depression associated with physical health; indeed, the GALI question is intended to capture this dimension. However, since women have higher rates of depression over their lifetimes (Kessler et al., 2003), this result could also reflect the interactive effects of hardship and mood disorders on their bodies. One possible mechanism for these effects might be the embodiment (Krieger, 2005) of material deprivation derived from stressors such as food insecurity, housing insecurity, or uncertainty regarding the future. For example, stress levels related to ordinary tasks, such as preparing family meals on a daily basis, may be heightened when access to food supplies is scarce/uncertain or if supplies are monotonous (Ramos & Salgado Pereira, 2018). Following this rationale, it is not surprising that in a society where the distribution of ordinary tasks remains gendered (Champagne et al., 2015), women with financial strains face higher levels of daily life stressors, leading to significantly more energy loss and other somatic symptoms.

Edge weights between 'failure' and both external nodes tended systematically to be stronger in socially advantaged groups, which may underlie within-group mechanisms. One possible explanation

for this trend might be that if success and failure are feelings commonly attributed to individuals (i.e., promoted by meritocracy values) in developed countries (Blacksher, 2002; Manstead, 2018), then socially advantaged groups are likely to feel social pressure to maintain their successful status constantly or to pursue high achievements. These groups might perceive more feelings of failure whenever experiencing difficulties simply because these struggles do not meet group expectations. In other words, the sense of failure may induce a higher burden because it is perceived as non-normative within successful groups.

Finally, 'People disliked me' was connected to Limitations in 8 models out of 12. This relationship may be an indicator of high levels of internalized stigma among participants who self-report a functional limitation. An in-depth analysis reveals that this connection was present primarily in socially disadvantaged groups. We believe this connection sheds light on the pervasive effects of the internalized stigma among people facing double jeopardy: people in more limited and lower social positions perceive more social rejection.

## **Limitations**

This study should be interpreted in light of its limitations. First, we used the CES-D items as proxies of symptoms presented in consultation with clinicians and from which they substantiated diagnoses. Nevertheless, items capture only a limited experience of depressive symptomatology and may fail to reflect other symptoms arising in consultation. Second, we could not account for the time since participants were first diagnosed. However, since the report of 'Limitations' was framed in a 6-month time window and there were seven symptoms in common with Clinical depression, we assumed that participants with a previous diagnosis were likely to experience, to some extent, these symptoms persistently. Third, we could not account for other factors that could have impacted the experience of depressive symptoms, such as age or social disadvantage's cumulative and interacting effects. Future research should address this gap. Fourth, for simplicity reasons, we grouped some occupation categories with very heterogeneous situations that might have influenced our results. Similarly, the

cutoff criteria used in educational level groups may be deemed arbitrary and inaccurate, as achieving the French baccalaureate secondary diploma may have different meanings for older birth cohort generations compared to more recent ones (*Niveau d'éducation de la population – France, portrait social* | Insee, 2020). Fifth, we used cross-sectional data, limiting our findings' causal interpretation. Sixth, our results may not be generalizable to other settings for two main reasons: cultural differences in the experience of depression and contextual differences in how social positions shape groups' living conditions (i.e., the depression social gap may be less pronounced in the least unequal countries and vice-versa (Patel et al., 2018)). Finally, we privileged power (sensitivity) when estimating networks. Many edges were estimated at the cost of sparsity.

## Conclusion

Four depressive symptoms were common to the diagnosis process and to participants' self-recognition of a depressive episode across all social positions. Depressed mood and energy loss are likely to participate more in the diagnosing process among disadvantaged groups than among advantaged groups. Increasing awareness about key symptoms and allowing patients from socially disadvantaged backgrounds to disclose their concerns may help improve depression care. We outlined different symptom patterns by social position, suggesting unique underlying mechanisms. In particular, we suggested possible mechanisms underpinning financial difficulties and educational level indicators. More research is needed to understand potential interactions between social norms and gender norms in the experience of depressive symptoms. Clinicians should be aware that socially advantaged groups are likely to experience depression through the lens of their within-group expectancies, in opposition to other social stressors that are likely to be accommodated.

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Insurance Fund ("Caisse nationale d'assurance maladie", CNAM) and its Health Screening Centres ("Centres d'exams de santé"), which are collecting a large part of the data, as well as the French National Old-Age Insurance Fund ("Caisse nationale d'assurance vieillesse", Cnav) for its contribution to the constitution of the cohort, and ClinSearch, Asqualab and Eurocell, which are conducting the data quality control. Thanks to Nathalie Bajos and Anne-Sophie Cousteaux for reading and helpful comments.

### **Conflict of interest**

The authors declare that they have no conflict of interest.

### **Contributions**

Authors EA, AR, and LR designed the study. EA managed the literature searches, undertook the statistical analysis and wrote the first draft of the manuscript. EW provided access to the data. All authors contributed to and have approved the final manuscript.

### **Ethics approval and consent to participate**

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures were approved by the Institutional Review Board of the French Institute of Health (INSERM). The Constances Cohort study has also been approved by the French Data Protection Authority ("Commission Nationale de l'Informatique et des Libertés", CNIL). Written informed consent was obtained from all participants.

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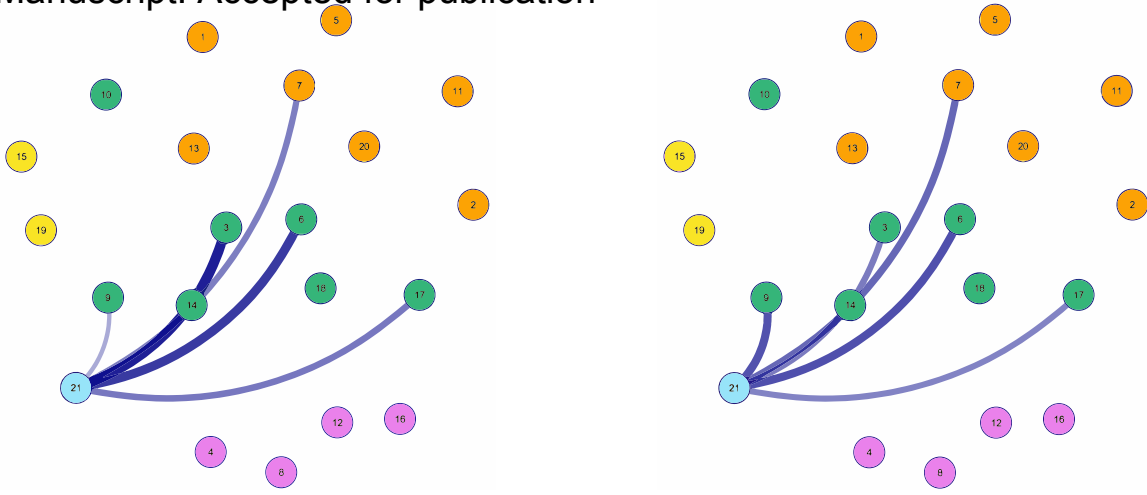
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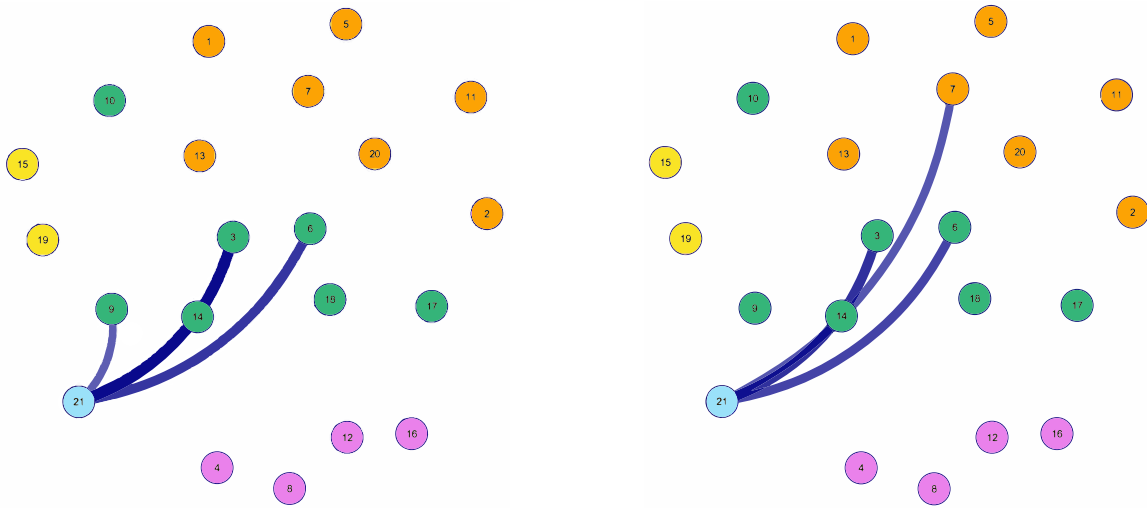
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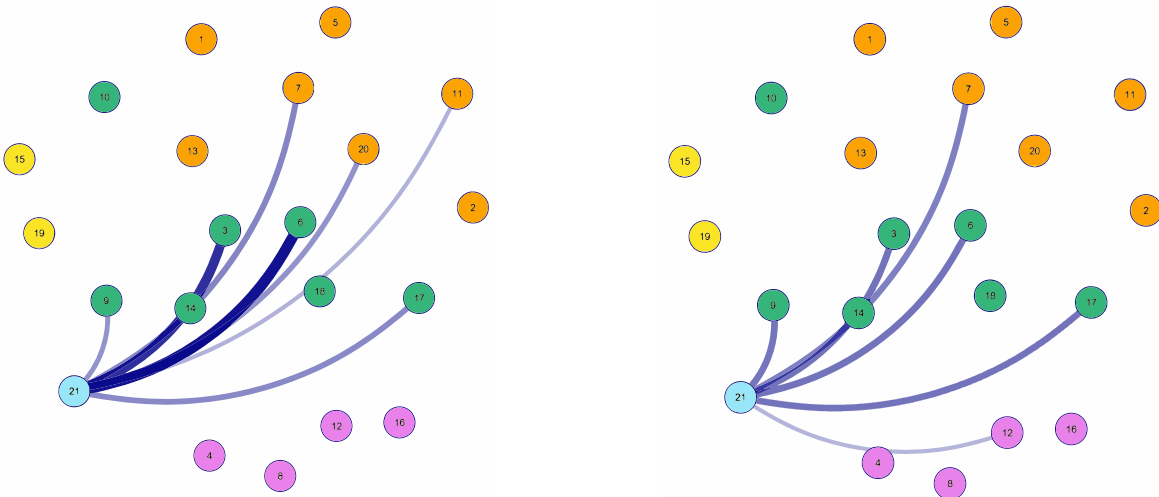
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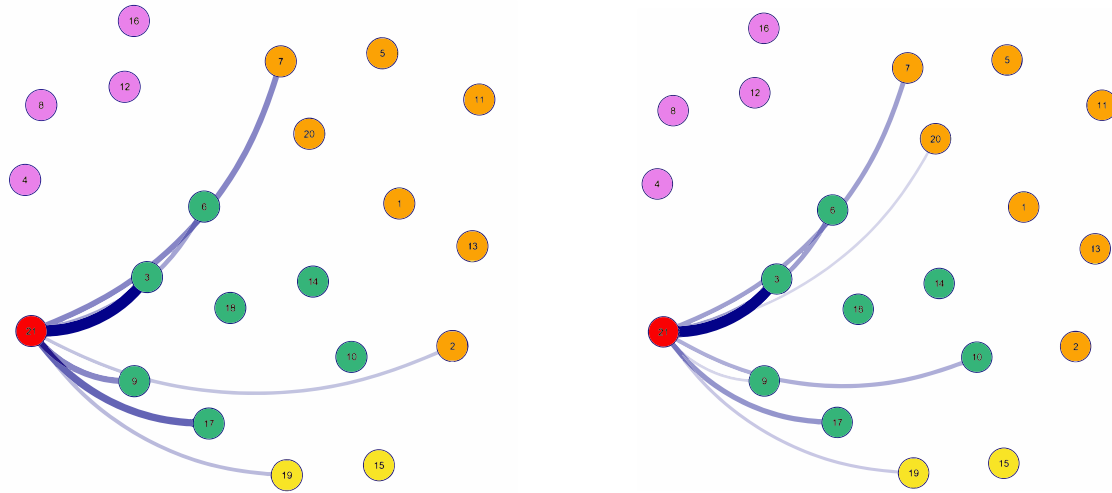


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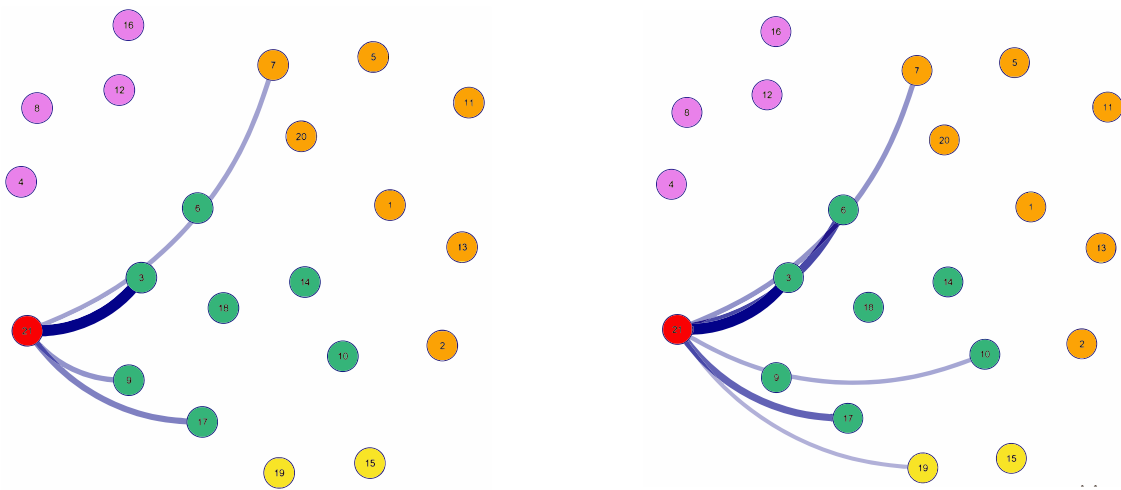


**Figure 2.** Connections between depressive symptoms and Clinical Depression (node 21) in men's network models. Panel 'a' left: men with low-skilled occupations, right: men with high-skilled occupations. Panel 'b' left: men with financial difficulties, right: men without financial difficulties. Panel 'c' left: men with a baccalaureate level of education, right: men with higher education. Edges' widths were scaled to the closest higher value than any absolute edge weight in order to facilitate comparisons by social position. Edges were curved to avoid overlapping. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal. Refer to Figure 1 for the legend.

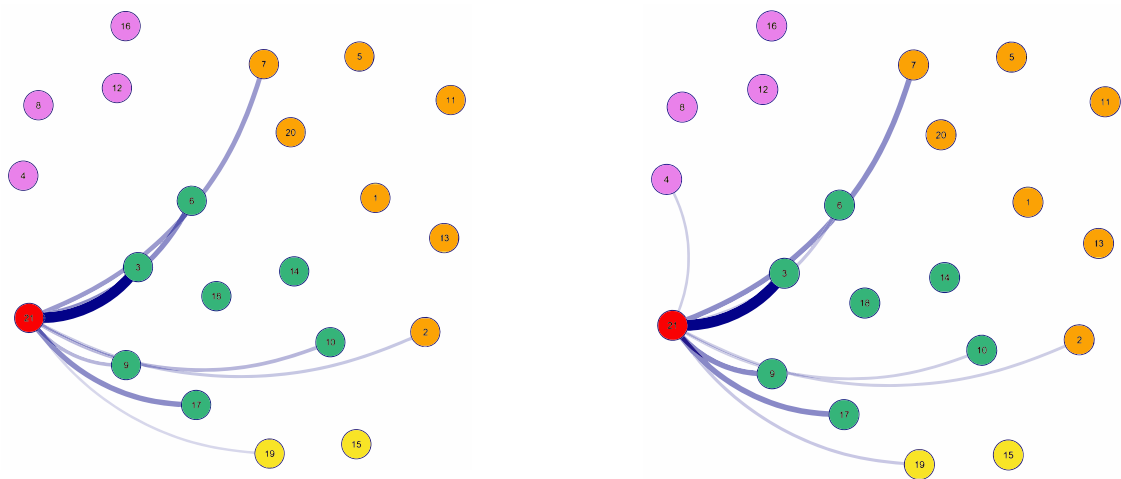
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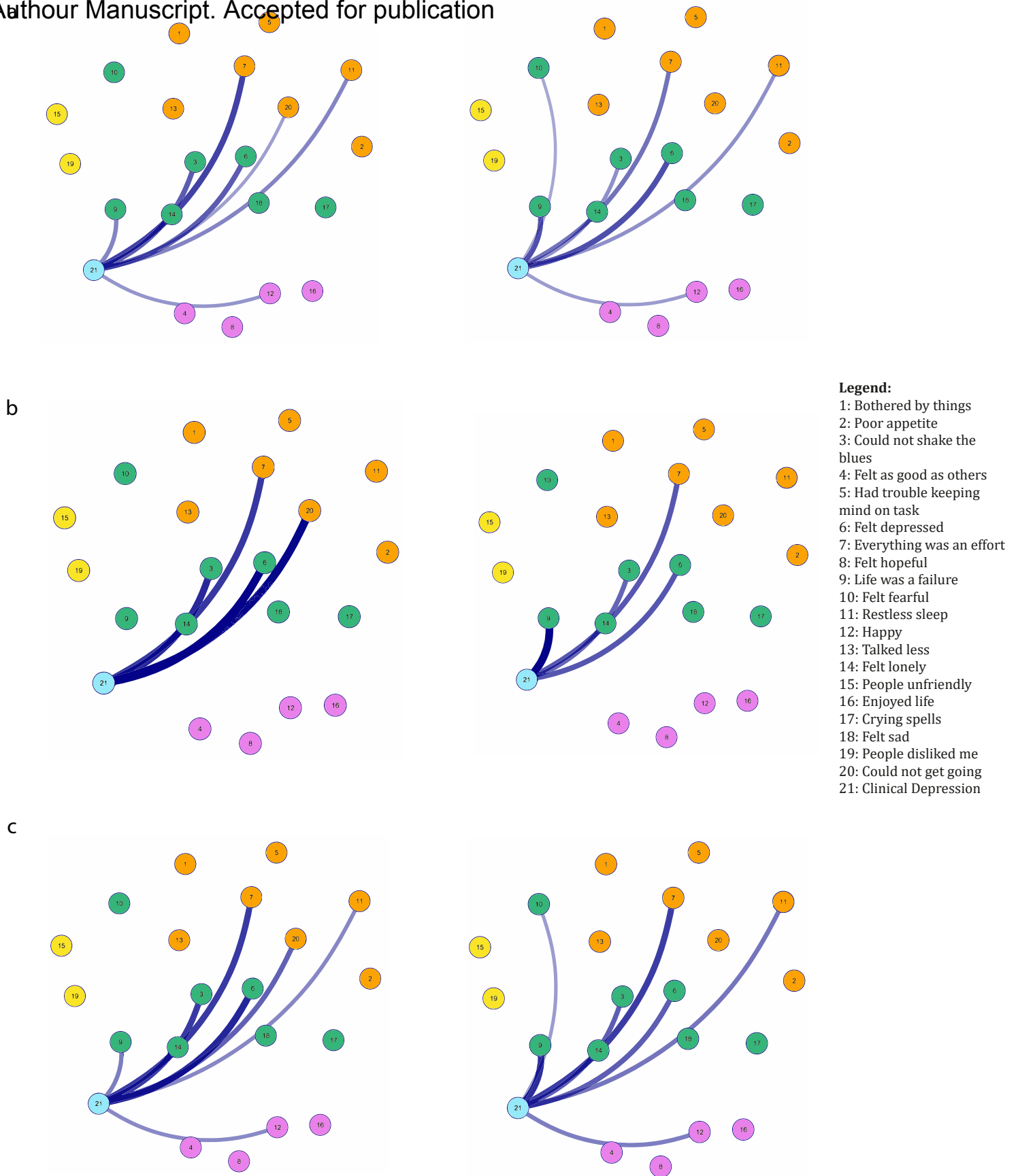
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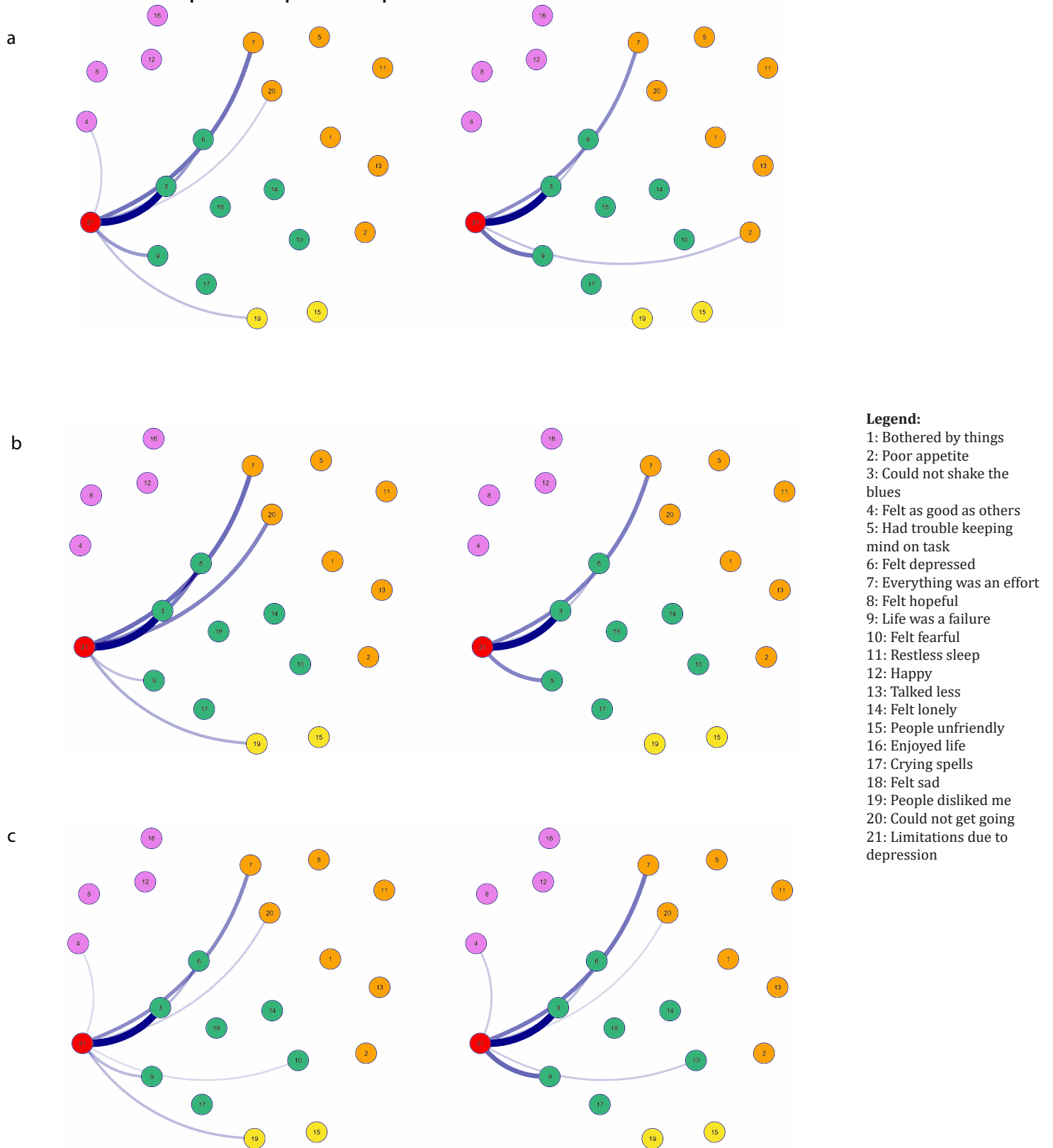
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**Figure 4.** Connections between depressive symptoms and Limitations (node 21) in men's network models. Panel 'a' left: men with low-skilled occupations, right: men with high-skilled occupations. Panel 'b' left: men with financial difficulties, right: men without financial difficulties. Panel 'c' left: men with a baccalaureate level of education, right: men with higher education. Edges' widths were scaled to the closest higher value than any absolute edge weight in order to facilitate comparisons by social position. Edges were curved to avoid overlapping. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal. Refer to Figure 3 for the legend.

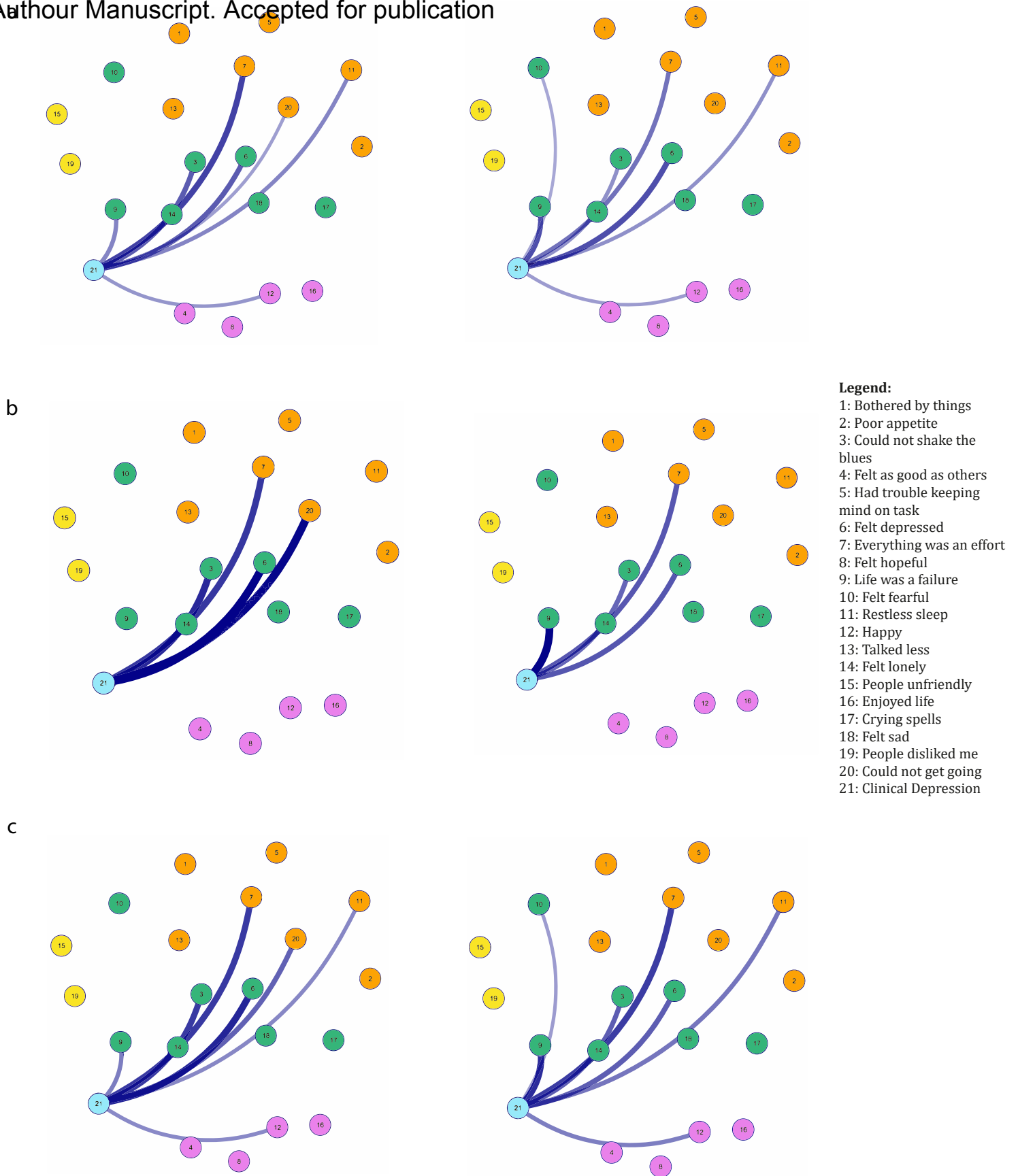


**Figure 1.** Connections between depressive symptoms and Clinical Depression (node 21) in women's network models. Panel 'a' left: women with low-skilled occupations, right: women with high-skilled occupations. Panel 'b' left: women with financial difficulties, right: women without financial difficulties. Panel 'c' left: women with a baccalaureate level of education, right: women with higher education. Edges' widths were scaled to the closest higher value than any absolute edge weight in order to facilitate comparisons by social position. Edges were curved to avoid overlapping. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal.

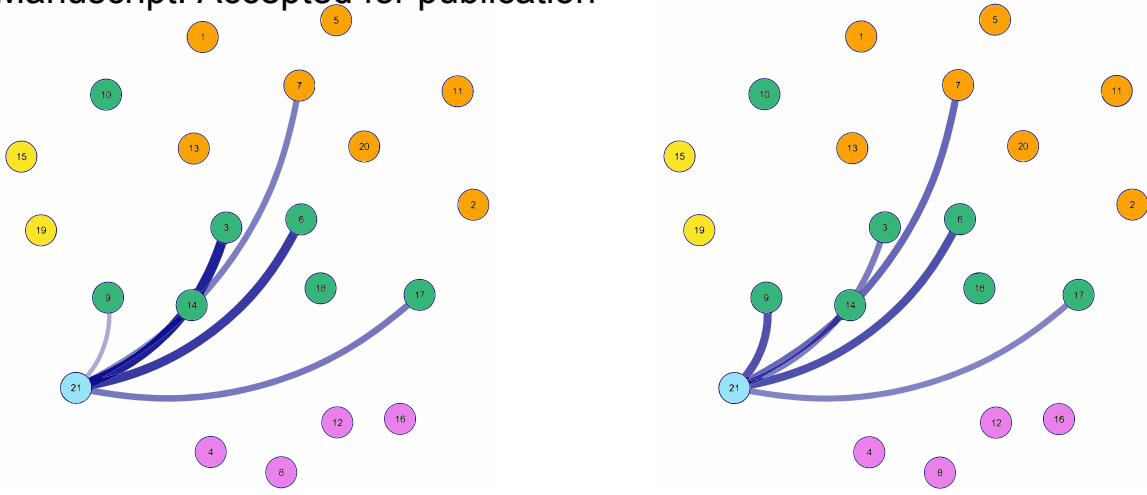


**Figure 3.** Connections between depressive symptoms and Limitations (node 21) in women's network models. Panel 'a' left: women with low-skilled occupations, right: women with high-skilled occupations. Panel 'b' left: women with financial difficulties, right: women without financial difficulties. Panel 'c' left: women with a baccalaureate level of education, right: women with higher education. Edges' widths were scaled to the closest higher value than any absolute edge weight in order to facilitate comparisons by social position. Edges were curved to avoid overlapping. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal.

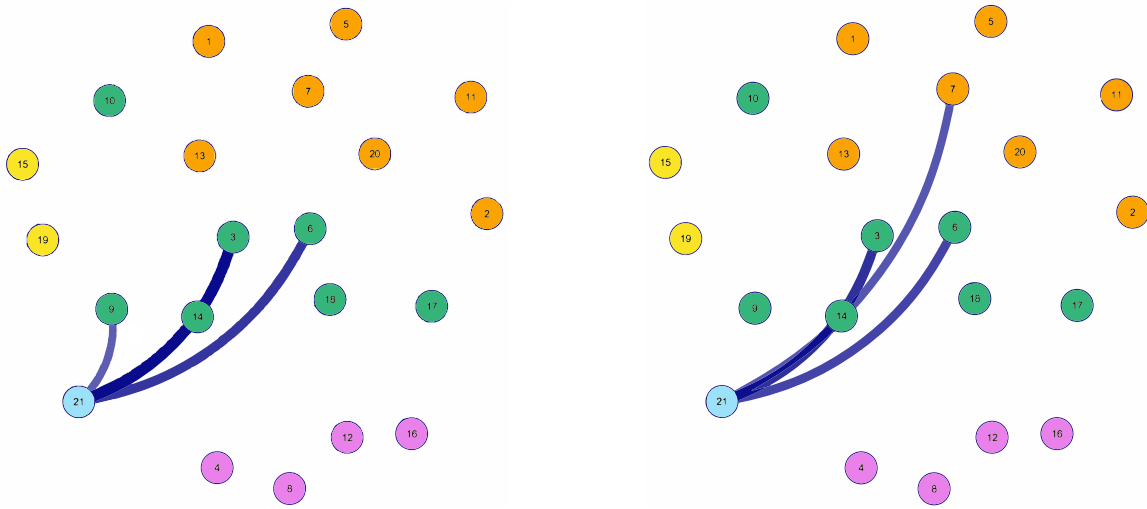




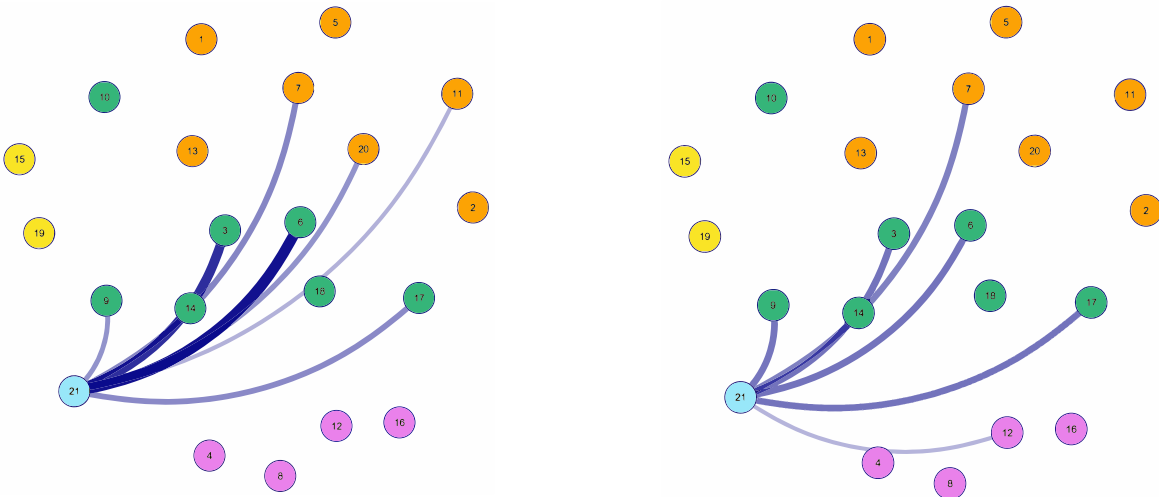
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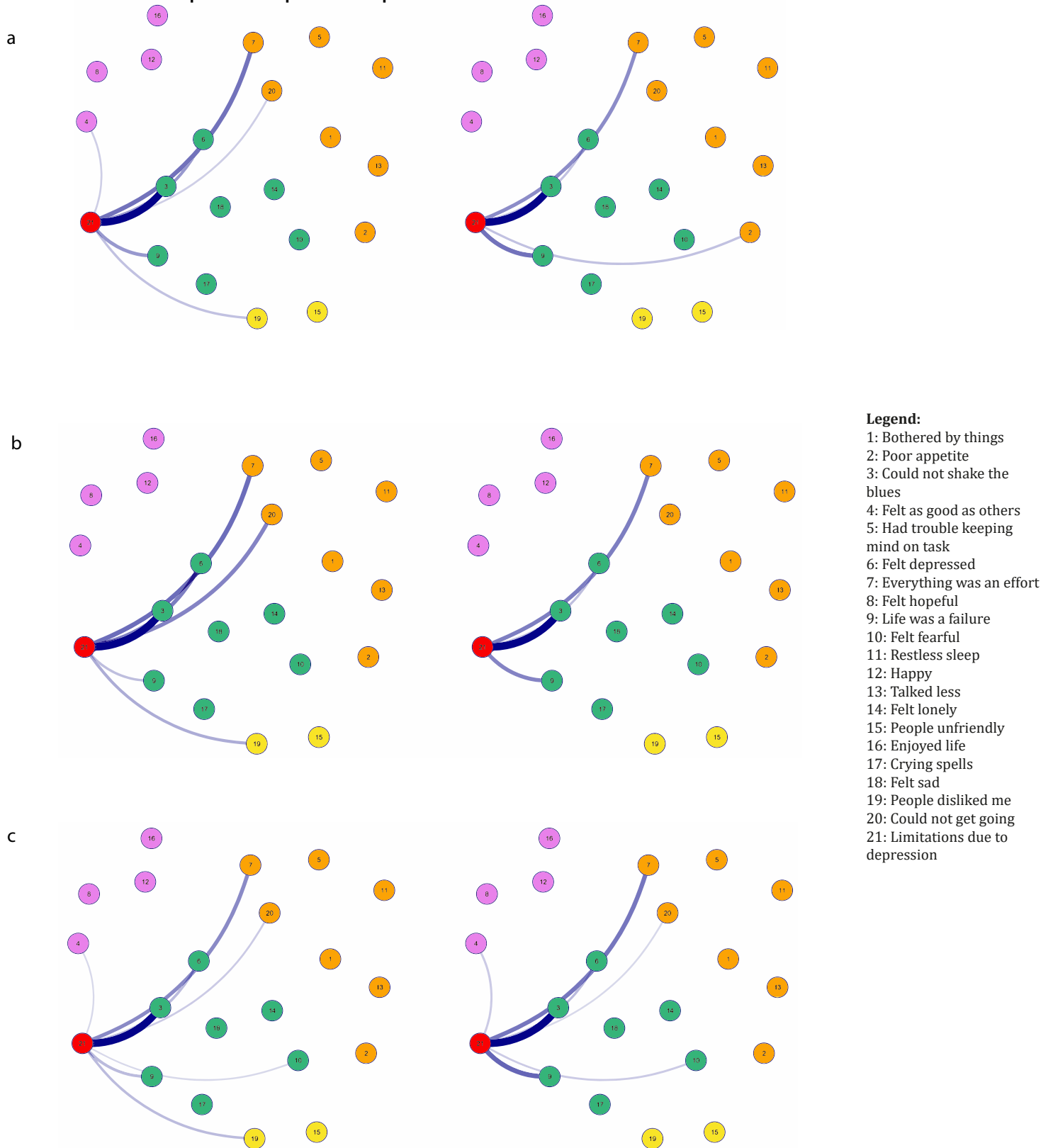
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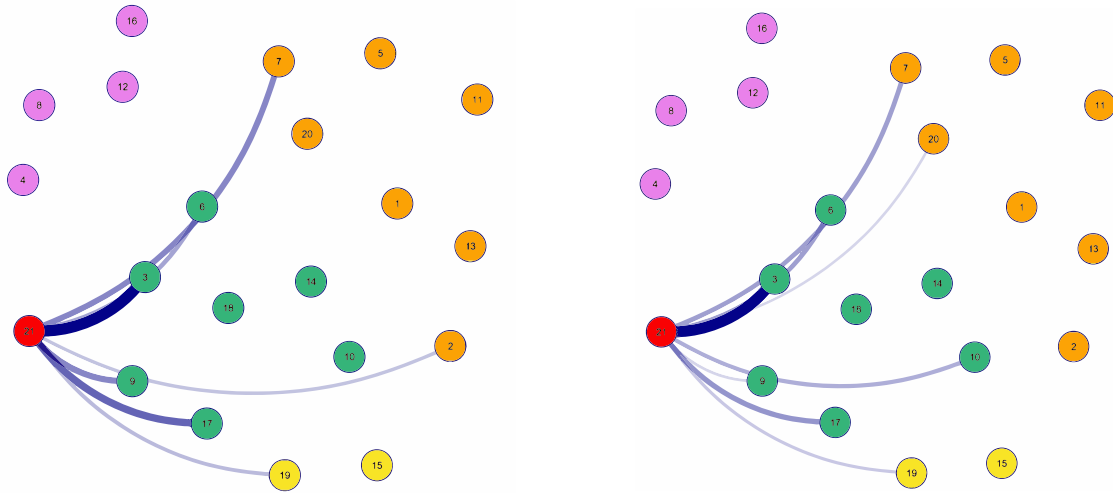
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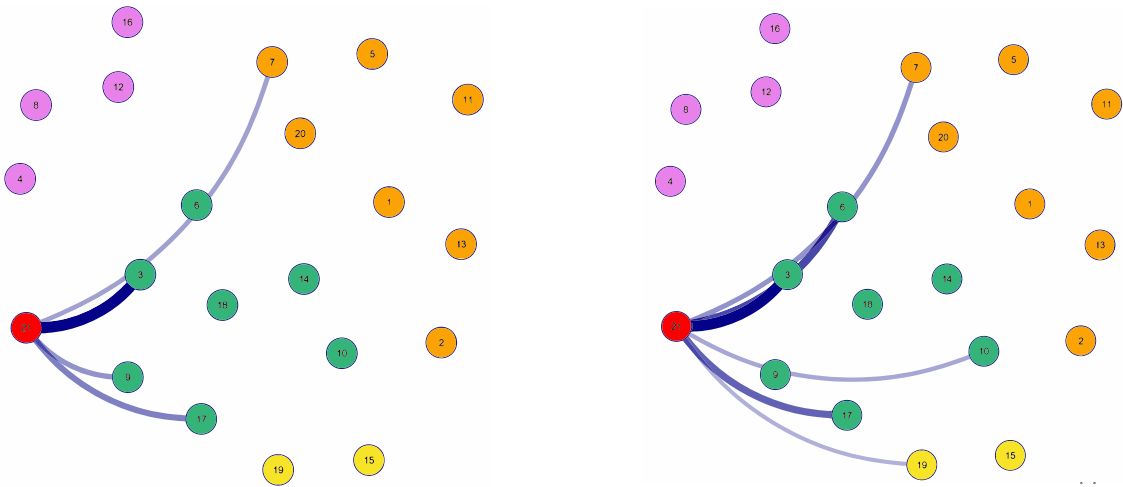
**Figure 2.** Connections between depressive symptoms and Clinical Depression (node 21) in men's network models. Panel 'a' left: men with low-skilled occupations, right: men with high-skilled occupations. Panel 'b' left: men with financial difficulties, right: men without financial difficulties. Panel 'c' left: men with a baccalaureate level of education, right: men with higher education. Edges' widths were scaled to the closest higher value than any absolute edge weight in order to facilitate comparisons by social position. Edges were curved to avoid overlapping. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal. Refer to Figure 1 for the legend.



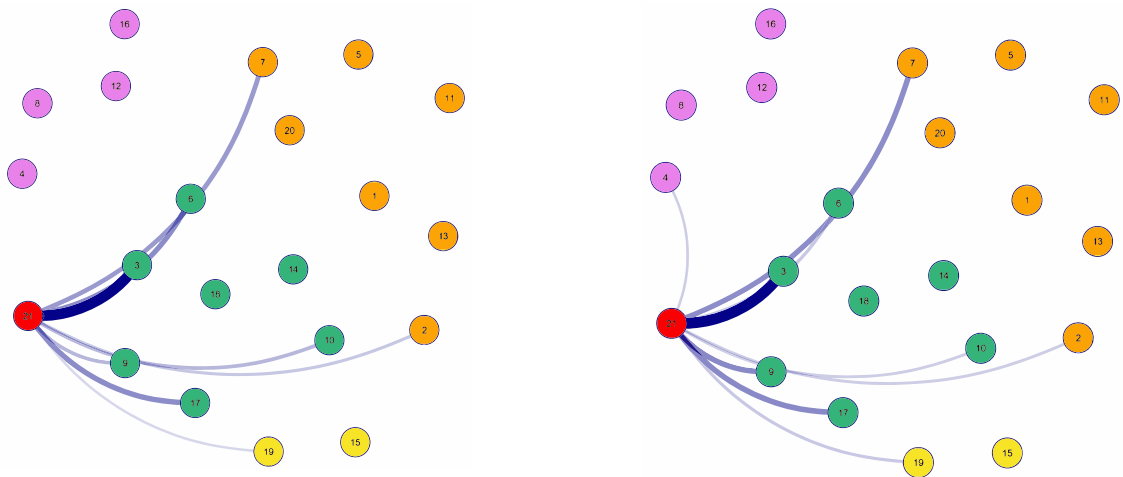
**Figure 3.** Connections between depressive symptoms and Limitations (node 21) in women's network models. Panel 'a' left: women with low-skilled occupations, right: women with high-skilled occupations. Panel 'b' left: women with financial difficulties, right: women without financial difficulties. Panel 'c' left: women with a baccalaureate level of education, right: women with higher education. Edges' widths were scaled to the closest higher value than any absolute edge weight in order to facilitate comparisons by social position. Edges were curved to avoid overlapping. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal.



b



c



**Figure 4.** Connections between depressive symptoms and Limitations (node 21) in men's network models. Panel 'a' left: men with low-skilled occupations, right: men with high-skilled occupations. Panel 'b' left: men with financial difficulties, right: men without financial difficulties. Panel 'c' left: men with a baccalaureate level of education, right: men with higher education. Edges' widths were scaled to the closest higher value than any absolute edge weight in order to facilitate comparisons by social position. Edges were curved to avoid overlapping. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal. Refer to Figure 3 for the legend.

### **Supplementary Information**

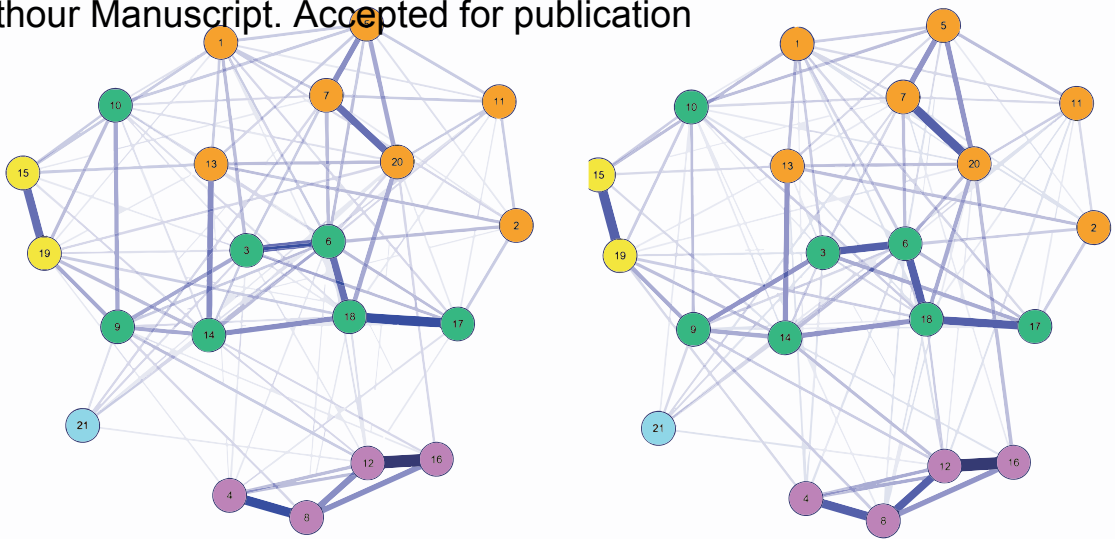
Supplemental Figure 1. Women's estimated networks including displaying all 20 CES-D items and external node 'Clinical Depression'

Supplemental Figure 2. Men's estimated networks including displaying all 20 CES-D items and external node 'Clinical Depression'

Supplemental Figure 3. Women's estimated networks including displaying all 20 CES-D items and external node 'Limitations'

Supplemental Figure 4. Men's estimated networks including displaying all 20 CES-D items and external node 'Limitations'

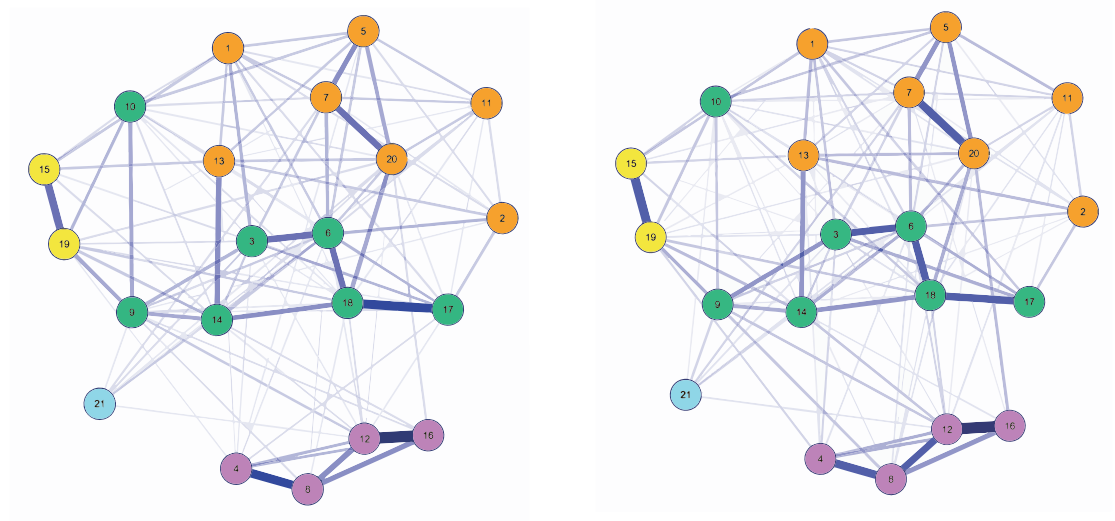
b



**Legend:**

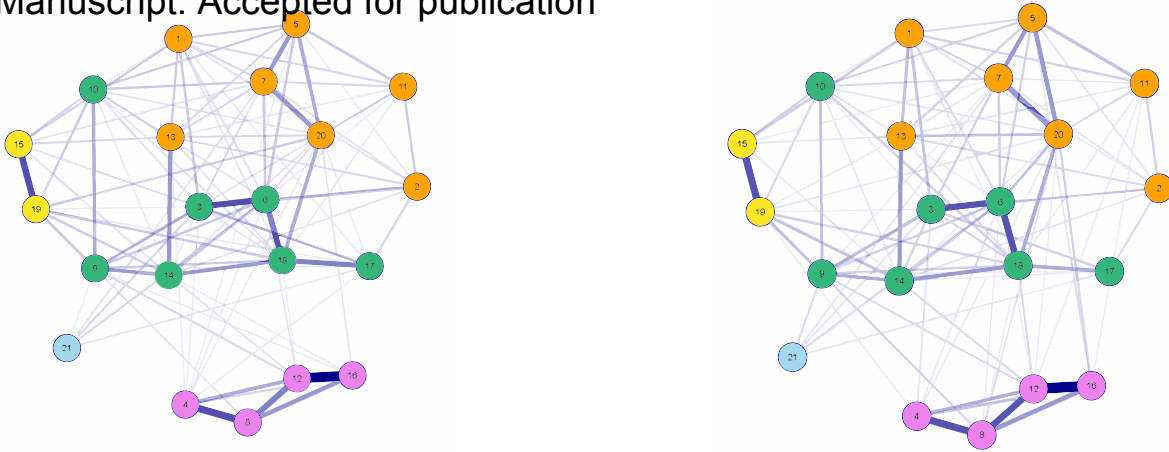
- 1: Bothered by things
- 2: Poor appetite
- 3: Could not shake the blues
- 4: Felt as good as others
- 5: Had trouble keeping mind on task
- 6: Felt depressed
- 7: Everything was an effort
- 8: Felt hopeful
- 9: Life was a failure
- 10: Felt fearful
- 11: Restless sleep
- 12: Happy
- 13: Talked less
- 14: Felt lonely
- 15: People unfriendly
- 16: Enjoyed life
- 17: Crying spells
- 18: Felt sad
- 19: People disliked me
- 20: Could not get going
- 21: Clinical Depression

c

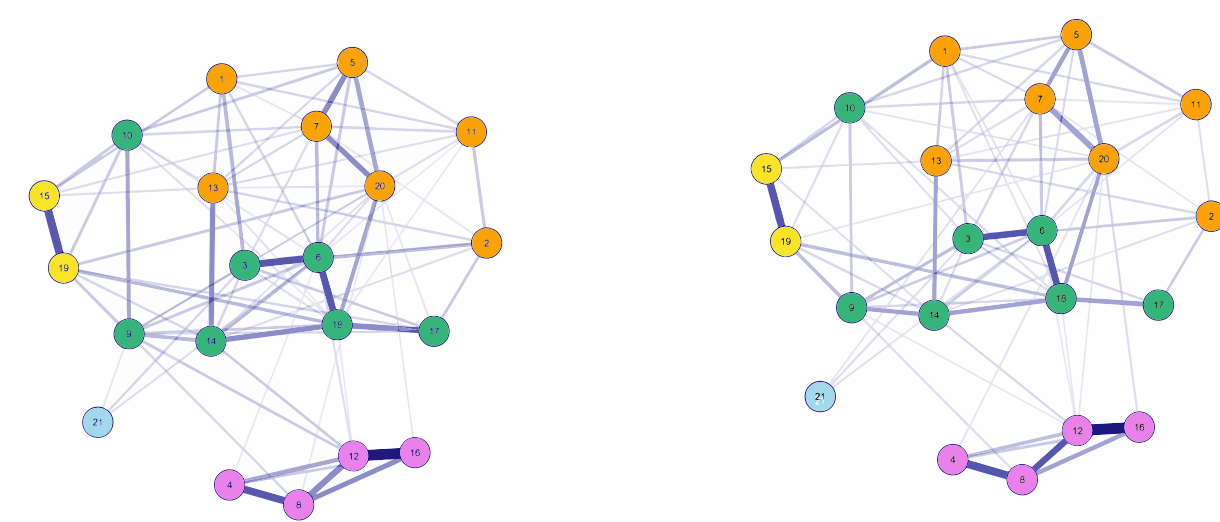


**Supplemental Figure 1.** Women's estimated Networks from Graphical Gaussian Models with Spearman's Rank Correlations. Nodes represent the 20 CES-D and Clinical Depression (node 21). Panel 'a' left: women with low-skilled occupations, right: women with high-skilled occupations. Panel 'b' left: women with financial difficulties, right: women without financial difficulties. Panel 'c' left: women with a baccalaureate level of education, right: women with higher education. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal.

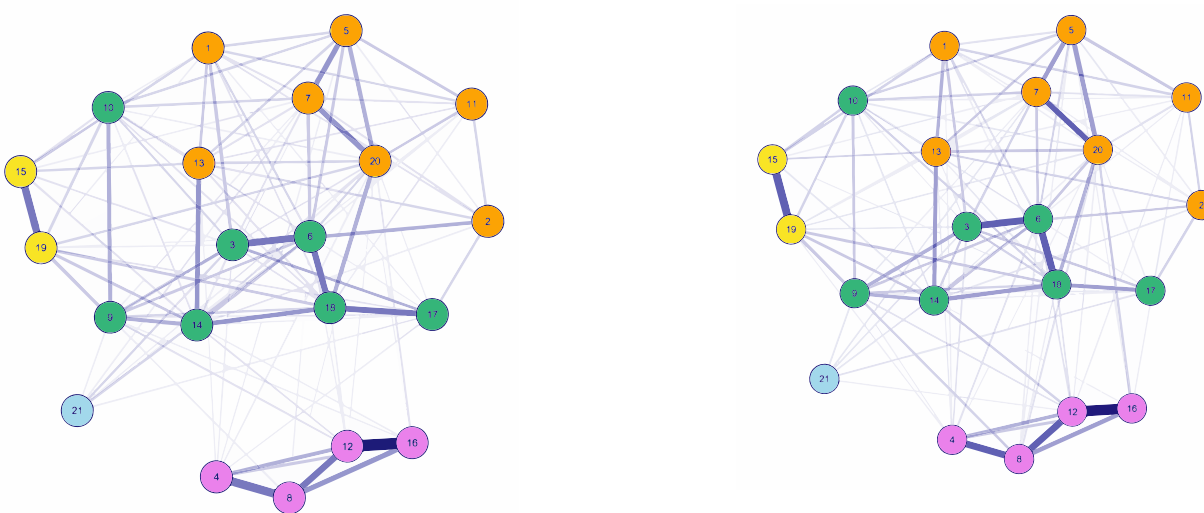
a



b



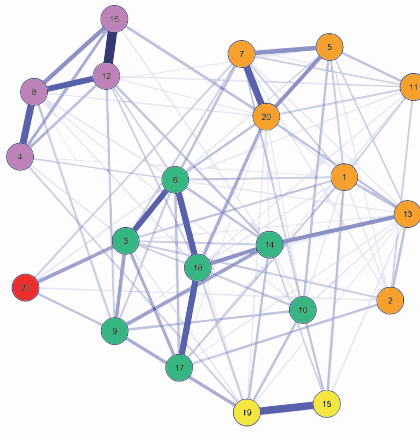
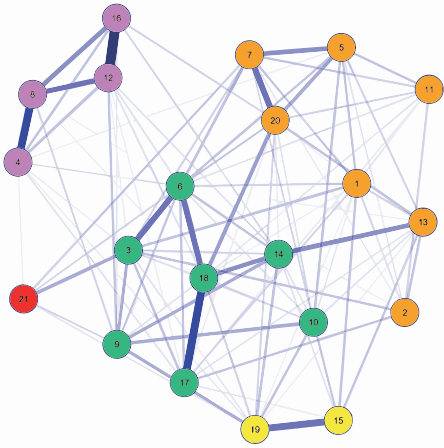
c



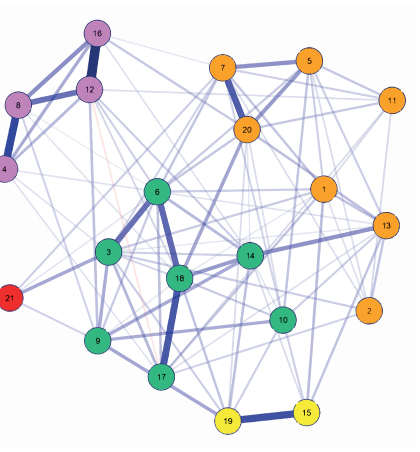
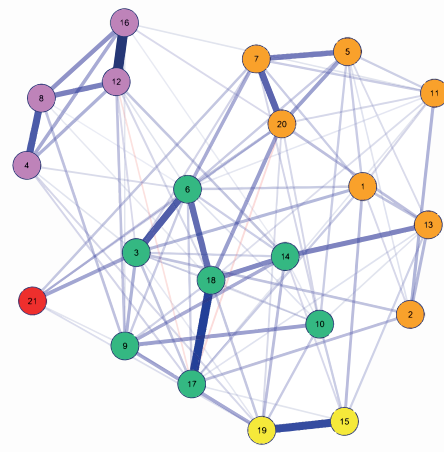
**Supplemental Figure 2.** Men's estimated networks from Graphical Gaussian Models with Spearman's Rank Correlations. Nodes represent the 20 CES-D and Clinical Depression (node 21). Panel 'a' left: men with low-skilled occupations, right: men with high-skilled occupations. Panel 'b' left: men with financial difficulties, right: men without financial difficulties. Panel 'c' left: men with a baccalaureate level of education or less, right: men with higher education. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal. Refer to Figure 1 for the legend.



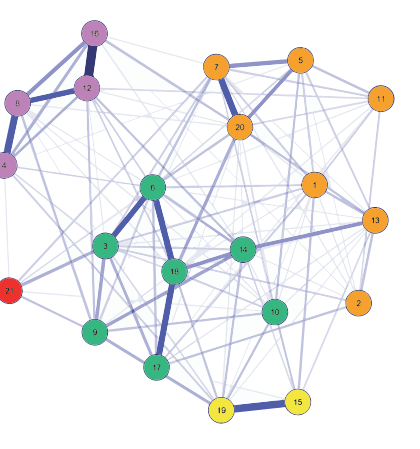
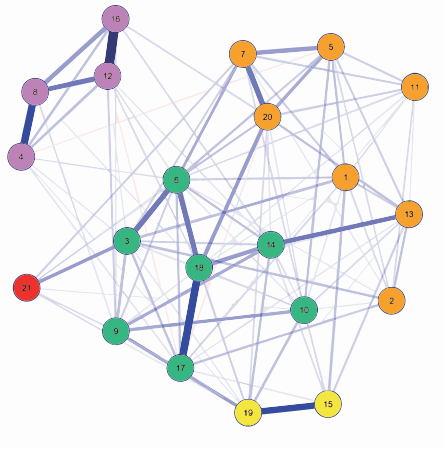
a



b



c

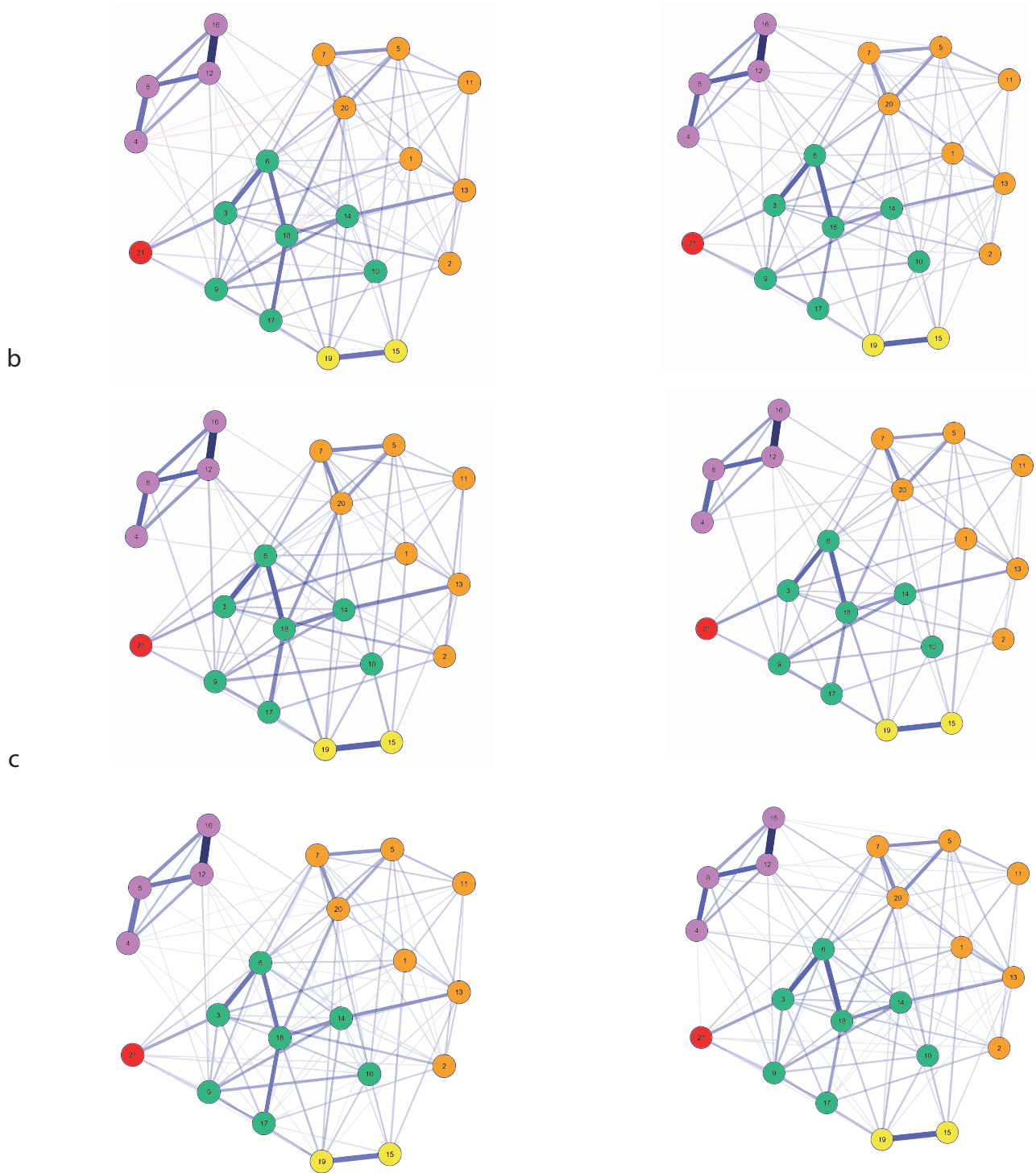


**Legend:**

- 1: Bothered by things
- 2: Poor appetite
- 3: Could not shake the blues
- 4: Felt as good as others
- 5: Had trouble keeping mind on task
- 6: Felt depressed
- 7: Everything was an effort
- 8: Felt hopeful
- 9: Life was a failure
- 10: Felt fearful
- 11: Restless sleep
- 12: Happy
- 13: Talked less
- 14: Felt lonely
- 15: People unfriendly
- 16: Enjoyed life
- 17: Crying spells
- 18: Felt sad
- 19: People disliked me
- 20: Could not get going
- 21: Limitations due to depression

**Supplemental Figure 3.** Women's estimated Networks from Graphical Gaussian Models with Spearman's Rank Correlations. Nodes represent the 20 CES-D and Limitations due to depression (node 21). Panel 'a' left: women with low-skilled occupations, right: women with high-skilled occupations. Panel 'b' left: women with financial difficulties, right: women without financial difficulties. Panel 'c' left: women with a baccalaureate level of education, right: women with higher education. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal.





**Supplemental Figure 4.** Men's estimated Networks from Graphical Gaussian Models with Spearman's Rank Correlations. Nodes represent the 20 CES-D and Limitations due to depression (node 21). Panel 'a' left: men with low-skilled occupations, right: men with high-skilled occupations. Panel 'b' left: men with financial difficulties, right: men without financial difficulties. Panel 'c' left: men with a baccalaureate level of education or less, right: men with higher education. Items were colored by dimensions: Green: depressive affect, Purple: positive affect; Orange: somatic; Yellow: interpersonal. Refer to Supplemental Figure 3 for the legend