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Mapping psychotic-like experiences: Results from an online survey

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Suggestions have been made that psychotic-like experiences (PLEs), such as hallucinatory and delusional experiences, exist on a continuum from healthy individuals to patients with a diagnosis of schizophrenia. We used the screening questions of the Questionnaire for Psychotic Experiences (QPE), an interview that captures the presence and phenomenology of various psychotic experiences separately, to assess PLEs in Norway. Based on data from an online survey in a sample of more than 1,400 participants, we demonstrated that the QPE screening questions show satisfactory psychometric properties. Participants with mental disorders reported more frequent lifetime and current hallucinatory experiences than participants without mental disorders. Childhood experiences were rather low and ranged from 0.7% to 5.2%. We further replicated findings that young age, illegal drug use, lower level of education, and having parents with a mental disorder are associated with higher endorsement rates of PLEs. Finally, a binomial regression revealed that the mere presence of PLEs does not discriminate between individuals with and without a mental disorder. Taken together, the findings of the present study support existing models that both hallucinations and delusions exist on a structural and phenomenological continuum. Moreover, we demonstrated that the QPE screening questions can be used by themselves as a complementary tool to the full QPE interview.

Key words: Delusions, Hallucinations, Predictors, Psychosis, Questionnaire for Psychotic Experiences, Transdiagnostic.

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INTRODUCTION

Hallucinatory and delusional experiences occur not only in psychotic disorders, such as schizophrenia (Aleman & Larøi, 2008; Andreasen & Olsen, 1982; Hugdahl & Sommer, 2018; Waters, Badcock, Michie & Maybery, 2006), where they have the status of first-rank positive symptoms (American Psychiatric Association, 2013), but they also occur in other disorders including, mood disorders, Alzheimer disease, migraine, hearing loss or borderline personality disorder (Baryshnikov, Suvisaari, Aaltonen *et al*., 2018; Linszen, Brouwer, Heringa & Sommer, 2016; Linszen, Lemstra, Dauwan, Brouwer, Scheltens, & Sommer, 2018; Merrett, Rossell & Castle, 2016; Vreeburg, Leijten & Sommer, 2016). In addition, *psychotic-like experiences* (PLEs) are defined as being hallucinations and/or delusions (Linscott & van Os, 2013), that do not fulfill diagnostic criteria for a mental disorder and are known to be present in the general population (Kelleher & Cannon, 2011). There are many other terms for not (yet) clinically relevant psychotic experiences in the scientific literature, for instance, "unusual experiences", "subthreshold psychotic experiences", "putative pre-psychotic states", "subclinical psychotic experiences", "sub-psychotic experiences" or "putative prodromal states" (e.g. Bourgin, Tebeka, Mallet, Mazer, Dubertret & Le Strat, 2019; Cella, Vellante & Preti, 2012; Jolley, Kuipers, Stewart, Browning, Bracegirdle Basit & Banerjea, 2018; Koyanagi, Stickley & Haro, 2016; Liu *et al*., 2013; Wigman *et al*., 2011). In this study, we prefer the term "psychotic-like experiences"/"PLEs," because it is used by most studies in the field and aims to reduce the stigma that is connected to psychotic episodes (Daalman, Diederen, Hoekema, van Lutterveld & Sommer, 2016; Kingdon, Vincent, Vincent, Kinoshita & Turkington, 2008; Sommer, Daalman, Rietkerk *et al*., 2010).

Crucially, the term PLEs reflects the essence of the continuum hypothesis, which posits that PLEs increase in symptom severity and persistence from healthy individuals to patients with a diagnosis of schizophrenia (Baumeister, Sedgwick, Howes & Peters, 2017; Linscott & van Os, 2013). It is not only valid for PLEs in general, but also for delusional (Freeman, 2006; Varghese, Scott & McGrath, 2008) and hallucinatory experiences (Aleman & Larøi, 2008; Badcock & Hugdahl, 2012) separately. The hypothesis can be understood in different ways: (1) *structural continuity* relates to the distribution of PLEs in the general population; (2) *phenomenological continuity* describes the idea that PLEs are independent of disorder and only differ quantitatively from dispositional or personality variables captured by the notion of psychosis-proneness or schizotypia (Daalman *et al*., 2011); and (3) *temporal continuity* refers to the idea that PLEs persist over time (Linscott & van Os, 2013).

Looking at both hallucinatory and delusional experiences together, a meta-analysis found a median lifetime prevalence for PLEs of 7.2% in the general population, ranging from 1.2% to 25.5% (Linscott & van Os, 2013). Newer studies support these findings. While a study by Pignon and colleagues (2018b) found

a prevalence rate of 22.5% of PLEs in the French general population, another recent study reports a similar rate of PLEs in a representative sample of non-institutionalized US citizens: more than 26% experienced at least one type of PLE (Bourgin *et al*., 2019).

However, hallucinatory and delusional experiences seem to have different prevalence rates in the general population. The frequency of hallucinatory experiences, for example, is modality specific. While a recent meta-analysis (Maijer, Begemann, Palmen, Leucht & Sommer, 2018) reported a general lifetime prevalence of 9.6% for auditory hallucinatory experiences, the prevalence was 7.3% for visual hallucinatory experiences in adults (Waters *et al*., 2014). The latter study was not a meta-analysis. Of specific interest is the study by Kråkvik *et al*. (2015) who found a prevalence for auditory verbal hallucinations of 7.3% hallucinatory experiences in the Norwegian population. Other modalities have been studied less frequently. Ohayon (2000) reported a frequency of 2.6% tactile (haptic) hallucinations and 1.5% for olfactory hallucinations (Ohayon, 2000). For delusional experiences, a recent review reported a high variability of endorsement for overall delusional experiences, ranging from 3% to 91% (Heilskov, Urfer-Parnas & Nordgaard, 2019).

PLEs have been associated with more general medical conditions in adults, such as asthma or chronic pain (Scott *et al*., 2018), as well as several sociodemographic predictors. Being female, young age, unemployment, secondary educational level, low family income, use of alcohol and recreational drugs, stressful and traumatic events, higher level of urbanicity, and a family history of mental disorder increase the odds of PLEs (Linscott & van Os, 2013). More recent studies support these findings (Bourgin *et al*., 2019; Khaled, Wilkins & Woodruff, 2019; Pignon, Schürhoff, *et al.*, 2018b).

The presence of PLEs are well described in children (Laurens, Hobbs, Sunderland, Green & Mould, 2012), adolescents (Kompus, Løberg, Posserud & Lundervold, 2015 & Lundervold, 2015), and also in the transition from childhood into adolescence (Thapar *et al*., 2012). In children between 5 and 7 years of age, Pignon, Geoffroy, Gharib *et al.* (2018a) for example, found a prevalence rate of 15.8% for auditory hallucinations. In addition, Kelleher and colleagues (2011), suggest that PLEs are normal childhood experiences that do not persist into adulthood. They found that the prevalence of PLEs in children decreases from 21% at age 11–13 to 7% in adolescents aged 13–16. Yet, other studies found that when PLEs are reported at the age of 9–12, there is an increased risk that PLEs were also reported later in adolescence (Gutteridge, Lang, Turner, Jacobs & Laurens, 2020), and that children/adolescents with persistent PLEs often need care in the future (Bartels-Velthuis, Wigman, Jenner, Bruggeman & Van Os, 2016; Maijer, Palmen & Sommer, 2017; Maijer, Steenhuis, Lotgering, Palmen, Sommer & Bartels-Velthuis, 2019). In adults, participants are often asked to report their lifetime PLEs, but there are no specific instructions whether these include childhood PLEs. Thus, it is unclear whether the PLEs described by adults were "merely" childhood/adolescence experiences that can be attributed to immaturity or whether they were exclusively experienced during adulthood. To our knowledge, this has not been investigated before.

Typically, PLEs are assessed with interviews or self-rating questionnaires. While prevalence rates on self-rating questionnaires tend to be higher than in interviews, self-rating instruments are suggested to have a high degree of accuracy as well (Kelleher & Cannon, 2011). However, most instruments do not capture the full spectrum and phenomenology of PLEs. Instruments either focus on only one hallucination modality, like auditory hallucinations (e.g. PSYRATS; Haddock, McCarron, Tarrier & Faragher, 1999) or on one delusional theme, like paranoia (e.g. Paranoid Thoughts Scale; Green, Freeman, Kuipers *et al*., 2008); or they provide global scores for hallucinations (Positive and Negative Syndrome Scale; Kay, Fiszbein & Opler, 1987) and delusions without rating individual themes (e.g. Neurospsychiatric Inventory; Cummings, 1997).

To overcome these shortcomings, the Questionnaire for Psychotic Experiences (QPE; Rossell, Schutte, Toh e*t al*., 2019; Sommer, Kleijer & Hugdahl, 2018) was developed. It aims to cover a wide range of PLEs, including hallucinations in different modalities (auditory, visual, tactile, olfactory) and common types of delusions (persecution, reference, guilt, control, religiosity, grandeur, nihilism, misidentification and somatic delusions). The QPE was also developed as a transdiagnostic instrument that can be applied to assess PLEs not only in different patient populations but also in the general population (for details see Rossell *et al*., 2019). The QPE was originally conceived as a full *interview*. This allows assessing detailed phenomenological information. However, it is also time consuming. For this reason, Sommer and colleagues (2018) provided a short *QPE screening questionnaire* that only asks about the presence of hallucinatory and delusional experiences. However, although the QPE screening questionnaire has already been used as a self-report questionnaire (Begemann, Linszen, de Boer *et al*., 2019) to group participants in terms of presence/frequency of PLEs (de Boer, Linszen, de Vries et a*l*., 2019), only the full QPE interview has been validated in a patient population so far (Rossell *et al*., 2019).

Therefore, the first aim of the present study was to test the psychometric properties of the QPE screening questionnaire. We examined its test-retest reliability, convergent validity, and the internal structure in a convenience sample recruited from the general population via an online survey. Our second aim was to map endorsement rates for both hallucinatory and delusional experiences in this sample. Third, we wanted to examine how many of the PLEs that adults reported in the present study were "merely" childhood experiences that did not transition into adulthood. Fourth, we aimed to replicate previous findings showing that sex, age, unemployment, level of education, parental mental disorder, and the use of illegal drugs/alcohol predict whether individuals experience PLEs. Finally, if the concept of phenomenological continuity is correct, then the mere presence of PLEs should not be a predictor for whether individuals have a mental disorder or not. To test this notion, we examined whether the QPE screening items can be used as predictors to distinguish between individuals with PLEs who either had or had not been diagnosed with a mental disorder

and to determine the sensitivity and specificity of the QPE screening items.

METHODS

Participants

In total, 46,916 and 2,216 participants visited the online survey at two different time points, respectively: time point 1 (TP1) and time point 2 (TP2) with approximately 1 week in-between. We excluded data from participants who: (1) did not start the survey at all and just consulted the first page; (2) reported an aberrant age or being underaged (≤18 years of age); (3) did not complete at least the QPE, Peters Delusion Inventory (PDI), and Cardiff Anomalous Perception Scale (CAPS); (4) made double entries; and (5) whose answers did not pass a validity check (for more details, please see the material section below). We also screened the comment section for invalid answers. After applying these exclusion criteria (see Fig. 1), there were 1,439 and 1,115 participants at TP1 and TP2, respectively. All 1,115 participants from TP2 also completed TP1 (77.5%).

Materials

QPE screening questionnaire (Sommer et al., 2018). We first created a Norwegian version of the full QPE interview through back-translation. For the online survey, we only included the screening questions assessing the general presence/absence of PLEs (see Table 3) while the follow-up questions were omitted. Participants indicate via "yes"/"no" whether they had any of the hallucinatory or delusional experiences in their life (lifetime experiences) or during the last seven days (current experiences). We adapted the QPE screening questions by additionally asking whether participants had experienced any of these PLEs in childhood ("Did you experience this only when you were a child?") with the same answer format.

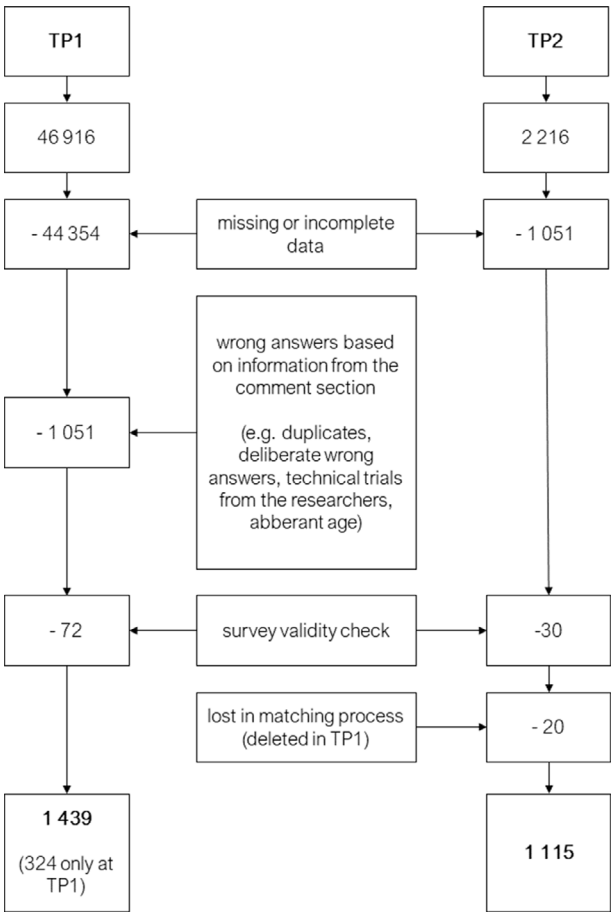

Fig. 1. Flow chart of the data cleaning procedure. There was no possibility for comments at TP2.

Peters Delusion Inventory (PDI; Peters, Joseph, Day & Garety, 2004). The PDI is a self-report questionnaire that was designed to assess delusional ideation multi-dimensionally in the general population. It contains 21 items, such as "Do you ever feel as if people are reading your mind?". In the original PDI, participants indicate the presence of delusional ideation with "yes"/"no" responses. In case they answer "yes", they further indicate on a five-point Likert-scale, how distressing and true this delusion is for them, and how much they think about it. For the present study, we only used the initial question that asks about the presence of delusional experiences, as it aligns with the "yes"/"no" answers from the QPE. The Norwegian translation of the PDI has a Cronbach's alpha of 0.782.

Cardiff Anomalous Perceptions Scale (CAPS; Bell, Halligan & Ellis, 2005). The CAPS is a self-report questionnaire that comprises 32-items and assesses perceptual anomalies on three subscales. In a non-clinical sample these subscales can be interpreted as clinical psychosis, chemosensation, and temporal lobe disturbance (Bell *et al.*, 2005). Participants indicate the presence/absence of anomalous perceptions with "yes"/"no" answers. In case they answer "yes", they are asked follow-up questions regarding the level of distress, intrusiveness, and frequency of those anomalous perceptions. As with the PDI, we adapted the CAPS such that the follow-up questions were not included. Cronbach's alpha for the Norwegian version of the CAPS is 0.901.

Survey validity check. As up to 23% of participants can be unreliable responders (Fervaha & Remington, 2013; Ladea, Szöke, Bran *et al.*, 2020), six items which were already used in another study (Bortolon, Lebrun & Laloyaux, 2020) were distributed across the entire survey to ensure the validity of participants' answers. Two items aimed to detect random completion or attention lapses (i.e., "Please tick "yes," "Please select "2–3 times per week."); two items to detect lies taken from the Eysenck Personality Questionnaire Revised (Eysenck, Eysenck & Barrett, 1985), where participants rated on a seven-point Likert-scale from "all my habits are bad" to "all my habits are good", as well as from "I have never cheated in games" to "I have always cheated in games"; and two items to detect the simulation of psychotic symptoms based on published clichés (Moritz, Van Quaquebeke, Lincoln, Köther & Andreou, 2013; that is, "Did you ever have the hallucination of seeing white mice or other small animals?" "Did you ever have a disruption in your perception of time and had the feeling that you are another person?"). At TP1 and TP2, six and three validity items were included, respectively. The number was lower at TP2 due to the lower total number of items. We excluded participants who answered three or more validity check items incorrectly at TP1 or who answered two or three items incorrectly at TP2, as some items were relatively subjective and/or related to possible, albeit highly rare phenomena (see also Laloyaux, Collazoni, Hirnstein, Kusztrits & Larøi, submitted).

Demographic questions and other measures. To examine factors that could be associated with PLEs, participants provided basic demographic and clinical information, including age, sex, education, employment status, family history of mental disorders, psychiatric and neurological diagnoses, medication, alcohol and drug consumption. The level of education was grouped into three categories: primary ("Grunnskole"), secondary (including "Framhaldsskole," "Folkehøyskole," "Realskole," "Middelskole," "Yrkeskole," "Videregående Skole," "Artium," "økonomisk gymnasium" and "allmennfaglig studieretning") and higher education (university degree). In addition, the online survey contained questions about trauma and auditory verbal hallucinations as well as the revised Beliefs About Voices Questionnaire (BAVQ-R; Chadwick, Lees & Birchwood, 2000), the Self-Compassion Scale (SCS;

Neff, 2003), and the Resilience Scale for Adults (RSA; Hjemdal, Friborg, Stiles, Rosenvinge & Martinussen, 2006). These questionnaires were collected to address other research questions (e.g., Laloyaux *et al*., 2020) and are therefore not described in more detail in this paper.

Procedure

The online survey was administered with the online tool SurveyXact (http://www.surveyxact.no). It was advertised via posters, flyers, email, publications on homepages and social media channels; on Facebook, there were advertisements targeting people who live in Norway and speak Norwegian, are over 18 years old, but without restrictions to sex, or geography. The online survey was accessible from August 2017 until the end of June 2018.

At TP1, participants first completed demographic questions, the QPE screening questionnaire, the PDI, and CAPS. Then, they completed questions regarding their clinical background, followed by questions related to auditory verbal hallucinations and trauma, as well as the BAVQ-R, SCS, and RSA. At the end, they were asked to voluntarily provide their email address for future research and had the opportunity to comment on the online survey. The total time to complete the online survey was between 20 and 40 min, depending on whether participants had experienced auditory hallucinations or not. Only participants who gave their informed consent to participate in future research were invited to TP2. Two invitations were sent out via email, seven and nine days after TP1 was completed. At TP2, participants only completed the QPE screening questionnaire, the PDI, and the CAPS.

The study was approved by the regional ethics committee (REK 2017/69) and informed consent was obtained beforehand from all participants at both time points.

Data analysis

The characteristics of the general sample are presented in Table 1. *Retest reliability* of the QPE screening questionnaire was determined with a test/retest-design and is expressed as the percentage of concordant and discordant answers across TP1 and TP2. (Dis-)concordance rates could thus only be calculated for participants who completed the QPE screening questionnaire at TP1 and TP2. A response was considered concordant when the same "yes" or "no" answer was given at TP1 and TP2. Discordance could arise for two reasons: first, it could reflect truly inconsistent responses, termed here "true discordance." That is, somebody who indicated "yes" at TP1 when asked about, for instance, lifetime auditory hallucinations but indicated "no" lifetime auditory hallucinations at TP2. There is, however, the possibility that somebody correctly indicated at TP1 that he/she had never experienced auditory hallucinations in their lifetime (= "no" answer) but experienced auditory hallucinations in the period between TP1 and TP2, leading to a "yes" answer at TP2. We termed this pattern "ambiguous discordance" and treated it as a separate category. For *convergent validity*, inter-scale concordance rates were calculated between the QPE screening questionnaire and corresponding items of the PDI and CAPS. We chose the items from the QPE, PDI, and CAPS based on their matching content (see Table 6). Given that all three questionnaires have a "yes"/"no" response format, we also calculated concordance rates here. In addition, we provided the mean square contingency coefficient phi (φ). As effect size measures, we used the index suggested by Cohen, as it is recommended for contingency tables (Olivier & Bell, 2013). To determine the internal structure of the QPE screening questionnaire, we ran a principal component analysis (PCA) with all 13 items following the recommendations of Neill (2008). Eigenvalues greater than 1 and factor loadings of greater than 0.4 were retained and considered satisfactory (Mokkink *et al*., 2010).

To *map PLEs*, we first report the endorsement rates of lifetime, current, and childhood PLEs at TP1 descriptively, separately for individuals with and without a self-reported mental disorder that was diagnosed by a psychiatrist or psychologist. Subsequently, we ran a multiple linear regression (not distinguishing between individuals with and without a diagnosed mental disorder) with sex, age, employment status, level of education, parental mental disorder, as well as the consumption of drugs and alcohol as predictors for having PLEs. Unknown answers were treated as missing values and excluded from the analysis. The dependent variable was the total score of lifetime PLEs at TP1, which was calculated as the sum of all QPE items where participants indicated their presence. Finally, a binomial logistic regression model and a receiver operating characteristic curve (ROC) were computed to assess how well the items of the QPE screening version at TP1 discriminate between individuals with and without a self-reported mental disorder who experience PLEs. In addition, sensitivity, specificity, and positive and negative predictive values were calculated.

Table 1. *Participant characteristics*

Variables	TP 1	TP 2
n	1439	1115
Age (M ± SD)	39.1 (13 ± 37)	39.62 (13 ± 36)
Sex: female/ male [%]	1254:185 [87.1 %/ 12.9 %]	975:140 [87.4 %/ 12.6 %]
Education		
Primary	3.8%	3.5%
Secondary	27.4%	24.8%
Higher	68.9%	71.7%
Have parents with a psychiatric diagnosis	8.2% (Unsure: 9.8%)	8.6% (Unsure: 10.5%)
Neurological disorder	3.1%	3.3%
Mental disorder:	32.2%	34.4%
Depression	25%	27.5%
Anxiety	18.8%	20.2%
Schizophrenia	2.2%	2.3%
Bipolar Disorder	3.0%	3.3%
Personality Disorder	3.3%	3.5%
Other	1.7%	1.8%
Consulting a specialist for mental health problems:		
General practitioner	40.7%	43.3%
Psychiatrist	15.6%	16.7%
Psychologist	43.4%	46.3%
Neurologist	3.5%	4.0%
other	3.1%	3.3%

Note: Questions regarding mental disorder and consulting a specialist were enabled for multiple responses.

RESULTS

General sample description

The mean difference, in number of days, between TP1 and TP2 was 8.77 (SD = 3.4). Participants at both time points were mostly highly educated and female, with a mean age around 40 years. For more details about participant characteristics, see Table 1.

Psychometric Properties

Test-retest reliability. Concordance rates between answers at TP1 and TP2 show high consistency of ≥ 85 % in 12 out of 13 items. Only one item (paranoia) is below 78 %. Ambiguous discordance is relatively rare, ranging between 0.2% and 1.8% (see Table 2).

Convergent Validity. Concordance rates between QPE screening questions and related CAPS/PDI items were ≥ 50.4%, with corresponding weak to strong effects (ϕ between 0.199 and 0.789; see Table 3).

Table 2. *Concordance rates for lifetime presence of hallucinatory and delusional experiences at TP1 and TP2*

QPE-items	Concordant answers	Discordant answers	
		True	Ambiguous
(1) Auditory hallucinations	85.0%	13.2%	1.8%
(2) Visual hallucinations	88.1%	11.2%	0.7%
(3) Tactile hallucinations	85.9%	13.7%	0.4%
(4) Olfactory hallucinations	88.8%	9.9%	1.3%
(5) Paranoia	77.5%	22.1%	0.4%
(6) Delusions of reference	89.5%	10.2%	0.3%
(7) Delusions of guilt	87.5%	12.1%	0.4%
(8) Delusions of control	88.9%	10.6%	0.5%
(9) Delusion of religiosity	97.0%	2.7%	0.3%
(10) Delusion of grandeur	89.4%	9.6%	1.0%
(11) Somatic delusions	86.7%	12.8%	0.5%
(12) Delusions of nihilism	92.3%	7.3%	0.4%
(13) Delusions of misidentification	94.7%	5.1 %	0.2%

Note: True discordance includes participants reporting lifetime PLEs at TP1 but not at TP2, while ambiguous discordance includes participants who reported no lifetime PLEs at TP1 but at TP2, which is hypothetically possible if they only had PLEs in the period between TP1 and TP2.

Internal structure. The data screening showed that with 1439 participants for 13 items, we had a satisfactory participant-to-item ratio of approximately 111:1. Several indicators were checked to assess overall suitability for a factor analysis. First, the determinant derived from the correlation matrix was 0.217 and thus above the recommended value of 0.00001. Moreover, inter-correlations were well below $r = 0.80$, suggesting there was no multicollinearity. Second, eight out of 13 items correlated with at least one other item $r \geq 0.30$. Third, the Kaiser-Meyer-Olkin measure of sampling adequacy (0.83) was above 0.60, Bartlett's test of sphericity was significant [$\chi^2(78) = 2816.46$, $p \leq 0.001$], and 11 out of 13 items showed communalities above 0.30. Based on these indicators, the data including all 13 items was regarded suitable for factor analysis.

We carried out a PCA with promax rotation, since we expected that the underlying factors are correlated. Three factors had eigenvalues greater than 1, the first two explaining 24% and 11% of the variance, respectively, while the last factor explained 8% variance. A two-factor solution seemed most appropriate: first, the characteristic bend in the scree plot as reflected by the eigenvalues occurred after two factors. Second, we compared the observed eigenvalues to randomly generated eigenvalues based on

Table 3. *Concordance rates and effect sizes for QPE and related CAPS/PDI items*

QPE item	CAPS item	Concordance rate	Phi (ϕ)
1) People sometimes hear another person speak, while no one seems to be there. Also, music or other sounds can be heard, while it is unclear where this comes from. Have you ever heard such voices, music or other sounds?	6) Do you ever hear noises or sounds when there is nothing to explain them?	74.5 %	0.49
	11) Do you ever hear voices commenting on what you are thinking or doing?	62.5 %	0.27
	13) Do you ever hear voices saying words or sentences when there is no one around that might account for it?	75.3 %	0.54
	28) Have you ever heard two or more unexplained voices talking with each other?	59.6 %	0.24
	32) Do you ever hear sounds or music that people near you don't hear?	76.8 %	0.55
2) It sometimes occurs that people see a person, animal or object that others cannot see. For some people, this can be a shade or shadow. Have you seen any of those objects, persons or images?	4) Do you ever see shapes, lights or colours even though there is nothing really there?	77.7 %	0.53
	31) Do you ever see things that other people cannot?	81.5 %	0.62
3) People sometimes feel things that are not there. For example, feeling a hand on their shoulder, while no one is around. Another example is feeling a tickling or itching sensation, as if there are tiny creatures under the skin. Have you ever experienced this?	5) Do you ever experience unusual burning sensations or other strange feelings in or on your body?	65.9 %	0.34
	12) Do you ever feel that someone is touching you, but when you look, nobody is there?	72.1 %	0.52
4) People sometimes smell things that are not there. For example, the scent of smoke, while there is no fire. Another example is someone who smells flowers, while there are no flowers around. Have you ever had such an experience?	8) Do you ever detect smells which don't seem to come from your surroundings?	89.2 %	0.79
	29) Do you ever notice smells and odors that people next to you seem unaware of?	75.7 %	0.52
QPE item	**PDI item**	**Concordance rate**	**Phi (ϕ)**
5) Were you ever convinced that other people were out to get you? Have you had the feeling that people were keeping an eye on you, or may even want to hurt you?	1) Do you ever feel as if people seem to drop hints about you or say things with a double meaning?	65.1 %	0.36
	4) Do you ever feel as if you are being persecuted in some way?	52.2 %	0.21
	5) Do you ever feel as if there is a conspiracy against you?	50.4 %	0.22

(continued)

Table 3. (continued)

QPE item	PDI item	Concordance rate	Phi (ϕ)
6) Were you ever convinced that things in your environment might have a special meaning just for you? For example, certain messages on TV or in the newspaper?	2) Do you ever feel as if things in magazines or on TV were written especially for you?	86.5 %	0.48
7) Were you ever convinced that you were guilty of some bad things that have happened? While others did not feel you were responsible?	14) Do you ever feel that you have sinned more than the average person?	77.5 %	0.30
8) Were you ever convinced that a thought or action was not quite your own? As if you were being controlled by someone else?	10) Do you ever feel as if electrical devices such as computers can influence the way you think?	83.6 %	0.22
9) Were you ever convinced you were specifically chosen by a god for a special purpose in life? Have you ever thought you were a god, devil, angel or a saint?	6) Do you ever feel as if you are, or destined to be someone very important?	88.5 %	0.30
	8) Do you ever feel that you are especially close to god?	89.2 %	0.34
	11) Do you ever feel as if you have been chosen by God in some way?	93.6 %	0.40
10) Were you ever convinced you had extraordinary talents or powers that no one else has?	7) Do you ever feel that you are a very special or unusual person?	75.3 %	0.32
11) Were you ever convinced that there was something strange with your body, while others said that this was not the case?	15) Do you ever feel that people look at you oddly because of your appearance?	64.6 %	0.20
12) Were you ever convinced that you somehow no longer existed? Have you ever had the feeling that you might be dead?	No similar item in CAPS No similar item in PDI		
13) Were you ever convinced that someone close to you might not be who they say they are? Or have you ever had the thought that this person had been replaced by an imposter?	3) Do you ever feel as if some people are not what they seem to be?	66.5 %	0.22

Table 4. *Mean scores of psychotic experiences and factor loadings of the QPE screening questions*

QPE-Item	Mean	Factor 1 delusional experiences	Factor 2 Hallucinatory experiences
(1) Auditory hallucinations	0.45		0.71
(2) Visual hallucinations	0.40		0.74
(3) Tactile hallucinations	0.51		0.63
(4) Olfactory hallucinations	0.47		0.68
(5) Paranoia	0.57	0.56	
(6) Delusions of reference	0.18	0.60	
(7) Delusions of guilt	0.24	0.65	
(8) Delusions of control	0.16	0.56	
(9) Delusions of religiosity	0.06	0.42	
(10) Delusions of grandeur	0.18	0.43	
(11) Somatic delusions	0.34	0.46	
(12) Delusions of nihilism	0.11	0.52	
(13) Delusions of misidentification	0.08	0.49	

13 variables, 1,439 participants, and 100 replications with the tool "Monte Carlo PCA for parallel analysis" (Watkins, 2000). Only the eigenvalues of the first two observed factors (3.1 and 1.4) were above the randomly generated eigenvalues (1.2 and 1.1), while subsequent observed eigenvalues were level with or below the randomly generated ones.

We then re-ran the PCA with the two-factor solution preselected, explaining a total variance of 35%. Factor loadings higher than 0.40 are presented in Table 4. As can be seen, Factor 1 represents items about delusions, while Factor 2 only contained items about hallucinations. We therefore called the two factors *delusional experiences* and *hallucinatory experiences*, respectively. In a last step, we analyzed the internal consistency for the two factors. Cronbach's alpha for *delusional experiences* and *hallucinatory experiences* were 0.671 and 0.645, respectively, suggesting relatively moderate, internal consistency.

Mapping PLEs

Endorsement rates of PLEs. In general, hallucinatory experiences were more often reported than delusional experiences (Table 5). Individuals with a mental disorder experienced more *lifetime* PLEs than those without a mental disorder. Looking at *current experiences*, a similar pattern arises, clustering around roughly ten percent. In general, just a few people reported having experienced PLEs only during *childhood*.

Factors predicting the frequency of PLEs. Using the enter method, the multiple regression model significantly predicted PLEs, $F(7, 1431) = 28.36$, $p < 0.001$, adj. $R^2 = 0.12$ (see Table 6). Age, education, parental mental disorder, drug and alcohol consumption were significant predictors of PLEs.

Discriminating Individuals with and without Mental Disorders based on QPE Screening Questions. The logistic regression model was statistically significant, $\chi^2(13) = 134.76$, $p \leq 0.001$. The model explained 12.6% (Nagelkerke R^2) of the variance of discriminating participants with and without a diagnosis and correctly classified 71.4% of cases. Sensitivity was 24.2%, specificity was 92.5%, positive predictive value was 58.8% and negative predictive value was 41.2%. Of the 13 predictor

Table 5. *Frequency of PLEs in the study sample*

	Lifetime		Current		Child	
	With	Without	With	Without	With	Without
Hallucinatory experiences						
Auditory	50.10%	42.70%	10.40%	5.60%	2.80%	4.10%
Visual	47.50%	36.80%	9.30%	5.00%	5.80%	4.50%
Tactile	58.30%	47.40%	18.40%	11.80%	2.40%	2.80%
Olfactory	55.70%	43.30%	14.00%	10.60%	0.90%	0.90%
Delusional experiences						
Paranoia	71.30%	50.60%	21.00%	10.00%	2.20%	2.80%
Reference	23.10%	16.30%	6.90%	5.00%	1.30%	0.50%
Guilt	39.50%	16.20%	8.40%	2.90%	4.80%	1.90%
Control	20.70%	13.10%	3.90%	2.00%	1.30%	1.20%
Religiosity	9.50%	4.00%	1.50%	1.60%	1.30%	0.70%
Grandeur	21.40%	16.40%	4.50%	5.60%	5.20%	3.90%
Somatic	43.60%	29.10%	13.40%	6.70%	1.70%	1.10%
Nihilism	17.50%	8.30%	2.20%	1.10%	1.70%	1.20%
Misidentification	10.60%	6.80%	0.40%	0.90%	3.50%	2.50%

Note: Percentage of individuals with and without a mental disorder diagnosed by a mental health professional, with separate rates for lifetime, current and childhood experiences.

Table 6. *Predictors of experiencing PLEs*

			CI_B 95%		
Variables	B	SE_B	Lower	Upper	β
Intercept	7.36	0.44	6.51	8.22	
Age	−0.02	0.01	−0.03	−0.01	−0.08*
Sex	−0.35	0.20	−0.74	0.05	−0.04
Employment status	0.01	0.01	−0.01	0.02	0.04
Education	−0.84	0.12	−1.08	−0.59	−0.17**
Parental mental disorder	0.01	0.01	0.01	0.02	0.16**
Illegal drugs	1.11	0.39	0.34	1.88	0.07*
Alcohol	−0.32	0.05	−0.43	−0.22	−0.16**

Notes: *$p \leq 0.005$, **$p < 0.001$; B = unstandardized regression coefficient; SE_B = standard error of coefficient; CI_B = confidence intervals of coefficient; β = standardized coefficient. Variable coding: age (in years), sex (male/female: 1/0), employment status (employed/unemployed: 1/0), education (primary/secondary/higher: 1/2/3), parental mental disorder (yes/no: 1/0), illegal drugs (yes/no: 1/0), alcohol (six-point-scale from "never" to "5 times per week: 0–5).

variables, five were statistically significant (in order of descending level of significance): guilt, paranoia, visual hallucinatory experiences, and delusional experiences of religiosity and nihilism (Table 7). The area under the ROC curve was 0.686 with a 95% CI between 0.656 and 0.716. According to Hosmer, Lemeshow and Sturdivant (2013), this represents a poor level of the whole model classifying individuals into the two groups.

DISCUSSION

Psychometric Properties

Our first aim was to examine the psychometric properties of the QPE screening questionnaire. Measures for retest reliability showed high concordance rates between the answers at the two time points, indicating that the QPE screening questionnaire is a stable measure. Only the item about paranoia had a medium concordance rate. In general, the screening questions are phrased rather broadly. This reduces stigma and lowers the threshold of reporting PLEs, but might also lead to higher fluctuations in participants' answers over time and, thus, more frequent (truly) discordant answers, even in non-clinical populations (Garety & Freeman, 2013). *Ambiguous discordance* is more difficult to interpret. It is possible that participants indeed had never experienced PLEs in their life before but experienced them in the week between TP1 and TP2. However, it is also possible that this reflects priming effects where individuals were more aware of their everyday experiences after participating in our survey (Weingarten, Chen, McAdams, Yi, Hepler & Albarracín, 2016). Nevertheless, the *ambiguous discordance* rates were rather rare and therefore not a concern.

Concordance rates between the selected items of the PDI/CAPS and the QPE screening questionnaire showed considerable variation. QPE items were designed to capture a lot of information about PLEs by merging questions of different existing instruments. At the same time, the wording of the QPE items was modified such that they represent one common theme. As a result, there is varying overlap between the phrasing of QPE items and items from other instruments (Rossell *et al*., 2019). For example, for the QPE screening item that asks about visual hallucinations ("It sometimes occurs that people see a person, animal or object that others cannot see. For some people, this can be a shade or shadow. Have you seen any of those objects, persons or images?"), there are two corresponding items in the CAPS ("Do you ever see shapes, lights or colours even though there is nothing really there?," "Do you ever see things that other people cannot?"). These modifications might be an explanation for the high variation in effect sizes and the difference in the psychometric properties to the full QPE interview. There were no corresponding items in the PDI or CAPS for delusions of nihilism and misidentification, as these delusions are typically not

Table 7. *Logistic regression predicting likelihood of having a diagnosed mental disorder based on the occurrence of psychotic experiences*

						95% CI for odds ratio	
QPE item	B	SE	Wald	df	odds ratio	lower	upper
(1) Auditory hallucinations	−0.13	0.14	0.92	1	0.34	0.67	1.15
(2) Visual hallucinations	0.32	0.14	5.74*	1	1.38	1.06	1.79
(3) Tactile hallucinations	0.10	0.14	0.53	1	1.10	0.85	1.44
(4) Olfactory hallucinations	0.23	0.13	2.88	1	1.25	0.97	1.63
(5) Paranoia	0.54	0.14	15.88**	1	1.72	1.32	2.24
(6) Delusions of reference	−0.20	0.17	1.38	1	0.82	0.59	1.14
(7) Delusions of guilt	0.89	0.14	38.65**	1	2.43	1.84	3.22
(8) Delusions of control	−0.05	0.18	0.07	1	0.96	0.68	1.35
(9) Delusion of religiosity	0.57	0.25	5.13*	1	1.77	1.08	2.91
(10) Delusion of grandeur	−0.10	0.16	0.40	1	0.90	0.66	1.24
(11) Somatic delusions	0.19	0.13	2.03	1	1.21	0.93	1.57
(12) Delusions of nihilism	0.38	1.88	4.11*	1	1.46	1.01	2.11
(13) Delusions of misidentification	0.02	0.22	0.01	1	1.02	0.66	1.57
Constant	−1.71	0.13	179.56**	1	0.18		

*p = 0.05, **p = 0.01

employed in psychiatric assessments due to their neurological character and the fact that they are very rare (Rossell *et al*., 2019).

The internal structure revealed two components: *hallucinatory experiences* and *delusional experiences*. While a solution with two components is highly intuitive, given that there were items about hallucinatory and delusional experiences, Rossell *et al*. (2019) found a three-factor solution in the full QPE interview. That is, one factor for auditory and visual hallucinations each, as well as a unidimensional solution for delusions. Tactile and olfactory hallucinations were not included in the analysis, as there were no other validation instruments available in a semi-structured interview format. In comparison to our study, however, the authors analyzed the follow-up questions of the interview and not the screening questions (Rossell *et al*., 2019). Cronbach's alpha for the two factors in the present study were moderate. This is not surprising given that it reflects the heterogeneity of hallucinatory and delusional experiences in the clinical reality: For example, while having hallucinatory experiences in one modality increases the odds of having hallucinatory experiences in other modalities, many individuals experience only auditory, or visual, or tactile, or olfactory hallucinatory experiences or various combinations thereof (Larøi, Bless, Laloyaux et *al*., 2019). This is also true for delusions. Taken together, the QPE screening questionnaire has satisfactory reliability and validity and can be used as a complementary tool for epidemiological studies: it provides less information than the full QPE interview but can be carried out much faster and does not require trained interviewers.

One should also bear in mind that while the low-threshold wording of the screening items invites participants to be more open about their experiences, the phrasing is also likely going to yield rather high endorsement rates of PLEs.

Mapping endorsement rates of PLEs

The second aim of the study was to map PLEs in our sample. The proportion of individuals with a diagnosed mental disorder was rather high (30%), as compared to an estimated 11% of individuals suffering from any mental health disorder worldwide, according to the World Health Organization (Ritchie & Roser, 2018). Therefore, we mapped PLEs for participants with and without a diagnosed mental disorder separately.

Both lifetime and current PLEs were consistently reported more often by individuals with a mental disorder. This was to be expected, as PLEs are associated with a wide range of mental disorders (Linscott & van Os, 2013). The frequency of delusional experiences with religious, grandiose and misidentification content were similar in both groups.

There were some differences between individuals with and without a diagnosed mental disorder with respect to childhood PLEs. While for all modalities of hallucinatory experiences participants without a mental disorder had higher endorsement rates than those with a mental disorder, delusional experiences did not show this pattern, as prevalence of delusional ideas were rather low in both groups. In general, however, childhood PLEs were rather rare, suggesting that when adults report lifetime PLEs they usually do not reflect childhood experiences. Kelleher and colleagues (2012) suggested that PLEs are part of normal childhood experiences that decrease over time. While the authors directly tested children and adolescents, we investigated PLEs in adults. This approach might give room for a memory bias that is connected to reporting retrospective life events (Lalande & Bonanno, 2011; Van den Bergh & Walentynowicz, 2016). Another potential issue is that we did not further define "childhood" when we asked participants about their experiences. We worded our question as "Did you experience this only when you were a child?." Thus, the definition of "when you were a child" may have varied between the participants, which might have made it difficult for participants to classify their childhood PLEs as such.

Regardless of individuals with and without a mental disorder, in general, frequencies in all lifetime PLEs were rather high. Between 4.0% and 71.3% of participants in our sample reported experiencing PLEs in their life. In comparison, Bourgin and colleages (2019) reported more than 26% with at least one

lifetime PLE, while prevalence rates of lifetime PLEs in Linscott and van Os (2013) ranged between 1.2% and 25.5%. In the present study, hallucinatory experiences in both individuals with and without a mental disorder were reported typically by 40% and more (lifetime perspective). For hallucinatory experiences in the auditory modality, for example, a meta-analysis reported a prevalence rate of below 10% (Maijer *et al*., 2018). In the present study the rate was 50% and 43% for participants with and without a mental disorder, respectively. For delusional experiences, there was a large variation, with highest endorsement rates for paranoia. The large variation is in accordance with the results of a recent review article, however, that reported rates between 3% and 91% for different delusional experiences (Heilskov *et al*., 2019). The high PLEs rates in the present study are likely due to the fact that the online survey was advertised as a project to assess PLEs, which probably attracted individuals who have had such experiences. As outlined above, another reason could be the open phrasing of the QPE screening questions. This possibility aligns with the similar high prevalence of endorsement in studies using the full QPE interview (Begemann *et al*., 2019; de Boer *et al*., 2019).

Predictive factors of PLEs

Irrespective of whether participants had a diagnosed mental disorder or not, young age, lower education, parental mental disorder, and the use of illegal drugs and alcohol were significantly associated with higher frequency of PLEs. Thus, despite a possible selection bias in our convenience sample, these findings replicate previous studies regarding age, parental mental disorder, and drug consumption effects on PLEs (Bourgin *et al*., 2019; Linscott & van Os, 2013b). The results are more inconsistent regarding education: Both Bourgin *et al*. (2019) and Pignon *et al*. (2018b) found a higher prevalence for "at least one PLE" in individuals with a secondary education level and higher, but Linscott and van Os (2013) did not find an association between education and PLEs. This discrepancy might arise from the fact that Linscott and van Os (2013) conducted a meta-analysis based on several samples, while Bourgin *et al*. (2019) and Pignon *et al*. (2018b) had only one sample in their analysis. Counterintuitively, we found that the consumption of more alcohol is associated with fewer PLEs. Possibly, alcohol consumption reflects the social behavior of participants in our sample, meaning that individuals go out more often and therefore consume alcohol more often per week. The resulting social network might function as a protective factor against the onset and recurrence of mental disorders (Avison, 1996). In general, however, the standardized coefficients did not exceed beta = 0.17, suggesting that the correlations we found in the present study were weak and their significance are rather the result of the large sample.

Discriminating individuals with and without mental disorders

Finally, we investigated whether PLEs, as assessed with the QPE screening questionnaire, can discriminate between people with and without a mental disorder. Five QPE questions were found to be significantly discriminating. These included items assessing (the highest are presented first): delusional experiences of guilt and paranoia, visual hallucinatory experiences, and delusional experiences of religiosity and nihilism. The significance levels of both delusional experiences of guilt and paranoia were much higher than those of the other significant items. This is in line with another study that reported delusional experiences of guilt and paranoia to be discriminators between psychotic and non-psychotic patients (Verdoux, Maurice-Tison, Gay, Van Os, Salamon & Bourgeois, 1998). However, the highest odds ratio in the present study was 2.4, implying that participants indicating "yes" on the item about delusional experiences of guilt have 2.4 times the odds of having a diagnosed mental disorder. Moreover, the logistic regression model showed a poor level of discrimination between the two groups. Both, the positive and negative predictive value congregate around 50%, which can also be based on chance. The fact that the presence (or absence) of PLEs appears to be fairly similar in both groups, although the frequency of PLEs is generally higher in individuals with a diagnosed mental disorder, supports the phenomenological aspect of the continuum hypothesis of PLEs (Linscott & van Os, 2013). These data show that the mere experience of a PLE does not provide much information about mental health status, as such experiences are ubiquitous. In the full QPE interview, additional questions are asked regarding the underlying phenomenology of PLEs. This information is necessary to differentiate between groups with and without mental health issues.

Limitations and conclusion

The results of our study should be interpreted in the light of some limitations. First, while our online survey was completed by a high number of participants, thus providing good statistical power and the possibility to compare subgroups, it attracted mostly female and highly educated participants, implying this is not a representative sample of the general population and makes it difficult to generalize our findings. This is a typical issue with convenience samples in epidemiological research on PLEs and in online surveys in general (see, e.g., Armando, Nelson, Yung *et al*., 2010, whose sample consisted of 75% college students). As pointed out above, the sample selection, together with the open phrasing of the QPE items, could account for the relatively high PLEs rates. The self-reporting nature of the QPE screening questionnaire could have further contributed to the high frequency. Linscott and van Os (2013) demonstrated a higher prevalence rate of PLEs in studies where researchers only used self-report measures in comparison to interview measures. However, there is also evidence that self-report instruments rather underestimate subthreshold PLEs which speaks for a social desirability bias (DeVylder & Hilimire, 2015). Moreover, while our strategy to use Facebook as a tool to recruit a lot of participants has already been used before and proved to be a viable approach (Kosinski, Matz, Gosling, Popov & Stillwell, 2015), the downside of this recruitment strategy is that a high number of clicks does not automatically translate into high quality data (Crosier, Brian & Ben-Zeev, 2016). This made it necessary to include survey validity items and have a rigid data cleaning procedure. In addition, we did not assess ethnicity, migration status, and the context in which PLEs were occurring, such as in sleep or while intoxicated, which are all relevant factors (Tortelli,

Nakamura, Suprani *et al*., 2018; Waters & Fernyhough, 2017). Finally, clinical diagnoses were self-reported and we had to trust participants, as we had no possibility to validate the diagnoses externally.

Despite the issues with representativeness, the present study allows us to draw a couple of conclusions with relevance to the ongoing debate about PLEs in the general population. First, we showed that the QPE screening questions have satisfactory psychometric properties. Researchers need to be aware that because of the open phrasing it is likely going to lead to higher frequencies of PLEs. Still, the open phrasing reduces the risk that participants refrain from reporting PLEs due to social desirability. We also showed that a range of PLEs, especially hallucinatory experiences, are ubiquitous in both individuals with and without a diagnosed mental disorder. Corroborating previous research, PLEs were predicted by young age, use of illegal drugs and parental mental disorder. Finally, the finding that the presence of PLEs discriminates rather poorly between individuals with and without a diagnosed mental disorder further supports the continuum hypothesis, implying a spectrum from subthreshold experiences in healthy people to severe symptoms of psychosis in those with mental disorders.

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DATA AVAILABILITY STATEMENT

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

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