

## Research Article

**Cite this article:** Chun CA, Cooper S, Ellman LM (2020). Associations of psychotic-like experiences, related symptoms, and working memory with functioning. *European Psychiatry*, 63(1), e20, 1–9  
<https://doi.org/10.1192/j.eurpsy.2020.21>

Received: 11 September 2019

Revised: 16 January 2020

Accepted: 18 January 2020

**Key words:**

clinical high risk; cognition; psychosis; role functioning; social functioning; working memory

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# Associations of psychotic-like experiences, related symptoms, and working memory with functioning

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**Abstract**

This study examined the association of spatial working memory and attenuated psychotic-like experiences and related symptoms with social and role functioning. Findings from this study suggest that symptom dimensions and working memory impairment were associated with diminished functioning across a variety of domains. Specifically, negative symptoms and working memory impairment were inversely associated with both social and role functioning, whereas positive and disorganized symptoms showed inverse associations with social functioning only. Symptom dimensions did not moderate cognitive and functional variables, although working memory and attenuated clinical symptoms had an additive effect on functioning. Post-hoc analyses examining symptom dimensions simultaneously showed negative symptoms to be the variable most strongly predictive of overall functioning. These findings suggest that even in a non-clinical sample, sub-threshold psychosis symptoms and cognition may influence people's social and role functioning.

Social and role functioning play an important role in the continuum of risk for psychosis. People with subclinical schizotypy, clinical high-risk (CHR) for psychosis, and schizophrenia show impairments in premorbid social adjustment, social functioning, and role functioning (in work, school, home, and community roles), which have major implications for quality of life and other domains of functioning [1–6]. Furthermore, poor social and role functioning and stalled social development predict later conversion to psychosis and worse long-term functioning in CHR groups [7–10], suggesting that this is an area of study relevant for clinical practice. However, it is unclear how social functioning is impacted by working memory in subclinical groups on the psychosis spectrum, especially in relation to specific dimensions of subclinical symptoms, including psychotic-like experiences (PLEs or attenuated positive psychotic symptoms) and attenuated negative and disorganized symptoms.

Cognitive deficits correlate with quality of life and functional outcomes, including social functioning, in schizophrenia and CHR samples [11–15]. Further, longitudinal research has indicated that improvement in cognition and symptoms across time predicts better outcomes for social and role functioning in CHR groups [16]. Working memory deficits have been repeatedly found across the psychosis spectrum, including among patients with schizophrenia, CHR samples, and unaffected first-degree relatives of psychosis patients [17–19]. Additionally, meta-analyses suggest that working memory may be one of the few specific cognitive deficits present in subclinical schizotypy groups [20] and that it predicts CHR conversion to psychosis [21,22]. Working memory impairment has been associated with diminished global functioning, social problem-solving skills, and premorbid social adjustment and role functioning in schizophrenia and CHR groups [2,17,23,24]. However, research is lacking on the impact of working memory on social and role functioning in individuals experiencing PLEs and other attenuated symptoms. One study found that working memory deficits were associated with a subscale of a schizotypal personality questionnaire that measures social connections [25], and another study found that objective quality of life showed small associations with overall neurocognitive performance among college students with high schizotypy scores [20]. However, to our knowledge, no study has thoroughly examined social and role functioning specifically in relation to working memory in subclinical psychosis risk.

Positive, negative, and disorganized schizophrenia-spectrum symptoms involve different aspects of cognition, affect, and behavior, and show differential outcomes in these areas on laboratory and experience-sampling measures of factors such as cognitive impairment, emotional experience, and social functioning [26–28]. Meta-analysis studies found that negative—but not positive—clinical symptoms were associated with working memory deficits in patients with schizophrenia [29], whereas positive and negative schizotypy both showed small working memory deficits in subclinical groups [20]. Disorganized symptoms generally show modest

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associations with working memory, intermediate to those of positive and negative symptoms [30,31]. Overall, however, findings are mixed with some studies finding null or inconsistent associations of working memory across symptom dimensions [32,33].

Negative and disorganized dimensions have been associated with social and role functioning in a variety of studies, and negative symptoms appear to contribute most strongly to functional impairment in schizophrenia and CHR groups, both concurrently and prospectively [24,34–36]. Positive symptoms tend to show the weakest associations with functional outcomes and in individuals at CHR, attenuated positive symptoms may be more strongly related to transition to psychosis than to other correlates of the illness [34]. Sub-clinical symptom dimensions of psychosis risk are also differentially associated with impairment in different aspects of social functioning. For example, one study found associations between positive schizotypy and peer-relationship problems, and between negative schizotypy and diminished prosocial behavior in a community sample of adolescents [37]. A longitudinal study using latent class analysis showed that a group with consistently high schizotypal traits also had high negative symptoms and poor social functioning over time [38]. Further, there is preliminary evidence that cognitive function may play a role in this relationship: one study found that executive function mediated the relationship between social anhedonia and social impairment in a subclinical group [39]. However, there has been little research on the potential contributing role of working memory toward functioning in subclinical populations.

In sum, there is a large body of research showing that clinical symptoms and neurocognition have major impacts on functioning in schizophrenia-spectrum groups [36,40,41]. However, the complex and possibly interacting relationships among these variables are not well characterized in individuals at putative risk for psychosis who are experiencing PLEs and other attenuated symptoms. Addressing these questions can improve our understanding of what disrupts social and role functioning in psychosis-spectrum psychopathology.

The current study sought to examine how PLEs and attenuated negative and disorganized symptoms and working memory relate to social and role functioning. Additionally, we aimed to investigate whether symptoms and working memory interact to predict functioning. As reviewed above, research has shown that working memory and negative symptoms are associated with one another and both contribute individually to functioning, supporting the hypothesis of an additive model. Further, engagement of working memory capacity requires cognitive effort [42]. Given that motivation and effort are often diminished in people high in negative symptoms, the combination of high negative symptoms and low working memory is expected to be associated with even worse functioning, consistent with the hypothesis of a moderation model.

Hypotheses were made after data collection, but before data analyses, and were pre-registered on Open Science Framework (<https://osf.io/4ndwz/>). Greater working memory sensitivity and faster reaction times (RT) on the spatial N-back were expected to correlate with better functioning overall and across social and role function subscales. It was hypothesized that negative and disorganized symptoms—but not PLEs—would predict worse N-back performance and lower total and subscale functioning scores. Negative and disorganized symptoms—but not PLEs—were expected to moderate the relationship between N-back performance and overall social and role functioning, such that greater symptoms and worse working memory would be associated with worse functioning. It was expected that these moderation models would fit the data better than additive models of symptom dimensions and working memory predicting social and role function.

## Method

### Participants

Temple University's Institutional Review Board approved this study. Undergraduate students ages 18+ from multiple disciplines at a socioeconomically and racially diverse urban university in the United States could sign up for the study through the university's online subject pool. After providing informed consent, participants completed questionnaires and cognitive tasks on a laboratory computer in the same testing session. They received course credit for their participation. Assessment of subclinical college samples is advantageous for several reasons: (a) participants' average age is within the window of typical age of onset of psychosis, (b) subclinical schizotypy predicts later onset of psychotic disorders, (c) it allows for premorbid examination of the correlates of psychotic psychopathology, (d) there are fewer confounds such as medication, stigma, and other effects associated with illness onset, and (e) examination of outcomes in this sample provides a conservative test of our hypotheses given that the sample is generally high functioning [43,44]. Nevertheless, there were substantially more females in the courses that could register for the study and it is possible that findings in our sample will not be generalizable to similarly aged non-college participants, therefore it is necessary for future studies to determine whether these findings can be replicated in community-based samples.

Of participants ( $N = 497$ ) who completed the study, 31 (6%) were excluded due to below-chance performance on the N-back, leaving a final sample of 466 participants. One participant was excluded for low accuracy on the 0-back condition, 10 on the 1-back condition, and 27 on the 2-back condition. Table 1 presents descriptive statistics. As noted in the table, variables had slightly different sample sizes due to missing data on some measures. Gender was significantly associated with all three symptom dimensions, working memory accuracy, and Social Functioning Scale (SFS) social engagement and independence-performance; thus, gender was included as a covariate in correlations among these variables.

### Materials

#### Prodromal Questionnaire (PQ) [45]

The PQ is a questionnaire designed to identify individuals at risk for psychosis. It has demonstrated concurrent validity with standard interview measures of psychosis risk, and PLEs in particular were found to predict CHR status [45]. Given that factor analytic studies have shown disorganized symptoms to be distinct from PLEs and negative symptoms [46–48], the current study divided PQ positive scale items into separate dimensions of PLEs (PQ items: unusual thinking, paranoia/suspiciousness, and perceptual abnormalities) and disorganized symptoms (PQ items: disorganized thoughts and speech). Items were summed within each dimension to compute continuous scores of symptoms occurring at least once per month. These symptom dimension conceptualizations have been used in previous psychosis risk research [47].

#### Temporal Experience of Pleasure Scale (TEPS) [49]

The TEPS measures self-report of anticipatory and consummatory pleasure and is appropriate for use with schizophrenia-spectrum groups [50]. The TEPS was selected because it taps negative symptoms that are characteristic of psychosis risk without including items directly related to social and role functioning. This allows us to examine associations between negative symptoms and functioning without inflating results from overlapping content. The

**Table 1.** Descriptive characteristics of the final sample

	<i>N</i>	Range	Mean (SD)
Age	458	18–36	20.5 (2.8)
Gender	466		
Male			28.3%
Female			71.7%
Race	466		
White			62.2%
Asian/Pacific islander			14.4%
Black or African American			12.2%
More than one race			4.1%
Unknown			7.1%
Ethnicity	466		
Hispanic/Latino			4.3%
Not Hispanic/Latino			95.7%
Maternal education	466		
Less than high school degree			5.4%
High school degree or equivalent			34.1%
Associates degree/two-year college completed			17.5%
Four-year college attended, not completed			4.3%
Bachelor degree			25.8%
Graduate degree			13.1%
Paternal education	466		
Less than high school degree			5.6%
High school degree or equivalent			35.2%
Associates degree/two-year college completed			14.2%
Four-year college attended, not completed			3.0%
Bachelor degree			26.4%
Graduate degree			15.7%
Positive symptoms	466	0–32	6.5 (5.8)
Disorganized symptoms	466	0–6	2.6 (1.8)
Negative symptoms	466	36–108	86.0 (11.2)
0-back RT (correct trials)	466	394.0–951.5	531.5 (96.3)
1-back RT (correct trials)	466	191.4–1194.2	401.6 (158.0)
2-back RT (correct trials)	466	149.7–1088.9	384.2 (153.6)
0-back <i>d'</i>	466	–0.06 to 4.91	2.7 (1.0)
1-back <i>d'</i>	466	–0.70 to 4.91	3.3 (1.3)
2-back <i>d'</i>	466	–0.87 to 4.91	2.3 (1.5)
SFS total	463	91–214	141.2 (19.2)
SFS social engagement	464	3–15	11.0 (2.2)
SFS interpersonal communication	465	3–9	8.3 (1.0)
SFS independence-performance	465	17–39	31.7 (5.1)
SFS recreation	464	5–45	18.5 (6.2)
SFS prosocial	464	3–66	25.3 (10.1)
SFS independence-competence	464	0–39	36.9 (3.2)
SFS occupation	464	9–10	9.5 (.5)

Abbreviations: RT, reaction times; SFS, Social Functioning Scale; SD, standard deviation.

current study summed items from anticipatory and consummatory subscales to compute continuous scores on a negative symptom dimension (see symptom dimensions in Analyses section below). Because higher scores on the TEPS indicate greater pleasure, scores were reversed for analyses to keep presentation of results consistent across symptom dimensions. Thus, associations described in the results are reported in terms of greater negative symptoms.

### Social Functioning Scale (SFS) [51]

The SFS is a self-report measure of social and role functioning that is sensitive to functional impairment across the psychosis spectrum [52]. SFS outcomes include a total score and seven subscale scores of social functioning (withdrawal, interpersonal behavior, and pro-social activities) and role functioning (recreation, independence-competence, independence-performance, and occupation). To mitigate issues associated with multiple comparisons, the current study only examined subscale scores in correlations; moderation analyses used the SFS total score.

### Spatial N-back [53]

The spatial N-back is a working memory task in which participants are instructed to indicate the location of a stimulus displayed in one of four circles fixed in a diamond pattern. There are three conditions: participants indicate the location of the current stimulus in the 0-back condition (control condition), the stimulus one trial back in the 1-back condition (low cognitive load), and the stimulus two trials back in the 2-back condition (high cognitive load). The stimulus duration was 400 ms and the inter-stimulus interval was 1,400 ms. Participants completed a set of practice trials followed by 6 blocks of 7 critical trials per condition, for a total of 126 critical trials. The first trial of every 1-back block and first two trials of every 2-back block were not scored because there were no preceding stimuli to which participants could respond. Average RT was calculated for correct trials only. It was decided a priori that participants who scored below chance (25% accuracy) on any of the three conditions would be excluded. A sensitivity index of performance accuracy was calculated as  $d' = Z_{\text{hits}} - Z_{\text{false alarms}}$ , which is found to be the most appropriate measure of working memory for the N-back in schizophrenia research [54]. Working memory measures for  $d'$  and RT were computed by controlling 2-back scores for 0-back scores. For example, 2-back  $d'$  was regressed on 0-back  $d'$  and the residuals were saved as a measure of working memory sensitivity.

### Analyses

Symptom dimension conceptualizations and planned analyses were established a priori and pre-registered. Symptom dimensions represent sums of continuous scores within each dimension of PLEs (PQ items: unusual thinking, paranoia/suspiciousness, and perceptual abnormalities), disorganized symptoms (PQ items: disorganized thoughts and speech), and negative symptoms (TEPS anticipatory and consummatory scores). Positive, negative, and disorganized symptoms of psychosis risk exist along a spectrum in the general population and we aimed to examine these symptoms continuously in a subclinical sample to maximize statistical power and avoid the use of artificial cutoffs.

Because all variables except SFS total score deviated from normality (one-sample Kolmogorov-Smirnov test: all other  $p < .001$ , indicating significant non-normality), associations were examined with Spearman rank-order correlations, which is a non-parametric

test appropriate for variables with these type of distributions. To assess for confounding variables, age, gender, race/ethnicity, and parental education were examined in association with symptom dimensions, working memory outcomes, and SFS total and subscale scores. Demographic variables were included as covariates when they were significantly associated with both the independent and dependent variable.

Correlations were conducted among SFS total and subscale scores; PLEs, negative, and disorganized symptom dimensions; and working memory sensitivity and RT. A series of moderation models examined whether PLEs, negative, and disorganized symptoms each respectively moderated the association between working memory sensitivity and overall functioning. These analyses were run independently using hierarchical linear regression and variables were standardized. All residuals from regression models were normally distributed, linear, and heteroscedastic. To reduce the number of analyses, moderation models were run with sensitivity ( $d'$ ) as the only measure of working memory. Additive models were examined when moderation models were not significant. Effect sizes for multiple regressions are reported in terms of  $f^2$ : values below 0.02 represent a negligible effect size and values of 0.02, 0.15, and 0.35+ represent small, medium, and large effect sizes, respectively [55].

Given differential findings for anticipatory and consummatory pleasures in the schizophrenia-spectrum literature [49,50], post-hoc analyses examined negative symptom associations separately by TEPS anticipatory and consummatory subscales. Finally, a post-hoc analysis examined PLEs, negative, and disorganized symptoms as independent variables simultaneously predicting SFS total scores to examine which symptom dimensions were most strongly predictive of functioning.

### Results

Table 2 presents Spearman rank-order correlations. PLEs and disorganized symptoms showed small associations with diminished functioning for social engagement, interpersonal communication, and independence-competence. Negative symptoms showed small associations with diminished social engagement, recreation, pro-social, and overall functioning. None of the symptom dimensions were associated with working memory  $d'$  or RT. Working memory sensitivity showed small associations with diminished recreation, independence-performance, and overall social and role functioning. Working memory RT was not associated with any measures of functioning on the SFS.

Table 3 presents moderation models. Three separate hierarchical linear regression models examined were conducted for each of the three symptom clusters as independent variables predicting overall functioning on the SFS, in conjunction with working memory (additive model), and in interaction with working memory (moderation model). Moderation models are displayed in Step 2. Contrary to hypotheses, none of the symptom dimensions moderated the relationship between working memory sensitivity and overall social and role functioning.

The additive models were all significant, but effects were subtle: PLEs and working memory (negligible effect size), disorganized symptoms and working memory (negligible effect size), and negative symptoms and working memory (small effect size) all predicted SFS total scores. The simultaneous regressions of working memory and symptom dimensions and their additive effects are displayed in the table at Step 1. The additive effects of working memory and each of the three symptom dimensions significantly predicted social

**Table 2.** Spearman's rank-order correlations between N-back variables, subclinical symptoms, and SFS outcomes ( $N=466$ )

	Soc Engag <sup>a</sup>	Interp Comm <sup>b</sup>	Indep-Perf <sup>b</sup>	Recr <sup>a</sup>	Prosoc <sup>a</sup>	Indep-Comp <sup>a</sup>	Occup <sup>a</sup>	PLEs	Dis Sx	Neg Sx	WM $d'$	WM RT
SFS Total <sup>c</sup>	0.38**	0.31**	0.67**	0.74**	0.84**	0.41**	0.20**	-0.06	-0.04	-0.19**	-0.11*	0.05
Soc Engag <sup>a</sup>		0.42**	0.14**	0.14**	0.29**	0.18**	0.15**	-0.12*	-0.12*	-0.13*	-0.04	0.008
Interp-Comm <sup>b</sup>			0.20**	0.03	0.22**	0.25**	0.08	-0.13**	-0.17**	-0.10*	0.02	0.03
Indep-Perf <sup>b</sup>				0.42**	0.32**	0.44**	0.19**	-0.07 <sup>d</sup>	-0.08 <sup>d</sup>	-0.18** <sup>d</sup>	-0.11* <sup>d</sup>	0.007
Recr <sup>a</sup>					0.51**	0.19**	0.07	0.03	0.04	-0.16**	-0.10*	0.04
Prosoc <sup>a</sup>						0.14**	0.14**	-0.04	-0.01	-0.12*	-0.08	0.04
Indep-Comp <sup>a</sup>							0.24**	-0.13**	-0.14**	-0.07	-0.01	0.002
Occup <sup>a</sup>								0.001	-0.06	0.07	0.02	-0.003
PLEs									0.71**	0.11*	-0.03	0.004
Dis Sx										0.12**	-0.03	-0.02
Neg Sx											-0.06	0.02
WM $d'$												-0.26**

Abbreviations: Dis, disorganized; Indep-Comp, independence-competence; Indep-Perf, independence-performance; Interp Comm, interpersonal communication; Neg, negative; Occup, occupation; PLEs, psychotic-like experiences; Prosoc, prosocial; Recr, recreation; SFS, Social Functioning Scale; Soc Engag, social engagement; Sx, symptoms; WM  $d'$  = working memory sensitivity. WM RT, working memory reaction time.

<sup>a</sup> $N=464$ .

<sup>b</sup> $N=465$ .

<sup>c</sup> $N=463$ .

<sup>d</sup>Gender as covariate.

\* $p < .05$

\*\* $p < .01$ .

**Table 3.** Hierarchical linear regression models of symptom dimensions and working memory as independent variables predicting total social and role functioning ( $N=463$ )

	Step 1 ( $df=2, 460$ )								Step 2 ( $df=1, 459$ )				
	Symptom dimension		WM $d'$		Step 1 total (additive model)			Symptom dimension $\times$ WM $d'$ (moderation model)					
	$B_1$	95% CI ( $B_1$ )	$\beta_1$	$B_2$	95% CI ( $B_2$ )	$\beta_2$	$f^2$	$p$	$B$	95% CI ( $B$ )	$\beta$	$f^2$	$p$
(1) PLEs	-0.13	(-1.88, 1.62)	-0.007	-2.37	(-4.11, -0.62)	-0.12	0.015	.03	0.05	(-1.71, 1.81)	0.003	0.000	.95
(2) Dis	-1.09	(-2.84, 0.65)	-0.06	-2.38	(-4.12, -0.64)	-0.12	0.019	.01	-1.09	(-2.83, 0.66)	0.01	0.000	.87
(3) Neg	4.79	(3.09, 6.49)	-0.25	-2.67	(-4.36, -0.98)	-0.14	0.083	<.0001	0.23	(-1.43, 1.88)	0.09	0.000	.79

Values of  $f^2$  and  $p$  for Step 2 reflect effect size and significance for the change in variance explained for Step 2 over and above Step 1. Three separate hierarchical regressions were conducted: (1) the additive model of PLEs and working memory as independent variables predicting SFS Total scores at Step 1, and the interaction of PLEs and working memory predicting SFS Total scores at Step 2 (testing whether the interaction term explains additional variance over and above the additive model); (2) the additive model of disorganized symptoms and working memory as independent variables predicting SFS Total scores at Step 1 and the interaction of disorganized symptoms and working memory predicting SFS total scores at Step 2; and (3) the additive model of negative symptoms and working memory as independent variables predicting SFS total scores at Step 1 and the interaction of negative symptoms and working memory predicting SFS total scores at Step 2.

Abbreviations:  $B$ , unstandardized coefficient;  $\beta$ , standardized coefficient; CI, confidence intervals; Dis, disorganized symptoms; Neg, negative symptoms; PLEs, psychotic-like experiences; WM, working memory.

functioning. With working memory and PLEs in the model simultaneously, working memory was the only independent variable that significantly predicted functioning. Similarly, with working memory and disorganized symptoms both in the model, only working memory was significant. This indicates that these symptoms do not add significant predictive value in functioning over-and-above working memory. In contrast, both working memory and negative symptoms significantly predicted social functioning when included simultaneously.

### Post-hoc analyses

Post-hoc analyses examining associations with TEPS anticipatory and consummatory subscales independently showed similar results

to the combined negative symptom dimension (see Table 4). Anticipatory anhedonia showed small associations with poor social engagement, interpersonal communication, recreation, prosocial, and overall social and role functioning. Consummatory anhedonia showed small associations with poor social engagement, recreation, and overall functioning. Neither TEPS subscale correlated with working memory sensitivity or RT.

Post-hoc analyses examined PLEs, negative, and disorganized symptoms as independent variables simultaneously predicting SFS total score using a single linear regression model (see Table 5). With all symptom dimensions in the model concurrently, negative symptoms was the only independent variable significantly predicting overall functioning, at the level of a small effect size.

## Discussion

Findings from this study suggest that PLEs, negative and disorganized symptoms and poor working memory sensitivity are associated with diminished functioning across a variety of domains. PLEs and disorganized symptoms were inversely associated with social functioning and negative symptoms were inversely associated with both social and role functioning, consistent with previous findings from studies assessing subclinical schizotypy [37,56]. These results are also consistent with findings that poor social and role functioning are associated with CHR status [10] and conversion to psychosis [9].

Symptom dimensions did not moderate cognitive and functional variables, although working memory and attenuated clinical symptoms had additive effects on functioning. Post-hoc analyses suggested that of the attenuated clinical symptom dimensions, negative symptoms was the independent variable most strongly predictive of overall functioning, consistent with previous research [34,36,57]. Additionally, negative symptoms and working memory each contributed unique variance to social and role functioning,

consistent with previous research in a CHR sample [36]. Overall, results from this study suggest that even at an attenuated level, symptoms and cognition are significantly associated with functioning in social interactions and work or community roles.

Associations between symptoms and functioning were small, especially compared to a meta-analysis that found very large effect sizes for functional differences between CHR and healthy control groups [58]. The subtle effects in our study could be attributed to the use of an undergraduate sample, which is expected to have high levels of social, role, and cognitive functioning on average. Further, university life provides structure and accessibility for engagement in social, recreational, and community roles. The small effects in our study may also be partially attributed to our examination of symptoms dimensionally, instead of restricting analyses to clinically relevant symptoms. Nevertheless, average SFS subscale scores from our sample were comparable to those from a previous study assessing social and role functioning in college undergraduates across a range of subclinical schizotypy scores [59].

The current study was correlational; thus, the mechanisms through which negative symptoms and working memory affect social and role functioning are still not well understood. A parsimonious explanation is that there is often overlap in content between measurement of negative symptoms and cognitive, social, and role functioning [60,61]. For example, the Scale for the Assessment of Negative Symptoms (SANS) [62] includes items assessing impaired attention, and the Clinical Assessment Interview for Negative Symptoms (CAINS) [63] includes items assessing motivation and pleasure for social, recreational, and vocational activities. However, some of these concerns are likely mitigated in the current study, given that the TEPS focuses largely on physical anhedonia, which has little overlap with SFS content or cognitive abilities.

An alternative hypothesis is that negative symptoms and working memory impairment may make social, occupational, and recreational activities more difficult, leading to withdrawal when tasks or interactions are perceived as too effortful and not sufficiently rewarding [44,64–66]. Instrumental activities of daily living such as managing food preparation, household chores, and finances are complex tasks that involve keeping goals in mind and remembering details while planning and executing multi-step processes [67]. Not surprisingly, these tasks are associated with executive functions such as working memory [67,68], which require cognitive effort [42]. Social interactions similarly involve a complex set of processes. For example, conversations may involve identifying other people's goals, interests, and beliefs; keeping track of what has been said; and integrating this information while generating ideas to discuss, following social conventions, and inhibiting inappropriate behavior [69,70]. Engagement in social activities taps executive functioning, emotional, and motivational resources [70–72]. Thus, diminished motivation and working memory impairment may

**Table 4.** Post-hoc analyses: Spearman's rank-order correlations using TEPS subscales ( $N=466$ )

	Anticipatory anhedonia	Consummatory anhedonia
SFS social engagement <sup>a</sup>	−0.14**	−0.10*
SFS interpersonal communication <sup>e</sup>	−0.13**	−0.06
SFS independence-performance <sup>b,c</sup>	−0.18**	−0.15**
SFS recreation <sup>a</sup>	−0.12**	−0.16**
SFS prosocial <sup>a</sup>	−0.15**	−0.07
SFS independence-competence <sup>a</sup>	−0.08	−0.06
SFS occupation <sup>a</sup>	−0.07	−0.05
SFS total score <sup>d</sup>	−0.20**	−0.16**
WM $d'$	−0.03	−0.08
WM reaction time	0.001	0.03

Higher TEPS anticipatory and consummatory anhedonia scores indicate more severe negative symptoms. Higher SFS scores indicate better functioning. Higher WM  $d'$  and lower (quicker) WM reaction times indicate better working memory performance.

Abbreviations: SFS, Social Functioning Scale; WM, working memory.

<sup>a</sup> $N=464$ .

<sup>b</sup> $N=462$ .

<sup>c</sup>Gender included as covariate.

<sup>d</sup> $N=463$ .

<sup>e</sup> $N=465$ .

\* $p < .05$ .

\*\* $p < .01$ .

**Table 5.** Post-hoc analyses: linear regression of symptom dimensions as independent variables simultaneously predicting social and role functioning ( $N=463$ )

	$B$	95% CI ( $B$ )	SE ( $B$ )	$\beta$	$f^2$	Total $R^2$	Total $F$
PLEs	0.23	(−0.17, 0.64)	0.21	0.07	0.003	0.06	9.95*
Disorganized symptoms	−0.82	(−2.13, 0.49)	0.67	−0.08	0.003		
Negative symptoms	−0.41	(0.25, 0.56)	0.08	−0.24*	0.06		

A regression was conducted of the three symptom clusters as independent variables jointly predicting SFS total scores.

Abbreviations: CI, confidence intervals; PLEs, psychotic-like experiences; SE, standard error.

\* $p < .01$ .

jointly make it difficult for people at risk for psychosis to be successful in social and role functioning activities.

The current study primarily investigated how cognitive variables relate to functioning. We did not aim to measure motivational variables or affective variables such as the experience and expression of emotions like happiness, sadness, or fear; however, the addition of such variables would be important for future studies to include. Previous findings indicate that affective variables likely play an important role in social functioning (see [69] for review). Further, affective factors may interact with cognitive factors. For example, one study showed that working memory moderated the relationship between self-report of physical anhedonia and intensity of emotional experience to positive stimuli in patients with schizophrenia and non-psychiatric controls. That is, people with better working memory showed stronger negative associations between anhedonia and emotional response to pleasant events [73]. Patients with schizophrenia may engage in fewer goal-directed and pleasurable activities due to decreased motivation associated with abnormalities in reward processing, and accompanying beliefs that they will not enjoy these activities [74,75]. Similar processes may influence the relationship between attenuated negative symptoms and functioning in subclinical groups [76,77]; however, overlapping mechanisms were not investigated in the current study and should be examined in future investigations. In summary, cognitive and affective variables likely both contribute to social and role functioning and may interact to predict functioning. Future studies may benefit from assessing cognition, affect, and functioning simultaneously across a range of impairment in psychosis-spectrum psychopathology.

Unexpectedly, symptom dimensions were not associated with working memory performance in the current study. This contrasts findings from studies in patients with schizophrenia [29], but is consistent with other schizophrenia-spectrum research [33]. Null findings could be attributed to the symptom measures used in the current study; for example, disorganized symptoms were assessed through self-report, whereas many other studies have used semi-structured interviews (e.g., the Structured Interview for Prodromal Symptoms; [78]) or behavior-based measures of natural speech (e.g., the Communication Disturbances Index [79]).

The current study had a number of limitations. The SFS primarily assesses retrospective report of the frequency of social and role activities. Future research on the relationship between cognition and functioning would benefit from using ecological momentary assessment to capture quantity and quality of social, role, and cognitive functioning in the moment [80]. The SFS was originally developed to assess social and role functioning in people with schizophrenia; thus, some of the subscales are not particularly relevant for many college students (e.g., employment/occupation). There are few questionnaires assessing social and role functioning designed with subclinical samples in mind but interview-based measures such as the Global Functioning: Social and Global Functioning: Role interviews [81] would be useful in future studies. Due to the high-functioning nature of the undergraduate sample assessed, SFS scores generally approached ceiling—with the exception of recreation and prosocial subscales—which may have limited our ability to find associations. Nonetheless, this strengthens the impact of the findings that symptoms and cognition were associated with functioning in this college sample. The current study used self-report measures of subclinical symptoms and findings from a meta-analysis suggest that these types of self-reports may be influenced by overestimation [82]. Because participants signed up for the study of their own accord and were not systematically recruited,

self-selection biases cannot be ruled out. Our sample was drawn from a public university with a relatively diverse body of students in terms of socioeconomic and ethnic/racial composition; however, effects may be even stronger in a community sample. Finally, there was a higher proportion of females to males in our study, although results held after controlling for gender.

## Conclusions

Social functioning, cognitive deficits, and negative symptoms are more stable and traditionally more treatment-resistant than other symptoms and sequelae of CHR and schizophrenia [9,83–86]. The current study found that working memory and subclinical symptoms, especially negative symptoms, are associated with social and role functioning in individuals at putative risk for psychosis. Because social functioning and impairment are key variables predicting conversion to psychosis [7], early identification is crucial. Opportunities for psychosocial and cognitive intervention may mitigate functional decline and improve long-term outcomes.

**Financial support.** Funding for this study was provided by Temple University's College of Liberal Arts Research Award, a University Start-Up Fund awarded to Lauren M. Ellman, PhD, and the following grant awarded to Lauren M. Ellman from NIMH: R01MH112613.

**Conflict of Interest.** The authors have no competing interests to declare.

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