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## Associations between momentary mental states and concurrent social functioning after remission from first episode psychosis: A HAMLETT ecological momentary assessment study

Matej Djordjevic<sup>a,\*</sup>, Hannah E. Jongsma<sup>a,b</sup>, Claudia J.P. Simons<sup>c,d</sup>, Priscilla P. Oomen<sup>c,d</sup>, Lieuwe de Haan<sup>e</sup>, Nynke Boonstra<sup>f,g,h</sup>, Martijn Kikkert<sup>i</sup>, Sanne Koops<sup>a</sup>, Chris N.W. Geraets<sup>a</sup>, Marieke J.H. Begemann<sup>a</sup>, HAMLETT-OPHELIA Consortium<sup>1</sup>, Machteld Marcelis<sup>c,d</sup>, Wim Veling<sup>a</sup>

<sup>a</sup> University of Groningen, University Medical Center Groningen, University Center for Psychiatry, Hanzeplein 1, PO Box 30.001, 9700 GZ, Groningen, the Netherlands

<sup>b</sup> Center for Transcultural Psychiatry Veldzicht, Ommerweg 67, Balkbrug, 7707 AT, the Netherlands

<sup>c</sup> Department of Psychiatry and Neuropsychology, School for Mental Health and Neuroscience, Maastricht University, Universiteitssingel 40, 6229 ER, Maastricht, the Netherlands

<sup>d</sup> Institute for Mental Health Care Eindhoven (GGzE), Vestdijk 61, 5611 CA, Eindhoven, the Netherlands

<sup>e</sup> Department of Early Psychosis, Amsterdam University Medical Center, Meibergdreef 5, 1105 AZ, Amsterdam, the Netherlands

<sup>f</sup> NHL/Stenden, University of Applied Sciences, Rengerslaan 8-10, 8917 DD, Leeuwarden, the Netherlands

<sup>g</sup> KieN VIP Mental Health Care Services, Oosterkade 72, 8911 KJ, Leeuwarden, the Netherlands

<sup>h</sup> Department of Psychiatry, UMC Utrecht Brain Center, University Medical Center Utrecht, Heidelberglaan 100, 3584 CX, Utrecht, the Netherlands

<sup>i</sup> Department of Research, Arkin Mental Health Care, Klaprozenweg 111, 1033 NN, Amsterdam, the Netherlands

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## ABSTRACT

**Background:** Symptom severity and social functioning are important outcomes after first episode psychosis (FEP), yet current evidence about associations between them is inconsistent and lacks (subclinical) momentary insights. **Methods:** The current Ecological Momentary Assessment (EMA) study was conducted in 58 people in remission from FEP, as part of the HAMLETT (Handling Antipsychotic Medication: Long-term Evaluation of Targeted Treatment) trial. At baseline, participants were prompted to report momentary mental states and social context 10x/day for eight consecutive days, including psychotic experiences (PEs), motivation/drive and negative affect, that may indicate proxies of (subclinical) psychotic, negative and general affective symptoms, respectively. We employed multilevel mixed-effects regressions to investigate associations between self-reported mental states and concurrent activity or social company and subjective appraisal thereof. We also conducted retrospective clinical assessments of symptoms (PANSS) and social functioning (WHODAS 2.0) and investigated their cross-sectional associations using multivariable linear regression. **Results:** Analyses of 3101 EMA-questionnaires showed that lower motivation/drive was associated with more passive activity and less company (OR = 0.96 [95%CI: 0.96; 0.97], OR = 0.95 [95%CI: 0.93; 0.96], N.B. ORs per 1-point symptom-score change). PEs and negative affect were associated with more proactive activity (OR = 1.02 [95%CI: 1.00; 1.03], OR = 1.02 [95%CI: 1.01; 1.03]). All three mental state domains were associated with lower activity appraisal overall, though activity-specific associations differed. PEs and negative affect were associated with lower company appraisal ( $B = -0.25$  [95%CI:  $-0.36; -0.14$ ],  $B = -0.15$  [95%CI:  $-0.23; -0.06$ ]). When assessed retrospectively, only PANSS general psychopathology was associated with poorer social functioning ( $B = 2.52$  [95%CI: 1.69; 3.34]).

\* Corresponding author. Matej Djordjevic University of Groningen, University Medical Center Groningen, University Center for Psychiatry, Hanzeplein 1, PO Box 30.001, 9700 GZ, Groningen, the Netherlands.

E-mail addresses: [m.djordjevic@umcg.nl](mailto:m.djordjevic@umcg.nl) (M. Djordjevic), [h.e.jongsma@umcg.nl](mailto:h.e.jongsma@umcg.nl) (H.E. Jongsma), [claudia.simons@ggze.nl](mailto:claudia.simons@ggze.nl) (C.J.P. Simons), [c.n.w.geraets@umcg.nl](mailto:c.n.w.geraets@umcg.nl) (C.N.W. Geraets).

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*Conclusion:* Self-reported PEs, momentary motivation/drive and general affective symptoms are associated with daily-life functioning after remission from FEP. Retrospective observer-rated and momentary self-report assessment methods do not measure the same aspects or intensity of psychopathology.

## 1. Introduction

### 1.1. Background

People with psychotic disorders often struggle with navigating daily life. This can include difficulties in interpersonal relationships, occupational or academic demands or household activities (Harvey, 2014; Owen et al., 2016; Velthorst E et al., 2017). It is not entirely clear to what extent these difficulties in social functioning are associated with different symptoms of psychotic disorders. Current evidence indicates that negative symptoms in particular impair a person's ability to function in daily-life (Best et al., 2016; Foussias et al., 2014; Harvey and Strassing, 2012; Ventura et al., 2009), both concurrently (Best et al., 2020; Bourdeau et al., 2012; Cacciotti-Saija et al., 2018; Vesterager et al., 2012) and in the longer-term (de Winter et al., 2022; Ventura et al., 2015). General symptoms such as depressed mood were also found to be associated with poorer functioning (Fulford et al., 2013; García-Portilla et al., 2021). However, findings on associations between positive symptoms and social functioning are inconsistent (Best et al., 2020; Cacciotti-Saija et al., 2018; Fulford et al., 2013; Grau et al., 2016; Stouten et al., 2017; Vesterager et al., 2012). While several studies from early and chronic patient populations indicate that positive symptoms are not associated with social functioning (Best et al., 2020; Cacciotti-Saija et al., 2018; Vesterager et al., 2012), there is also evidence suggesting the opposite (Fulford et al., 2013; Grau et al., 2016; Stouten et al., 2017). Indeed, a systematic review and meta-analysis of 36 studies with data from 4742 people with psychotic disorders suggests that all symptomatic subdomains correlate with social functioning outcomes, challenging the notion that it is mainly negative symptoms impacting functioning (Handest et al., 2023).

The vast majority of previous studies utilized retrospective clinical assessments, which may fail to capture real-world experiences. Since retrospective questionnaires enquire about the previous weeks or months, they usually reflect *average* symptoms or functioning during that period and do not zoom in on specific situations nor capture transient variations in symptoms and functioning. This might be problematic when assessing people who are in recent clinical remission but may still experience difficulties in particular daily-life situations. Furthermore, as has been shown in studies on depressive symptoms (Horwitz et al., 2023; Urban et al., 2018), peak-end and recall bias can limit the accuracy of retrospective self-reports. An adequate method to measure real-time symptoms and social functioning is Ecological Momentary Assessment (EMA) (or the Experience Sampling Method, ESM) (Myin-Germeys et al., 2009). With EMA, people report on momentary mental states such as negative affect and psychotic experiences (PEs), as well as social context and their appraisal thereof repeatedly throughout the day. These mental states may be indicators of (subclinical) symptoms relevant to psychosis. EMA thus enables the investigation of (subclinical) symptoms, social functioning and their interrelations soon after they occur. A study investigating whether symptomatic remission was related to ESM-assessed symptoms and social functioning showed that people in clinical remission from psychosis continued having mild psychotic experiences (PEs) in their daily-life and that increased severity of PEs indeed negatively impacted social functioning (possibly in a dose-response manner) (Oorschot et al., 2012). However, a magnified view on the experience of (subclinical) symptoms and the concurrent situations during which they occur is still lacking since *momentary* associations between symptoms of psychotic disorders and different areas of social functioning were not investigated. Moreover, to this date, there is no similar study focused on the illness phase after clinical remission

from first episode psychosis (FEP).

Therefore, the current study aimed to investigate in-the-moment associations of PEs, motivation/drive and negative affect with different aspects of social functioning, including the appraisal thereof, in people in remission from FEP. In order to compare findings from self-reported EMA with “conventional” observer-rated assessments, we also aimed to investigate cross-sectional associations between baseline symptoms and social functioning as assessed by the Positive And Negative Syndrome Scale (PANSS) (Kay et al., 1987) and the World Health Organization Disability Assessment Schedule 2.0 (WHODAS2.0) (Ustun et al., 2010).

### 1.2. Hypotheses

We hypothesized that 1.) PEs and momentary proxies of negative and general affective symptoms are negatively associated with concurrent daily-life indicators of social functioning, and 2.) retrospectively observer-assessed negative and general symptoms, but not positive symptoms, are associated with lower levels of retrospectively assessed social functioning.

## 2. Methods

### 2.1. Study population

Data for this study were collected between September 2017 and May 2023. We used baseline data collected as part of the ongoing HAMLETT (Handling Antipsychotic Medication: Long-term Evaluation of Targeted Treatment) study (Begemann et al., 2020). HAMLETT is a Dutch multicenter randomized controlled trial evaluating early tapering of antipsychotic medication after remission from FEP. Participants were 16–60 years old, in clinical remission from positive symptoms (i.e., no or mild residual symptoms based on clinical grounds (Andreasen et al., 2005)), had sufficient command of the Dutch language and provided written informed consent. Exclusion criteria were dangerous or harmful behavior and coercive treatment with antipsychotic medication during FEP.

At baseline, subjects were invited to take part in the EMA add-on study. All study procedures were in line with local and international ethical standards, including the Declaration of Helsinki. Ethical approval was issued by the Medical Ethical Committee of University Medical Center Groningen (HAMLETT protocol number: NL 62202.042.17, trial registration EudraCT number: 2017-002406-12).

### 2.2. Measurements

Depending on the participant's preference, baseline assessments took place in one of the study centers or during a home visit. Measurements were administered in Dutch by trained researchers. The EMA baseline assessment included repetitive self-report data collection over eight days.

#### 2.2.1. Sociodemographic and clinical characteristics

Sociodemographic information was collected through the Comprehensive Assessment of Symptoms and History (CASH) (Andreasen et al., 1992). The use and dosage of antipsychotic medication was reported by participants or their treating psychiatrist and taken into account as a potential confounder because it may be associated with symptom severity and social functioning (Tandon et al., 2010). Dosages were converted into olanzapine equivalents according to the 95% Effective

Dose Method (Leucht et al., 2020). Neurocognitive functioning was assessed with the Brief Assessment of Cognition in Schizophrenia (BACS) (Keefe et al., 2004). The BACS composite score was included as a potential confounder based on findings from an earlier HAMLETT study (Oomen et al., 2023).

Next to EMA, we assessed presence and severity of symptoms using PANSS (Kay et al., 1987). This semi-structured interview enquires about positive, negative and general symptoms during the past seven days. Social functioning was assessed with WHODAS 2.0 (Ustun et al., 2010), a self-report tool evaluating daily-life impairments during the past month.

### 2.2.2. EMA of symptoms and social functioning

On ten semi-random moments throughout the day for eight days, participants were prompted to complete a digital self-report questionnaire via their mobile phone. The questionnaire was valid for 20 min and enquired about PEs, current emotions as well as social context and appraisal thereof. Prompts were sent within time-blocks of 1:20h, with time-intervals of at least 30 min. The software environment was provided by RoQua (RoQua.nl). Participants were briefed about the EMA procedure by trained researchers and contacted in case they did not complete at least one questionnaire within the first two days, in order to provide further instructions when needed. They were offered to receive a personal visual summary-report of their EMA measurements and received a €10 voucher for completion of >17 questionnaires. In line with a response-rate cutoff of 1/3 (Myin-Germeys and Kuppens, 2021), we excluded subjects with <27 completed questionnaires. We also excluded questionnaires where subjects took >20 min for completion.

EMA items and their groupings were selected following theoretical consideration of the relevant concepts (i.e., the three main symptom domains of psychotic disorders and aspects of social functioning) and review of existing EMA literature (Bell et al., 2023a; Wright et al., 2021; Kirtley et al., 2024) (Table 1). Regarding the positive symptom domain (PEs), previous EMA research has established that subjects can self-report auditory hallucinations in a direct manner, while delusions are better assessed indirectly (Bell et al., 2023b; Myin-Germeys et al., 2005; Oorschot et al., 2012; van der Steen et al., 2017). For the negative symptom domain, we chose items enquiring about behavioral patterns and emotions (Oorschot et al., 2009) reflecting motivation/drive, which could serve as momentary proxies of the underlying symptoms (similar to the “state-level” assessment in (Bartolomeo et al., 2022)). For instance, lack of initiating social contact as a proxy for asociality and avolition or feelings of listlessness and low enthusiasm as proxies for apathy (Correll and Schooler, 2020). For the general affective symptom domain, we chose items enquiring about emotions associated with depression and anxiety, as established in previous research (Bell et al., 2023a; Myin-Germeys and van Os, 2007; Reininghaus et al., 2016). In order to assess the internal reliability of these item-groupings, we calculated Cronbach’s alpha and McDonald’s omega coefficients (Table 1). Sum scores of each symptom domain were used for the analyses.

Social functioning was subdivided into current activity and social company (Granholtm et al., 2019; Havermans et al., 2007; Leendertse et al., 2018; Oorschot et al., 2012). Both were assessed with categorical items and items enquiring about the subjective appraisal of the current activity or company as rated on visual analogue scales (VAS) of 1–100 (Table 1). In line with previous work where activities were classified based on productivity or goal-directedness (Granholtm et al., 2019; Kasanova et al., 2018), we grouped current activities into proactive versus passive activities.

### 2.3. Statistical analyses

First, we employed descriptive analyses to characterize the study sample. We also ran missing value analyses. Similar to previous research (Granholtm et al., 2019), we performed Pearson’s (bi-serial) correlation

**Table 1**

EMA items assessing the different symptom domains and areas of social functioning.

Construct	EMA-items	
<b>Symptom domains</b> (each item was scored on a VAS of 1–100)		
		<b>Cronbach’s <math>\alpha</math> McDonald’s <math>\omega</math></b>
Psychotic experiences	I feel suspicious.	0.65
	I feel safe. (reversed)	0.67
	I hear things that others cannot hear. I have control over my thoughts. (reversed)	
Low Motivation/ Drive	Since the last measurement, I took initiative to have social contact, e.g., by starting a chat. (reversed)	0.77
	Since the last measurement, I did what I needed or wanted to do. (reversed)	0.78
	I feel listless. I feel slow. I feel enthusiastic. (reversed) I feel energetic. (reversed)	
Negative affect	I feel anxious.	0.89
	I feel irritated.	0.90
	I feel tense. I feel restless.	
	I feel sad.	
<b>Social functioning</b> (VAS of 1–100 for appraisal items)		<b>Cronbach’s <math>\alpha</math> McDonald’s <math>\omega</math></b>
Current Activity (categorical)	<u>Proactive</u> What am I doing right now? Work/study Active leisure activity <sup>b</sup> Activities of Daily Life (ADL) <sup>c</sup> En route/on your way	
	<u>Passive</u> What am I doing right now? Screen-time activity <sup>d</sup> Resting, doing nothing or sleeping	
	Activity Appraisal	This activity takes effort. (reversed) 0.74 I am good at this activity. 0.76
	Social Company (categorical)	<u>Being in the company of a familiar person</u> Who am I with right now? Familiar person <sup>e</sup>
<u>Not being in the company of a familiar person</u> Who am I with right now? Nobody Healthcare provider or stranger <sup>f</sup>		
Company Appraisal		I feel accepted. <sup>a</sup> 0.71 I feel insecure. <sup>a</sup> (reversed) 0.81 I feel connected to this company. <sup>a</sup> I find this company pleasant. <sup>a</sup> Since the last measurement, I would have preferred to be more in the company of others. (reversed)

<sup>a</sup> Conditional branch item. Not applicable when the person indicated to be alone.

<sup>b</sup> One of the following: sports, going for a walk, riding a bike, hobby (e.g., making music, handicraft), day trip (e.g., to the city center, concert), something intimate (e.g., cuddling, sex), talking to someone. The latter only counted as active leisure when respondents were not at the same time at work, school or with their healthcare provider.

<sup>c</sup> One of the following: eating, chores, grocery shopping, administration, self-care (e.g., taking a shower, get dressed, shaving), taking care of someone else (e.g., child or parent).

<sup>d</sup> One of the following: TV, YouTube, internet, playing video games, WhatsApp.

<sup>e</sup> One of the following: my partner, my children, family member that I am living together with, family member that I am not living together with, housemate (non-family), friend or acquaintance, colleague or classmate.

<sup>f</sup> In case respondents were with a stranger while at the same time being with a familiar person, this would count as being with a familiar person (see also (Fett et al., 2022)).

analyses between PANSS/WHODAS2.0 and the respective EMA-measures.

### 2.3.1. Associations between momentary mental states and concurrent social functioning

Multilevel mixed-effects regressions were used to investigate average cross-sectional associations between PEs, momentary motivation/drive or negative affect and concurrent social functioning. Sum scores of each symptom domain were the independent variables in each model, thereby controlling for covariance between them. The following multilevel mixed-effects models were constructed:

- 1.) Logistic regression with engagement in proactive current activity as dichotomous outcome.
- 2.) Logistic regression with being in social company as dichotomous outcome.
- 3.) Linear regression with activity appraisal *overall* as dependent variable.
- 4.) Linear regressions with appraisal *per activity* and *per company* (i. e., being in company or alone), respectively, as dependent variables.

All models were adjusted for age, gender, antipsychotic medication dosage and neurocognition (BACS). We calculated Intraclass Correlation Coefficients (ICCs) for each multilevel model to assess the degree of inter-individual variation. We also controlled for multiple hypotheses testing using the Benjamini Hochberg procedure with a False Discovery Rate (FDR) of 10% (Benjamini and Hochberg, 2018). Scores were not participant mean-centered in order to capture overall associations entailing both within- and between-person effects.

### 2.3.2. Associations between retrospectively assessed symptoms and social functioning

Multivariable linear regression analyses were conducted to investigate cross-sectional associations between positive, negative and general symptoms in the past week (PANSS) and social functioning in the past month (WHODAS2.0). Again, we corrected for age, gender, antipsychotic medication dosage and neurocognition (BACS).

For all analyses, we used Stata Statistical Software: Release 17 (StataCorp, 2021).

## 3. Results

### 3.1. Sample characteristics

In total, 85 out of 444 HAMLETT-participants took part in the EMA add-on study. Fifty-eight (68%) of those participants completed >26 questionnaires and thus met our inclusion criteria, yielding a total of 3101 questionnaires for analysis.

The majority of our sample was male (N = 36, 62%), born in The Netherlands (N = 52, 90%), living with their partner/family (N = 42, 72%) and currently studying (N = 18, 31%) or in paid employment (N = 28, 48%) (Table 2). Baseline symptom severity in the past week (PANSS) was relatively low, especially in the positive subdomain (Mean (M) = 8.76, Standard Deviation (SD) = 2.50; Table 2). The average WHODAS2.0 summary score (M = 51.69, SD = 16.03, Table 2) indicated that people in our sample experienced more difficulty with social functioning in the past month than around 95% of the general population (Ustun et al., 2010). Our EMA data indicate that participants spent around the same amount of time in company versus alone (47.6% versus 49.8%) and slightly more time in proactive versus passive activity (56.2% versus 40.8%, Fig. 1). Note that these numbers do not add up to 100% because we excluded instances when participants were with their healthcare provider or when they indicated to be doing “something else”. Details on the EMA mental state score distribution can be found in Supplementary Table S1.

**Table 2**  
Sociodemographic and clinical sample characteristics (N = 58).

Characteristic	Measure
<i>Median (Inter Quartile Range)</i>	
Age in years	25 (22–32)
<i>Frequency (percentage)</i>	
<b>Gender</b>	
Male	36 (62.1)
Female	22 (37.9)
<b>Migrant status</b>	
Born in The Netherlands	52 (89.7)
Not born in The Netherlands	6 (10.3)
Both parents born in The Netherlands	44 (75.9)
At least one parent not born in The Netherlands	14 (24.1)
<b>Living situation</b>	
Alone	8 (13.8)
With partner or family (incl. children)	42 (72.4)
With friend or housemates	6 (10.3)
With fellow patients	2 (3.5)
<b>Education</b>	
Elementary, middle or high school	10 (17.2)
Practically oriented formal education (e.g., professional training to become a carpenter)	17 (29.3)
Theoretically oriented formal education (e.g., university)	31 (53.5)
<b>Occupation</b>	
Paid work	28 (48.3)
Student	18 (31.0)
Unemployed or on long-term sick leave	12 (20.7)
<b>Substance use during the last month<sup>a</sup></b>	
Alcohol <sup>b</sup>	37 (66.1)
Cannabis	9 (16.1)
Other	4 (7.1)
<i>Mean (Standard Deviation)</i>	
Antipsychotic medication dosage in mg/d of olanzapine	9.01 (5.36)
Neurocognitive status (BACS Z-score) <sup>a</sup>	−0.10 (1.17)
<b>Symptom severity (PANSS)</b>	
Positive subdomain	8.76 (2.50)
Negative subdomain	11.52 (3.99)
General subdomain	21.81 (4.90)
<b>Social functioning (WHODAS 2.0)</b>	
	51.69 (16.03)

<sup>a</sup> For substance use, there were N = 2 (3.4%) missing values. For BACS, there were N = 7 (12.1%) missing values.

<sup>b</sup> Note that there was one participant with a history of alcohol use disorder who had, however, not used any alcohol during the past month.

A dropout-analysis (Supplementary Table S2) comparing our final sample with EMA-participants who completed <27 questionnaires (N = 27, 32%) showed that our sample included more theoretically educated people ( $X^2 = 8.02$ ,  $p = 0.005$ ) and those with paid work ( $X^2 = 6.86$ ,  $p = 0.009$ ), albeit no differences were found in symptom severity (PANSS) or social functioning (WHODAS2.0). The average response-rate was similar throughout the day and lower at night (66.2% between 6 and 13h, 69.8% between 13 and 18h, 66.8% between 18 and 24h, 41.0% between 0 and 6h).

Missing value analyses indicated that only BACS had >5% cases with incomplete data (N = 7, Missing At Random). These were handled with Multivariate Imputation using Chained Equations (MICE) of Predictive Mean Matching (PMM) with the donor number set at  $d = 5$ . For the multilevel analyses, we used the average subject-specific BACS Z-scores from 10 imputed datasets.

### 3.2. Correlations between retrospective clinical assessments and EMA

Correlations between baseline PANSS/WHODAS2.0 scores and the respective EMA-items were generally low ( $r_s < 0.5$ ) (Hinkle et al., 2003) but statistically significant, except for engagement in proactive social activity (Supplementary Table S3).



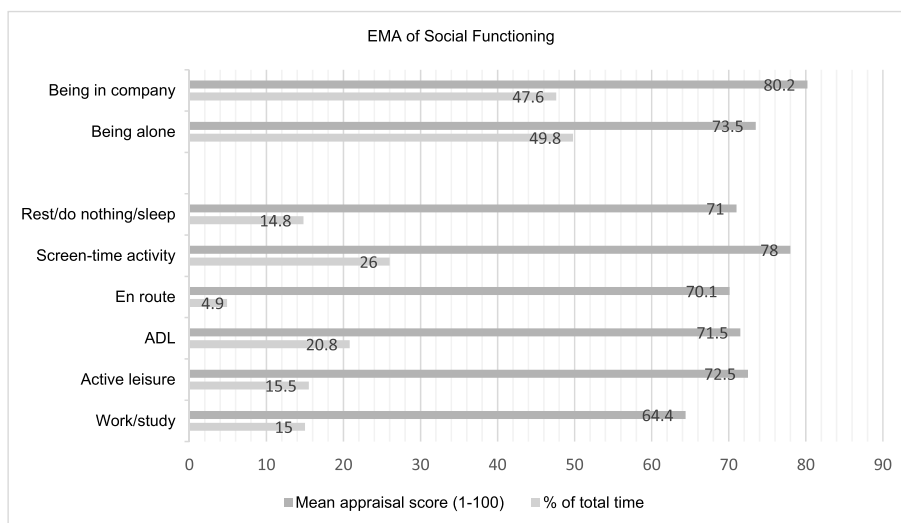


Fig. 1. Percentage of total time spent per activity and company and appraisal thereof  
EMA = Ecological Momentary Assessment, ADL = Activities of Daily Living

Note that these numbers do not add up to 100% because we excluded instances when participants were with their healthcare provider or when they indicated to be doing “something else”.

### 3.3. Associations between momentary symptoms and concurrent social functioning

Covariate-adjusted multilevel mixed-effects logistic regressions (Table 3) showed that a decrease in momentary indicators of motivation/drive was associated with less engagement in proactive current activity (Odds Ratio (OR) = 0.96 [95% Confidence Interval (CI): 0.96; 0.97]) and being in social company (OR = 0.95 [95% CI: 0.93; 0.96]). An increase in PEs (OR = 1.02 [95% CI: 1.00; 1.03]) and negative affect (OR = 1.02 [95% CI: 1.01; 1.03]) was associated with higher odds of being engaged in proactive current activity but not with social company.

Covariate-adjusted multilevel mixed-effects linear regressions (Table 3) showed that PEs (Beta coefficient (B) = -0.26 [95% CI: -0.35; -0.16]), low motivation/drive (B = -0.24 [95% CI: -0.30; -0.18]) and negative affect (B = -0.16 [95% CI: -0.24; -0.08]) were associated with

lower concurrent activity appraisal overall, though negative affect was not associated with activity appraisal when analyzed separately for each activity. Momentary indicators of motivation/drive were associated with the concurrent appraisal of each activity. PEs were associated with the appraisal of all activities except for work/study. PEs (B = -0.25 [95% CI: -0.36; -0.14]) and negative affect (B = -0.15 [95% CI: -0.23; -0.06]) were associated with worse concurrent company appraisal. Increased negative affect was also associated with worse appraisal of the absence of social company, i.e., being alone (B = -0.17 [95% CI: -0.31; -0.02]). There were no associations between momentary motivation/drive and concurrent appraisal of (the absence of) company.

For each multilevel model, ICCs were statistically significant at  $\alpha = 0.05$  and ranged from 0.1 to 0.7 (Table 3). All results remained statistically significant after correcting for multiple hypotheses testing (FDR-adjusted significance level  $\alpha = 0.11$ ).

Table 3

Multilevel regression analyses of associations between momentary mental states and concurrent social functioning indicators<sup>a</sup>.

Multilevel mixed-effects logistic regression of associations between psychotic experiences (PEs), low motivation/drive and negative affect and concurrent engagement in proactive current activity or social company							
	PEs		Low motivation/drive		Negative affect		ICC
	OR	95% CI	OR	95% CI	OR	95% CI	
Proactive current activity	1.02	<b>[1.00; 1.03]</b>	0.96	<b>[0.96; 0.97]</b>	1.02	<b>[1.01; 1.03]</b>	<b>0.1</b>
Being in company	1.00	[0.98; 1.01]	0.95	<b>[0.93; 0.96]</b>	1.01	[0.99; 1.02]	<b>0.2</b>
Multilevel mixed-effects linear regression analyses of momentary associations between psychotic experiences, low motivation/drive and negative affect and concurrent appraisal of social activity and company							
	PEs		Low motivation/drive		Negative affect		ICC
	B	95% CI	B	95% CI	B	95% CI	
<b>Activity Appraisal</b>							
Overall	-0.26	<b>[-0.35; -0.16]</b>	-0.24	<b>[-0.30; -0.18]</b>	-0.16	<b>[-0.24; -0.08]</b>	<b>0.3</b>
Work/study	-0.08	[-0.22; 0.07]	-0.49	<b>[-0.61; -0.38]</b>	-0.01	[-0.14; 0.12]	<b>0.7</b>
Active leisure	-0.31	<b>[-0.47; -0.15]</b>	-0.48	<b>[-0.58; -0.37]</b>	-0.11	[-0.26; 0.05]	<b>0.2</b>
Screen-time activity	-0.30	<b>[-0.42; -0.19]</b>	-0.24	<b>[-0.31; -0.16]</b>	-0.10	[-0.20; 0.02]	<b>0.3</b>
Rest, do nothing, sleep	-0.41	<b>[-0.57; -0.26]</b>	-0.12	<b>[-0.21; -0.02]</b>	-0.09	[-0.20; 0.02]	<b>0.4</b>
ADL	-0.17	<b>[-0.34; -0.01]</b>	-0.27	<b>[-0.36; -0.18]</b>	-0.12	[-0.24; 0.00]	<b>0.4</b>
En route/on your way	-0.32	<b>[-0.55; -0.09]</b>	-0.39	<b>[-0.55; -0.24]</b>	-0.02	[-0.24; 0.20]	<b>0.6</b>
<b>Company Appraisal</b>							
Alone	-0.12	[-0.41; 0.17]	0.09	[-0.05; 0.23]	-0.17	<b>[-0.31; -0.02]</b>	<b>0.7</b>
With familiar person	-0.25	<b>[-0.36; -0.14]</b>	-0.03	[-0.10; 0.03]	-0.15	<b>[-0.23; -0.06]</b>	<b>0.5</b>

ADL = Activities of Daily Living.

<sup>a</sup> All analyses were adjusted for age, gender, antipsychotic medication dosage and neurocognition (BACS). Bold font indicates a statistically significant result at  $\alpha = 0.05$ . All results retained significance after correction for multiple hypotheses testing (10% FDR-adjusted significance level  $\alpha = 0.11$ ).

**Table 4**

Cross-sectional associations between baseline symptom severity in the past week (PANSS) and social functioning in the past month (WHODAS2.0).

	Multivariable linear regression analyses of associations between retrospectively assessed symptoms (PANSS) and social functioning (WHODAS 2.0) <sup>a</sup>					
	PANSS positive		PANSS negative		PANSS general	
	B	95% CI	B	95% CI	B	95% CI
WHODAS 2.0	-0.26	[-1.96; 1.44]	-0.47	[-1.57; 0.64]	2.52	<b>[1.69; 3.34]</b>

<sup>a</sup> All analyses were adjusted for age, gender, antipsychotic medication dosage and neurocognition (BACS). Bold font indicates a statistically significant result at  $\alpha = 0.05$ .

### 3.4. Associations between retrospectively assessed symptoms (PANSS) and social functioning (WHODAS2.0)

Covariate-adjusted multivariable linear regression analysis (Table 4) showed that increased general symptom severity (PANSS) was associated with poorer social functioning (WHODAS2.0) ( $B = 2.52$  [95% CI: 1.69; 3.34]). Positive and negative symptoms (PANSS) were not associated with social functioning in the past month (WHODAS2.0).

## 4. Discussion

In the current study, we investigated associations between self-reported PEs, motivation/drive and negative affect and daily-life social functioning in 58 people after remission from FEP. Our first hypothesis was confirmed: All of these momentary mental states were associated with concurrent activity or company and appraisal thereof when estimated using EMA, albeit to varying degrees. Our second hypothesis was partially supported, as only PANSS-assessed general symptoms were significantly associated with poorer functioning.

### 4.1. Psychotic experiences and social functioning

Participants had more PEs when they were engaged in proactive concurrent activity, and higher PE intensity was associated with worse overall activity appraisal. The direction of these associations as well as the clinical relevance of their effect sizes are not clear. To put them into perspective: an increase of 30 points on the PE scale was associated with a 60% increased likelihood of being engaged in proactive concurrent activity. The ICC in this model was 0.1, indicating relatively small between-person variation. These numbers suggest that PEs can be a determining factor in social activity, though variation in social activity is largely explained by other factors as well. Our findings might also suggest that proactive daily-life activity harbors more potential to be perceived as stressful than passive activity, as this would be in line with literature on stress-reactivity in psychosis, wherein unpleasant or stressful daily-life situations are reasoned to trigger subsequent symptoms (Myin-Germeys and van Os, 2007; Reininghaus et al., 2016). One previous study showed that daily-life stressful situations indeed preceded PEs by 90 min in people with early psychosis (Vaessen et al., 2019). Interestingly, we identified divergent associations between momentary experiences of the three symptom domains and various activities, implying that the dynamics between specific daily-life situations and PEs or other momentary (subclinical) symptoms can vary. For instance, PEs were associated with worse appraisal of each activity, except for work/study (NB: ICC = 0.7, indicating relatively large between-person variation). One explanation might be that people have fewer PEs when distracted by work tasks. This could also be a factor explaining the mixed findings on associations between positive symptoms and functioning in previous research (Best et al., 2020; Cacciotti-Saija et al., 2018; de Winter et al., 2022; Fulford et al., 2013; Grau et al., 2016; Stouten et al., 2017; Vesterager et al., 2012), since occupational outcomes are not uniformly assessed across studies. With

respect to social company, our analyses show that PEs were associated with worse company appraisal, indicating that PEs could interfere with social interactions, e.g., during a conversation. It is also possible that the impact or character of daily-life stress differs depending on whether the stress is related to social interaction or work/study. While such micro-level daily-life difficulties likely shape social functioning in a broader sense, those associations might have been missed in earlier studies (Best et al., 2020; Cacciotti-Saija et al., 2018; Vesterager et al., 2012). It is relevant to note that scores of PEs may have been dominated by changes in paranoia levels as half of the item-grouping related to feelings of suspiciousness/safety.

### 4.2. Momentary motivation/drive and social functioning

Our findings on associations between momentary indicators of motivation/drive and concurrent activity substantiate the current evidence indicating that negative symptoms play a central role in social functioning (Best et al., 2016, 2020; Bourdeau et al., 2012; Cacciotti-Saija et al., 2018; de Winter et al., 2022; Foussias et al., 2014; Harvey and Strassing, 2012; Ventura et al., 2009, 2015; Vesterager et al., 2012). On average, participants were around two times more likely to be in social company at moments when they reported highest levels of motivation/drive compared with moments of low motivation/drive (NB: mean within-person range was 38.2 points). The fact that our findings correspond to studies using retrospective assessments of negative symptoms (Best et al., 2016, 2020; Bourdeau et al., 2012; Cacciotti-Saija et al., 2018; de Winter et al., 2022; Foussias et al., 2014; Harvey and Strassing, 2012; Ventura et al., 2009, 2015; Vesterager et al., 2012) suggests that negative symptoms might have a momentary as well as sustained impact on social functioning. This could be explained by smaller variations in negative symptom severity, e.g., as compared with positive symptoms, and aligns with the conceptualization of negative symptoms as phenomena manifesting over an extended period. The consistent associations between negative symptoms and functioning could also reflect their overlapping conceptualizations. That is, next to manifestations such as apathy, this symptom domain entails social withdrawal and avolition (Correll and Schooler, 2020), which are quasi per definition associated with poor functioning. However, behavioral and affective aspects appear to be closely linked. Our analyses show that self-reported low motivation/drive, including feelings of listlessness and low enthusiasm, were associated with worse appraisal irrespective of activity type. This suggests that negative symptoms might hamper “subjective” functioning even at moments when an individual is “objectively” functioning well, e.g., when working or meeting a friend (note that effect-sizes were highest during these activities).

In contrast to the findings for concurrent activity, momentary motivation/drive was neither associated with appraisal of social company nor the desire to be in company when being alone. This conflicts with a previous study (Culbreth et al., 2021) wherein retrospectively assessed self-reported, but not clinician-rated, negative symptoms were associated with greater daily-life loneliness. Nevertheless, participants in our study were more likely to be alone at moments when they

experienced lower motivation/drive. Taken together, momentary levels of motivation/drive thus appeared to have no association with subjective experience of social interactions nor of its absence but may determine whether someone seeks out company. While the latter result was expected in that it reflects social withdrawal, the former indicates that motivation/drive might not be associated with (social-)stress-reactivity to the same extent as PEs or negative affect are (Edwards et al., 2018; Reininghaus et al., 2016). In order to capture the complete picture of negative symptoms in daily-life situations after FEP, we need further research into (subclinical) symptoms that were not covered in the current investigation, e.g., *alolia* or diminished affective expression.

#### 4.3. Momentary negative affect and social functioning

Similar to our findings on PEs, the identified associations between momentary negative affect and concurrent activity align with literature on stress-reactivity mentioned above (Myin-Germeys and van Os, 2007; Reininghaus et al., 2016; Vaessen et al., 2019) yet seem to be context-independent in our sample. That is, negative affect was associated with poorly appraised concurrent activity *overall* but not with any specific activity. Likewise, participants had a worse subjective experience of their company as well as a greater desire to be in company while being alone at moments of increased negative affect. This replicates findings from previous studies in people with schizophrenia (Culbreth et al., 2021; Granholm et al., 2013) and underscores the need to address symptoms of depression or anxiety as well as social needs in people recovering from FEP.

#### 4.4. Comparison with retrospective clinical assessments (PANSS/WHODAS2.0)

A systematic review of 49 studies using retrospective and momentary assessments of symptoms and functioning in psychosis found EMA to be consistently related with clinic-based retrospective measures (Wright et al., 2021). Akin to our findings (Supplementary Table S3), correlations and associations between PANSS and EMA were statistically significant but generally small in effect-size (Wright et al., 2021). Overall, the evidence thus indicates that EMA measures concepts that are likely related to the constructs measured through conventional retrospective clinical assessments but does not capture the full breadth of the underlying psychopathology. Indeed, our analyses yielded different results concerning associations between (subclinical) symptoms and functioning when assessed with PANSS/WHODAS2.0 versus EMA. Only general symptoms as assessed by PANSS were associated with social functioning as assessed by WHODAS2.0. This only partly corresponds to earlier findings (Best et al., 2020; Bourdeau et al., 2012; Cacciotti-Saija et al., 2018; Foussias et al., 2014; Fulford et al., 2013; García-Portilla et al., 2021; Harvey and Strassing, 2012; Ventura et al., 2009; Vesterager et al., 2012) but might be explained by comparatively weak statistical power in these analyses ( $N = 58$  PANSS/WHODAS2.0 scores versus  $N = 3101$  EMA datapoints). It may also be related to a potential floor effect as, in contrast to previous study populations, each HAMLETT participant was in clinical remission from positive symptoms. This might also explain why we found different results using EMA, since momentary experiences of (subclinical) symptoms may be too subtle to be captured by retrospective assessments. Overall, our study informs clinicians and researchers that there can be considerable qualitative differences between data collected through EMA versus retrospective clinical assessments.

#### 4.5. Strengths and limitations

This is the first study to zoom in on associations between momentary mental states that may be indicative of subclinical symptoms after clinical remission from FEP and multiple concurrent indicators of social functioning, including people's subjective appraisals. The abundant

datapoints originate from various situations and were relatively equally distributed throughout the day, indicating valid daily-life representation. In addition to EMA, we included widely used retrospective questionnaires, thereby providing an illustrative comparison and, to some extent, reciprocal validation of both assessment methods. Another strength is that, in contrast to previous EMA-studies, we corrected for antipsychotic medication dosage and neurocognitive functioning, two factors that can be associated with (self-reported) symptoms and social functioning (Oomen et al., 2023; Tandon et al., 2010).

There are also limitations to this study. First, recruitment for the EMA add-on study took place until a pre-determined sample size was reached and included a temporary recruitment-pause due to COVID-19. Therefore, not every participant has been invited to take part in the EMA add-on study. Since our sample comprises only around 1/5 of all HAMLETT-participants, the results may not be entirely representative of the total sample, as EMA participants had slightly lower average scores on the PANSS general symptom domain than the remaining study sample. A second limitation is that conclusions about the direction of associations cannot be drawn. In order to answer our research question, it is most appropriate to simultaneously investigate mental states and the daily-life situations during which they occur, albeit questions related to temporal aspects in (subclinical) symptom experience and social functioning remain subject to future research. Another limitation of this study is that the share of subjects with a response-rate of  $>1/3$  is lower than in similar research (Reininghaus et al., 2016), though the overall response-rate in the final sample is not (Vaessen et al., 2019). Based on the dropout-analysis (Supplementary Table S2), our results should be interpreted in light of a potential bias towards theoretically educated people and those with paid employment. However, there were no differences in terms of baseline symptoms and functioning, which suggests there are no bias in the variables of interest. It should also be noted that, despite our EMA questionnaire being similar to the ones used in previous research (Bell et al., 2023a), we may have missed associations of (subclinical) symptoms that were not assessed in the current study, e.g., visual hallucinations or *alolia*. Furthermore, this study needs replication in more diverse patient populations, e.g., with respect to initial treatment response. Lastly, some limitations inherent to EMA should be acknowledged. Since current EMA protocols rely on repeated completion of the same questionnaire, we cannot exclude potential bias related to fatigue or habituation effects. Moreover, despite pre-assessment briefing sessions, the interpretation of questionnaire items might differ between persons as well as time points. As the EMA questionnaire is a fully structured form of assessment, our study can only attempt to approximate the participants' first-person experience (Nordgaard et al., 2013).

## 5. Conclusion

Our findings indicate that impaired social functioning after FEP may be explained by the interactions between momentary experiences of subclinical psychotic or general affective symptoms and the concurrent engagement in daily-life activity, in addition to withdrawal from those activities associated with low levels of motivation/drive. With respect to social company, our study suggests that motivation/drive is associated with the quantity of social company, while PEs and negative affect are primarily associated with its quality. The results might also indicate that pleasant social interactions in daily-life can decrease PEs and negative affect. Finally, when assessed with PANSS/WHODAS2.0, only general symptoms were associated with poorer social functioning. The discrepant results as well as low correlations between EMA and PANSS/WHODAS2.0 suggest that retrospective observer-rated and momentary self-report assessment methods may not measure the same aspects or intensity of psychopathology. Future research will benefit from including both measures to ensure multifaceted assessment and, in turn, more comprehensive evidence.

## CRedit authorship contribution statement

**Matej Djordjevic:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Hannah E. Jongma:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Claudia J.P. Simons:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Priscilla P. Oomen:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Lieuwe de Haan:** Writing – review & editing, Resources, Project administration, Methodology, Conceptualization. **Nynke Boonstra:** Writing – review & editing, Resources, Project administration, Methodology, Conceptualization. **Martijn Kikkert:** Writing – review & editing, Resources, Project administration, Methodology, Conceptualization. **Sanne Koops:** Writing – review & editing, Resources, Project administration, Methodology, Investigation, Conceptualization. **Chris N.W. Geraets:** Writing – review & editing, Project administration, Methodology, Investigation, Conceptualization. **Marieke J.H. Begemann:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Machteld Marcelis:** Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Conceptualization. **Wim Veling:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Conceptualization.

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<sup>1</sup>Department of Psychiatry, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands; <sup>2</sup>Department of Early Psychosis, Amsterdam UMC, Academic Medical Center, Amsterdam, The Netherlands; <sup>3</sup>Department of Psychiatry, UMC Utrecht Brain Center, University Medical Center Utrecht, Utrecht, The Netherlands; <sup>4</sup>Department of Psychiatry and Neuropsychology, School for Mental Health and Neuroscience (MHeNs), Maastricht University Medical Centre, Maastricht, The Netherlands; <sup>5</sup>King's College London, King's Health Partners Department of Psychosis Studies; Institute of Psychiatry, Psychology & Neuroscience, London, United Kingdom; <sup>6</sup>Department of Epidemiology and Biostatistics, Amsterdam Public Health Research Institute, Amsterdam University Medical Centers, location VUmc, Amsterdam, The Netherlands; <sup>7</sup>Department of Clinical, Neuro and Developmental Psychology, Amsterdam Public Health Research Institute, Vrije Universiteit, Amsterdam, The Netherlands; <sup>8</sup>Centre of Economic Evaluation & Machine Learning, Trimbos Institute (Netherlands Institute of Mental Health), Utrecht, The Netherlands; <sup>9</sup>Institute for Mental Health Care Eindhoven (GGZE), Eindhoven, The Netherlands; <sup>10</sup>Department of Research, Arkin Mental Health Care, Amsterdam, The Netherlands; <sup>11</sup>Antes Center for Mental Health Care, Rotterdam, The Netherlands; <sup>12</sup>Department of Neuroscience, Erasmus MC, Rotterdam, The Netherlands; <sup>13</sup>NHL Stenden, University of Applied Sciences, Leeuwarden, The Netherlands; <sup>14</sup>KieN VIP Mental Health Care Services, Leeuwarden, The Netherlands; <sup>15</sup>Department of Psychiatry, Yale University School of Medicine, New Haven, Connecticut; <sup>16</sup>Douglas Mental Health University Center, McGill University, Montréal, Canada; <sup>17</sup>Mondriaan Mental Health Care, Heerlen, The Netherlands; <sup>18</sup>Dimence Institute for Mental Health, Deventer, Zwolle, The Netherlands; <sup>19</sup>Early Intervention Team, GGZ Centraal, Amersfoort, The Netherlands; <sup>20</sup>Yulius, Mental Health Institute, Dordrecht, The Netherlands; <sup>21</sup>Reinier van Arkel Institute for Mental Health Care, 's Hertogenbosch, The Netherlands; <sup>22</sup>Tranzo, TSB, Tilburg University, Tilburg, The Netherlands; <sup>23</sup>Lentis Research, Lentis Psychiatric Institute, Groningen, The Netherlands; <sup>24</sup>Center for Youth with Psychosis, Mediant ABC Twente, Enschede, The Netherlands; <sup>25</sup>Department of Psychotic Disorders, GGZ-Drenthe, Assen, The Netherlands; <sup>26</sup>Department of clinical and developmental neuropsychology, faculty BSS, University of Groningen, Groningen, The Netherlands; <sup>27</sup>Department ABC Early Psychosis, Altrecht Psychiatric Institute, Utrecht, The Netherlands; <sup>28</sup>GGZ Delfland, Delfland Institute for Mental Health Care, Delft, The Netherlands; <sup>29</sup>Community Mental Health, Mental Health Service Noord-Holland Noord, Alkmaar, The Netherlands; <sup>30</sup>Early Intervention Psychosis Team, GGZ inGeest Specialized Mental Health Care, Hoofddorp, The Netherlands; <sup>31</sup>Parnassia Psychiatric Institute, The Hague, The Netherlands; <sup>32</sup>GGZ Breburg, Tilburg, The Netherlands; <sup>32</sup>Program for Psychosis & Severe Mental Illness, Pro Persona Mental Health, Wolfheze, The Netherlands; <sup>33</sup>Janssen-Cilag B.V., Breda, The Netherlands.



## Appendix A. Supplementary data

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