Schizophrenia Research 209 (2019) 32–39

Contents lists available at ScienceDirect

Schizophrenia Research

journal homepage: www.elsevier.com/locate/schres

Predictors of persisting psychotic like experiences in children and adolescents: A scoping review

Janos L. Kalman [a,b,c,*], Michaeline Bresnahan [d], Thomas G. Schulze [a,e,f,g], Ezra Susser [d,h]

[a] Institute of Psychiatric Phenomics and Genomics (IPPG), University Hospital, LMU Munich, Munich, Germany
[b] Department of Psychiatry and Psychotherapy, Ludwig-Maximilians-University Munich, Munich, Germany
[c] International Max Planck Research School for Translational Psychiatry (IMPRS-TP), Munich, Germany
[d] Mailman School of Public Health, Columbia University, New York, NY, United States
[e] Department of Psychiatry and Behavioral Sciences, Johns Hopkins University, Baltimore, MD, United States
[f] Department of Psychiatry and Psychotherapy, University Medical Center, Georg-August University Göttingen, Göttingen, Germany
[g] Department of Genetic Epidemiology in Psychiatry, Medical Faculty Mannheim, Central Institute of Mental Health, University of Heidelberg, Mannheim, Germany
[h] New York State Psychiatric Institute, New York, New York, United States

ARTICLE INFO

Article history:
Received 4 October 2018
Received in revised form 22 February 2019
Accepted 5 May 2019
Available online 17 May 2019

Keywords:
Psychotic like experiences
Trajectory
Remission
Persistence
Children
Adolescents

ABSTRACT

Background: Subclinical psychotic experiences (PLEs) are among the frequently reported mental health problems in children/adolescents. PLEs identified in cross sectional studies of children/adolescents are associated with current and future mental health problems. These associations are stronger for PLEs that persist over time. Hence, it could be useful to examine which children/adolescents with PLEs at a first assessment (baseline) are more likely to have PLEs at subsequent assessments.

Methods: We conducted a scoping review of studies that examined whether characteristics of children/adolescents (≤18 years) with PLEs at baseline predict whether PLEs are likely to be persistent or remittent at subsequent assessments. We included studies published between January 2002 and December 2017, conducted on general child/adolescent populations of ≥300 individuals, that provided data on PLEs for at least 2 time points, had available follow-up data for ≥50% of those assessed for PLEs at baseline and targeted for follow-up examination, and reported the differences between individuals with PLEs that persisted or remitted during the study period.

Results: Six studies met our criteria. Each of them investigated a wide range of baseline characteristics but no predictor of persistence was replicated.

Conclusions: Our knowledge about which children/adolescents with PLEs at an initial assessment are likely to have persistent PLEs at subsequent assessments is sparse. A handful of predictors of persistent PLEs have been investigated so far, and none replicated. A better understanding of these predictors would be an important complement to investigations examining the evolution of PLEs and of mental health problems in children/adolescents.

1. Introduction

Psychosis liability is more common in the general population than the prevalence of psychotic disorders (Linscott and van Os, 2013). Its expression is considered to exist on a continuum and includes conditions such as psychotic (like) experiences (PLE), ultra-high risk states, schizotypal traits and psychotic disorders (Fonseca Pedrero and Debbané, 2017; Linscott and van Os, 2010). The milder, early or atypical manifestations of psychosis liability (e.g. PLEs, clinical high risk (CHR), ultra-high risk (UHR) states) have been subject to intensive research because they may offer opportunities to examine the neurobiological and psychopathological roots of psychoses and inform early prevention, diagnosis and intervention (David and Ajnakina, 2016; Debbané et al., 2015).

Measures of PLEs in population studies have most often assessed positive psychotic like symptoms, such as hearing voices or having unfounded worries of being followed or deliberately harmed; negative, disorganized and cognitive symptoms have received less attention (Linscott and van Os, 2013; van Os et al., 2009; Yung and Lin, 2016). Although PLEs have historically been considered as the mildest expression of psychosis liability, evidence suggests that they are also associated with a wide range of further mental health problems. For example, experiencing PLEs at any time point appears to be associated with distress, functional impairment and more frequent use of mental health services; it is also associated with common mental disorders as well as

* Corresponding author at: Institute of Psychiatric Phenomics and Genomics (IPPG), Medical Center of the University of Munich LMU, Nußbaumstraße 7, 80366 Munich, Germany.
E-mail address: janos.kalman@med.uni-muenchen.de (J.L. Kalman).

https://doi.org/10.1016/j.schres.2019.05.012

psychotic disorders (Jolley et al., 2017; Laurens and Cullen, 2016; Pain et al., 2018).

Studies have shown, that it is usually individuals with pre- and perinatal problems, sociodemographic factors (ethnic minority status, urbanicity, lower socio-economic status, single marital status), exposure to various environmental adversities (abuse, neglect, bullying) and comorbid substance abuse who are at higher risk of developing PLEs (van Os et al., 2009, Linscott and van Os, 2013, Howes & Murray, 2014).

The course and pathophysiological role of PLEs in childhood/adolescence is of special interest as PLEs are most frequent during this developmental period and tend to become less common with age (Laurens et al., 2012; Rubio et al., 2012; Verdoux et al., 1998). Although PLEs are transient in the majority of cases, they are dynamic, and as outlined by the psychosis-proneness-persistence-model, can become persistent if the individual is exposed to ongoing environmental adversities during development (Cougnard et al., 2007). Children whose PLEs persist into late adolescence are at increased risk of adverse outcomes compared to healthy controls or those with only transient PLEs (Calkins et al., 2017; Cougnard et al., 2007; Fisher et al., 2013; Fonville et al., 2015; Thapar et al., 2012; Werbeloff et al., 2012). Therefore, PLE persistence is hypothesized to be indicative of a more serious underlying psychopathological process and often considered as an early and non-specific forerunner of later mental health problems (Escher et al., 2002; van Os et al., 2009; Kelleher et al., 2012; Lancefield et al., 2016).

In recent years considerable research has been done to understand the longitudinal course of PLEs during childhood/adolescence (Rubio et al., 2012). Understanding the differences between children/adolescents who have PLEs at baseline (time point at first cross sectional assessment) but experience a remission and those who continue to experience PLEs over longer periods of time could complement the knowledge gained through the studies that construct trajectories of PLEs in children and adolescents in a dynamic way and might help to develop individually tailored prevention and intervention strategies (Dominguez et al., 2010; van Os et al., 2009). Therefore, we conducted a scoping review of studies that examined the baseline differences between children and adolescents (≤18 years) with persistent (PLE both at baseline and follow-up) and remitting (PLE only at baseline) PLEs.

2. Methods

The central goal of scoping review methodology is to "map the existing literature…in terms of the volume, nature, and characteristics of the primary research" (Arksey and O'Malley, 2005; Daudt et al., 2013; Pham et al., 2014). It also provides an effective strategy to identify critical gaps in the research. As laid out by Arksey and O'Malley (2005), a scoping review includes five stages: identifying the research question, identifying relevant studies, study selection, charting the data, reporting results (Arksey and O'Malley, 2005). We have followed these procedures, deviating only in laying out inclusion/exclusion criteria for study selection a priori, before identifying the relevant studies.

2.1. Identifying the research question

What distinguishes at baseline children and adolescents (≤18 years) with persistent (PLE both at baseline and follow-up) PLEs from those with remitting (PLE only at baseline) PLEs, or with PLE trajectories that could be reasonably characterized as persistent or remitting as described below?

2.2. Study selection: inclusion and exclusion criteria

To answer this question, we identified a priori the following inclusion criteria for studies: (1) the study was published in English language in a peer-reviewed journal between 01.01.2002 and 31.12.2017, (2) study reports original data, (3) study reported on PLEs in a general child/adolescent population (≤18 years) at baseline and follow-up (4) study sample size was ≥300, (5) PLEs were measured at least at two time points, (6) follow-up data was available for ≥50% of those assessed for PLEs at baseline and targeted for follow-up examination, and (7) data on the persistent vs. remitting course comparison for baseline characteristics was either already available or was obtainable from the data presented in the manuscript. The rationale for criterion four is that studies below that sample size have very small numbers of persistent and remitting PLEs and would be subject to random fluctuation. The rationale for criterion six was to limit bias due to attrition.

2.3. Identifying the relevant studies

An electronic search was conducted to identify the studies investigating risk factors for the development of PLEs in child/adolescent general population samples, using the following search term in PubMed:

("psychosis like") OR ("psychotic like") OR ("psychotic experiences") OR ("non-clinical psychotic symptoms") AND (("2002/01/01"[PDat]: "2017/12/31"[PDat])) AND (("2002/01/01"[PDat]: "2017/12/31"[PDat])),

The search was intentionally broad and did not include terms that restricted the screening to longitudinal studies. Articles identified in the electronic search were screened by reading titles and abstracts, followed by methods and results to determine eligibility for inclusion. Additional papers were identified in the references cited in papers meeting inclusion criteria, and through nominations by collaborators. These articles were subjected to the same review procedures. Studies meeting inclusion criteria 1–5 were abstracted using a standardized form. Two investigators (MB, JLK) were involved in the selection process and in case of uncertainty the final decision on the inclusion was made including ES in the decision process, using majority voting.

As shown in Fig. 1, the initial search yielded 1103 results including 23 studies meeting criteria 1–5. Six studies met all inclusion criteria (Bourque et al., 2017; Mackie et al., 2013; Thapar et al., 2012; Thompson et al., 2015; Wigman et al., 2011; Yamasaki et al., 2018). The seventeen studies that met criteria 1–5 but were excluded for not fulfilling criteria 6–7 are listed in Supplementary Table 1 along with the reason for exclusion (Bartels-Velthuis et al., 2012, 2011; Calkins et al., 2017; De Loore et al., 2011, 2007; Downs et al., 2013; El Bouhaddani et al., 2018; Kelleher et al., 2014, 2013; Lancefield et al., 2016; Mackie et al., 2011; Martin et al., 2015; Sullivan et al., 2014; Wallace and Linscott, 2018; Wigman et al., 2012; Wolke et al., 2014; Zammit et al., 2013).

2.4. Extracting and charting the data

We identified 6 articles pertaining to 5 cohort populations with information on baseline differences between the persistent and remitting PLE groups/trajectories. From the included studies, the following qualitative and quantitative data were extracted and analysed: sample characteristics (cohort, sample size, age at the interviews), PLE measurement technique (self-report vs. interview), PLE type (e.g. hallucinations, delusions), methods used to characterize of PLE over time, psychometric properties of the scales used to measure PLEs, predictors of PLE persistence/remittance (Tables 1, 2A, B and Supplementary Table 2 [psychometric properties]).

Studies followed two different approaches to identify PLE courses. In the first approach (*Studies identifying PLE groups*), PLE status was treated categorically (yes/no) at baseline and at follow-up. Here persistence was defined as PLE at baseline and follow-up, and remittance as PLE at baseline but not at follow-up (Thompson et al., 2015; Yamasaki et al., 2018). The second approach derived PLE trajectories based on continuous PLE scores (*Studies identifying PLE trajectories*). These studies found that either 3- (Bourque et al., 2017; Mackie et al., 2013) or 4-cluster

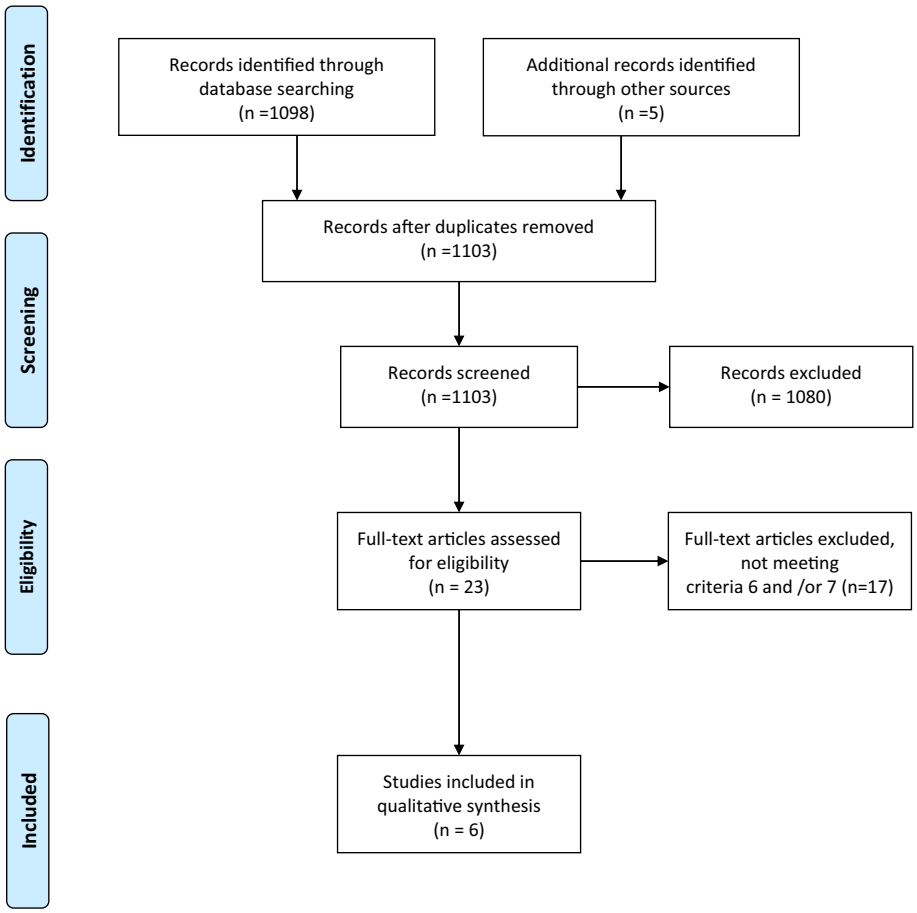

Fig. 1. An overview of the study selection process.

(Thapar et al., 2012; Wigman et al., 2011) solutions fit the data the best. The marked differences in the shape of these trajectories made the presentation and interpretation of the results challenging (i.e. in 3 out of 4 studies children and adolescents with remitting PLEs were characterized by higher PLE severity at baseline than those with persistent PLEs due to the "crossing" of the trajectories) (Bourque et al., 2017; Mackie et al., 2013; Thapar et al., 2012). Trajectories with persistently high (Thapar et al., 2012) or constantly increasing (Bourque et al., 2017; Mackie et al., 2013; Wigman et al., 2011) PLE course were considered as persistent, whereas those with constantly decreasing (Bourque

Table 1
Overview of the study methodology.

Author	Study (country)	Sample size	Mean age (years)	Study duration	Frequency of follow-ups
Studies identifying PLE groups					
Thompson et al., 2015	ALSPAC (United Kingdom)	T0: 4060 T1: 4060	T0: 12	72 months	1
Yamasaki et al., 2018	(Japan)	T0: 887 T1:887	T0: 14	12 months	1
Studies identifying PLE trajectories					
Bourque et al., 2017	Co-venture trial (Canada)	T0: 2566 T1: 2566 T2: 2566 T3: 2566	T0: 12.8	36 months	3
Mackie et al., 2013	London secondary school study (United Kingdom)	T0:1098 T1: 851 T2: 988 T3: 897 T4: 843	T0: 13.6	24 months	4
Thapar et al., 2012	ALSPAC (United Kingdom)	T0: 7572 T1: 7129 T2: 6037 T3: 5131	T0: 11.5	60 months	3
Wigman et al., 2011	TRAILS (Netherlands)	T0: 2230 T1: 2149 T2: 1816	T0: 11.1	62.1 months	2

Abbreviations: ALSPAC: Avon Longitudinal Study of Parents and Children; TRAILS: Tracking Adolescents' Individual Lives Survey;

Table 2
A. Overview of the PLE assessment, prevalence at T0, and persistence (≥2 time points) or remission at follow-up in studies identifying PLE groups. B: Overview of the PLE assessment, PLE trajectory types and trajectory prevalence in studies identifying PLE trajectories.

A

Author	Type of PLE	Instrument	Definition of PLE	PLE frequency	Persisting PLEs (N)	Remitting PLEs (N)
Thompson et al., 2015	Hallucinations, Delusional ideation, Suspiciousness, Thought interference	Psychosis Like Symptom Interview (PLIKSi) 12-items, semi-structured interview Timeframe: 6 months	Any of the symptoms rated as suspected or definite	T0: 11.6% (470) T1: 7.14% (290)	21.3% (100) of those with PLEs at T0. 2.5% of the sample	78.7% (370) of those with PLEs at T0. 9.1% of the sample
Yamasaki et al., 2018	Hallucinations, Delusional ideation	Diagnostic Interview Schedule (DISC) 4-items, self-report Timeframe: not reported	Any of the 4 items answered as "yes, once" or "yes, twice or more".	T0: 16.3% (145) T1: 12.7% (113)	44.13% (64) of those with PLEs at T0. 7.2% of the sample	55.87% (81) of those with PLEs at T0. 9.1% of the sample

B

Author	Type of PLE	Instrument	Definition of PLE	Trajectories in publication	Trajectory considered as persisting (N)	Trajectory considered as remitting (N)
Bourque et al., 2017	Hallucinations, Delusional ideation, Strange experiences	Diagnostic Interview Schedule (DISC) 9 items, self-report Timeframe: 12 months	Item scores were summed to obtain global PLE score.	Low decreasing High decreasing Moderate increasing	8.2% (211) of the sample "Moderate increasing"	7.9% (203) of the sample "High decreasing"
Mackie et al., 2013	Hallucinations, Delusional ideation, Strange experiences	Diagnostic Interview Schedule (DISC) 9-items, self-report Timeframe: 6 months	PLE trajectories based on total PLE score	Low Increasing Elevated	8.4% (79) of the sample "Increasing"	4.7% (44) of the whole sample "Elevated"
Thapar et al., 2012	Hallucinations, Delusional ideation, Suspiciousness, Strange experiences, Thought interference	Psychosis Like Symptom Questionnaire (PLIKS-Q) 7 items, self-report Timeframe: 12 months	Either endorsing hallucination as definitely present or reporting a recurring delusional belief (≥monthly).	Low Persistent Intermittent Decreasing	0.9% (34) of the sample "Persistent"	1.7% (172) of the sample "Decreasing"
Wigman et al., 2011	Hallucinations, Delusional ideation, Strange ideas or behavior	"Thought problems" subscale of the Youth Self Report 9-items, self-report Timeframe: 6 months	PLE trajectories using thought problems subscale score.	Low Increasing Decreasing Persistent	2% (41) of the sample "Persistent"	9% (204) of the sample "Decreasing"

et al., 2017; Thapar et al., 2012; Wigman et al., 2011), or initially increasing but later steeply decreasing (Mackie et al., 2013) PLE scores as remitting.

Baseline characteristics that were evaluated for risk of persistence/remittance across all studies were itemized, and results from each study are shown in Table 3. If at least two studies (i) reported significant increase/decrease in risk of PLE persistence compared to remitting groups/trajectories or (ii) found no association, findings were considered "replicated". Recognizing the limitations of relying on significance testing, we also report raw data for baseline differences in Supplementary Table 3.

3. Results

3.1. Study characteristics

As shown in Table 1 the number of follow-up timepoints for studies working with PLE groups was 1, and the interval between baseline and last follow-up ranged from 12 months to 72 months. The number of follow-up timepoints for studies identifying PLE trajectories was 2–4, and the interval between baseline and last follow-up ranged from 24 months to 62.1 months.

As shown in Table 2A and B, PLEs were measured either with self-report questionnaires (N = 5) or with semi-structured interview (N = 1). Most studies assessed multiple types of PLEs, including hallucinations, delusional ideation, thought problems and strange experiences separately; however, these were always collapsed into a single summary PLE variable. Only Wigman et al. (2011) investigated symptoms (e.g., attentional problems, thoughts of self-harm, repetitive behavior, sleep) outside the core positive symptoms. Interrater reliability and test-retest validity of the PLE measurements was investigated by three studies and were found to range around 0.81 (Supplementary Table 2).

3.2. Baseline differences between the different PLE courses

Six studies compared the different PLE courses for genetics/family history, sociodemographic and early developmental risk factors, personality traits, cognition, substance consumption, stressors and various domains of psychopathology. In total, 28 different baseline predictors were examined by these studies, however each one was usually investigated only by a handful of studies (Table 3).

3.2.1. Studies identifying PLE groups

Children and adolescents with remitting and persistent PLEs were compared for gender (Yamasaki et al., 2018) and frequency of nightmares, parasomnias and night terrors (Thompson et al., 2015) and none of these factors were found to differ across the trajectories.

3.2.2. Studies identifying PLE trajectories

The information for this comparison was based on more studies (4) and a markedly longer list of baseline factors (27). Still, none of the positive/negative associations was reported by more than one study. There was somewhat more consistency in studies reporting no significant differences between the trajectories. These characteristics included gender [*difference/all studies*] (1/4) (Bourque et al., 2017; Mackie et al., 2013; Thapar et al., 2012; Wigman et al., 2011), socioeconomic status (0/3) (Bourque et al., 2017; Mackie et al., 2011; Thapar et al., 2012), IQ (0/2) (Bourque et al., 2017; Thapar et al., 2012), smoking (0/

Table 3
Baseline differences between the persistent/remitting PLE groups and persistent/decreasing PLE trajectories.
("–" not investigated; "↑" higher in persistent PLE groups/trajectories; "↓" lower in persistent PLE groups/trajectories; "0" no association with PLE groups/trajectories)
(**ns**) variable has been investigated as a potential predictor of group/trajectory membership, but no significant association has been found.
Bourque et al., 2017: moderate increasing vs high decreasing; Mackie et al., 2013: increasing vs. elevated; Thapar et al., 2012: persistent vs. decreasing; Wigman et al., 2011: persistent vs. decreasing.

	Studies identifying PLE groups			Studies identifying PLE trajectories				
	Thompson et al., 2015	Yamasaki et al., 2018	Σ	Bourque et al., 2017**	Mackie et al., 2013	Thapar et al., 2012	Wigman et al., 2011**	Σ
Genetics/family history								
Family history of psychosis	–	–	–	–	–	0	–	0/1
Family history of depression or other mental health problems	–	–	–	–	–	0	–	0/1
Sociodemographic								
Gender (male)	–	0	0/1	0	0	0	↓	1/4
Belonging to an ethnic minority group	–	–	–	–	0	–	↑	1/2
Socioeconomic status	–	–	–	0	0	0	–	0/3
Urbanicity			–	–		–	0	0/1
Early developmental risk factors								
Pregnancy, infections during pregnancy, delivery, condition of the child right after birth	–	–	–	–	–	↑	–	1/1
Maternal smoking during pregnancy	–	–	–	–	–	0	–	0/1
Personality traits								
Externalizing	–	–	–	0	–	–	–	0/1
Internalizing	–	–	–	↓	–	–	–	1/1
Borderline personality traits	–	–	–	–	–	0	–	0/1
Cognition								
IQ	–	–	–	0	–	0	–	0/2
Spatial working memory	–	–	–	0	–	–	–	0/1
Delayed recall	–	–	–	0	–	–	–	0/1
Response inhibition	–	–	–	0	–	–	–	0/1
Developmental problems	–	–	–	–	–	–	0	0/1
Substance consumption								
Smoking	–	–	–	0	0	–	–	0/2
Cannabis or other illicit drug use	–	–	–	0	0	–	–	0/2
Alcohol consumption	–	–	–	–	0	–	–	0/1
Stressors								
Bullying/victimization/stressful life events	–	–	–	–	0	–	0	0/2
Psychopathology								
Thought problems	–	–	–	–	–	–	0	0/1
Characteristics of PLEs	–	–	–	↓	–	–	–	1/1
Peer problems	–	–	–	↓	–	–	0	1/2
Autistic traits	–	–	–	–	–	0	–	0/1
Depression	–	–	–	↓	0	0	0	1/4
Anxiety, fear	–	–	–	↓	–	–	0	1/2
Attentional and conduct problems	–	–	–	–	–	0	0	0/2
Nightmares, parasomnias, night terrors	0	– (**ns**)	0/1	–	–	–	–	–

** P-values were calculated by fuller statistical models in the publications.

2), cannabis or other illicit drug use (0/2) (Bourque et al., 2017; Mackie et al., 2013), bullying/victimization (0/2) (Mackie et al., 2013; Wigman et al., 2011), depressive symptoms (1/4) (Bourque et al., 2017; Mackie et al., 2013; Thapar et al., 2012; Wigman et al., 2011) and attentional/conduct problems (0/2) (Thapar et al., 2012; Wigman et al., 2011).

Some of the variability in the results might be related to the already discussed differences in trajectory definition and course. For example Bourque et al. reported that lower baseline symptoms were often more common in the group with the persistent PLE trajectory ("moderate increasing") than among those with a remitting trajectory ("high decreasing") (Bourque et al., 2017).

3.3. Predicting trajectory membership

Only Thompson et al., 2015 has analysed the baseline variables for prediction of persisting vs. remitting group membership. They have investigated the predictive value of nightmares, night terrors and any parasomnia and found no association with group membership (Table 3).

4. Discussion

The aim of this study was to provide a comprehensive overview of current knowledge on the baseline differences in children and adolescents with persistent and remitting PLEs. After reviewing over 1000 manuscripts published since 2002, six studies met our criteria which provided information on this comparison. We could not find any variable that was identified by more than one study. Studies were somewhat more consistent in not finding any significant difference for gender, socioeconomic status, smoking, cannabis or other illicit drug use, bullying/victimization, depressive symptoms and attentional/conduct problems. However, these findings should be interpreted with caution as studies often had low statistical power to detect differences between the persistent and remitting PLE groups.

There are various possible explanations for this scarcity of predictive baseline variables. Firstly, although we selected studies with a baseline sample size exceeding 300 (range in the reviewed studies: N = 887–7572), most studies probably still had low power to compare the much rarer persistent (N = 34–100) and remitting (N = 44–370) groups/trajectories.

Second, the impact of baseline status may be somewhat overshadowed by the dynamic interaction between PLEs and the subsequent exposure to environmental risk and protective factors (Crush et al., 2018; Nelson et al., 2017). Wigman et al. (2011) found evidence that exposure to severe trauma, such as bullying, gossip, violence and sexual harassment during the follow-up period is more frequent in the persistent than in the remitting group (Wigman et al., 2011). Also, Kelleher et al. reported that trauma predicted the onset, whereas its cessation the cessation of PLEs (Kelleher et al., 2013). Technological data collection aids, such as smartwatches and mobile applications enable us to collect real-time data on the psychopathological well-being and environmental characteristics of children and adolescents over longer periods of time, and provide a unique opportunity to relate the baseline characteristics to the longitudinal courses and model the PLE course x environment interaction (Nelson et al., 2017).

Third, there were marked differences, even across the short list of included studies, which made the comparison challenging. It is important to note that while the diagnosis and treatment of most psychosis spectrum constructs are aided by international guidelines, PLEs are still elicited by very differing approaches. The variation in terminology (e.g. PEs vs. PLEs vs. subclinical psychotic symptoms), the lack of standardized thresholds to define PLE severity, the ways PLEs are endorsed (questionnaire vs. lay or clinical interview) and the lack of consensus on whether only positive symptoms or also additional symptom dimensions should be included in the PLE construct, impose conceptual and methodological problems in PLE research (David and Ajnakina, 2016; Lee et al., 2016). In addition, hallucinatory, delusional and unusual experiences were mostly examined together by the reviewed studies, implying that they have equal validity and importance. However, evidence shows that this is not necessarily the case and the relevance of the symptoms varies even within the positive symptom dimension (Cederlöf et al., 2017). For example, Calkins et al. (2017) investigated which positive symptoms discriminated best between the persistent and remitting groups and found, that certain symptoms, such as thought control, mind tricks and the feeling of being persecuted and suspiciousness were not only more severe in the persistent group, but also differentiated between the two groups in the receiver operator curves analysis. On the other hand, differences were smaller for superstitions, grandiosity, predict future, and audible thoughts and these had hardly any influence on group membership. There was also a great variance in the reviewed studies in the number of visits, the total length of the follow-up period, the applied PLE assessment techniques (self-report vs. interview), the coding of PLEs (categorical vs. continuous) and the definition of PLE course (groups vs. trajectories) and the number and shape of the trajectories across the reviewed studies. Lacking independent validation datasets, there was no means to establish one clustering approach as most valid or most generalizable. In this context, in order to enable comparisons across studies, we had to adopt a brute force simplification for characterizing the trajectories and disregard the specificities of the individual studies (e.g. crossing trajectories (Bourque et al., 2017; Mackie et al., 2013; Thapar et al., 2012) or the additional cluster of individuals with stable, intermediate PLEs (Thapar et al., 2012)).

Fourth, the investigated studies also showed marked differences in the definition and assessment of the baseline factors, which introduced an additional layer of heterogeneity and influences the comparison of their results. For example, Bartels-Velthuis et al. (2011) derived socioeconomic status (SES) from "from parental averaged educational levels and family income", Calkins et al. (2017) from parental education and neighbourhood SES, Bourque et al. (2017) and Mackie et al. (2013) from a measure of family affluence (family car ownership, own bedroom, family holidays during the past 12 months, and family computer(s)), whereas Thapar et al. (2012) used parental occupation, education level and housing type as indicators of SES.

Fifth, the information provided by reviewed studies on the predictive power of the individual (or the combined) baseline variables in the persistent vs. remitting comparison was even more limited than that on the baseline differences as only Thompson et al. (2015) provided data on the influence of a baseline variable. Building models to predict e.g. response to medication or conversion from a prodromal state to psychosis has major clinical implications and receives increasing attention with the more widespread availability of big data (Chekroud et al., 2017; Koutsouleris et al., 2018). Similar efforts to separate children/adolescents who are more likely to experience PLE over longer periods of time based on baseline clinical or biological variables could contribute to the development of the PLE field.

Finally, mostly due to our decision not to include studies with >50% drop-out rate, we had to eliminate some studies which investigated the persistent vs. remitting comparison. Without these exclusion criteria an additional three studies, investigating six further baseline variables would have been (Bartels-Velthuis et al., 2011; Calkins et al., 2017; Mackie et al., 2011). These studies have found that PLE severity, a phenotype not investigated by the originally included studies, was higher in the persistent group [difference/all studies] (2/2) (Supplementary Table 3). In addition, these studies provided further evidence that there was no difference between the persistent and remitting groups/trajectories in terms of gender, SES, externalizing, smoking, cannabis and alcohol consumption and depression. In light of their high attrition, however, results from these studies should be interpreted with caution.

5. Conclusion

This study was the first to review the literature on PLE course in the child/adolescent population with a special focus on predictors of PLE persistence. The importance of PLE persistence is now widely recognized and discussed (Dominguez et al., 2011). Large cohorts are available and have been used to understand the dynamics of PLE course over time (Calkins et al., 2017). Whereas large efforts have been made to identify the baseline differences between the no PLE and persistent PLE groups and the associated outcomes, knowledge on the persistent vs. remitting comparison is still missing. Description of these distinctive factors, already recognizable at baseline, might provide complementary knowledge for the identification of children/adolescents who are most likely to benefit from early intervention programs and experience the biggest improvement in terms of future mental well-being or functioning.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2019.05.012.

Contributors

J.L.K., M.B. and E.S. were involved in the study selection process. J.L.K. and M.B. managed the literature searches, abstracted and analysed the data from the reviewed studies. All authors contributed to and have approved the final manuscript.

Funding body agreements and policies

Thomas G. Schulze is supported by the Deutsche Forschungsgemeinschaft (DFG) within the framework of the projects www.kfo241.de and www.PsyCourse.de (SCHU 1603/4-1, 5-1, 7-1) and by a grant awarded from the German Federal Ministry of Education and Research (BMBF) through the Integrated Network IntegraMent (Integrated Understanding of Causes and Mechanisms in Mental Disorders), under the auspices of the e:Med Programme (01ZX1614K). Thomas G. Schulze received additional support from the German Federal Ministry of Education and Research (BMBF) within the framework of the BipoLife network (01EE1404H) and the Dr. Lisa Oehler Foundation, Kassel (Germany).

Declaration of Competing Interest

All other authors declare that they have no conflicts of interest.

Acknowledgements

We thank Mary Colette Perrin, PhD, Assistant Professor of Psychiatry at New York University, who made a major contribution to the early phase of this work before her death.

References

Arksey, H., O'Malley, L., 2005. Scoping studies: towards a methodological framework. Int. J. Soc. Res. Methodol. 8, 19–32. https://doi.org/10.1080/1364557032000119616.

Bartels-Velthuis, A.A., van de Willige, G., Jenner, J.A., van Os, J., Wiersma, D., 2011. Course of auditory vocal hallucinations in childhood: 5-year follow-up study. Br. J. Psychiatry 199, 296–302. https://doi.org/10.1192/bjp.bp.110.086918.

Bartels-Velthuis, A.A., van de Willige, G., Jenner, J.A., Wiersma, D., van Os, J., 2012. Auditory hallucinations in childhood: associations with adversity and delusional ideation. Psychol. Med. 42, 583–593. https://doi.org/10.1017/S0033291711001590.

Bourque, J., Afzali, M.H., O'Leary-Barrett, M., Conrod, P., 2017. Cannabis use and psychotic-like experiences trajectories during early adolescence: the coevolution and potential mediators. J. Child Psychol. Psychiatry 58, 1360–1369. https://doi.org/10.1111/jcpp.12765.

Calkins, M.E., Moore, T.M., Satterthwaite, T.D., Wolf, D.H., Turetsky, B.I., Roalf, D.R., Merikangas, K.R., Ruparel, K., Kohler, C.G., Gur, R.C., Gur, R.E., 2017. Persistence of psychosis spectrum symptoms in the Philadelphia Neurodevelopmental Cohort: a prospective two-year follow-up. World Psychiatry 16, 62–76. https://doi.org/10.1002/wps.20386.

Cederlöf, M., Kuja-Halkola, R., Larsson, H., Sjölander, A., Östberg, P., Lundström, S., Kelleher, I., Lichtenstein, P., 2017. A longitudinal study of adolescent psychotic experiences and later development of substance use disorder and suicidal behavior. Schizophr. Res. 181, 13–16. https://doi.org/10.1016/j.schres.2016.08.029.

Chekroud, A.M., Gueorguieva, R., Krumholz, H.M., Trivedi, M.H., Krystal, J.H., McCarthy, G., 2017. Reevaluating the efficacy and predictability of antidepressant treatments. JAMA Psychiatry 74, 370. https://doi.org/10.1001/jamapsychiatry.2017.0025.

Cougnard, A., Marcelis, M., Myin-Germeys, I., De Graaf, R., Vollebergh, W., Krabbendam, L., Lieb, R., Wittchen, H.-U., Henquet, C., Spauwen, J., Van Os, J., 2007. Does normal developmental expression of psychosis combine with environmental risk to cause persistence of psychosis? A psychosis proneness-persistence model. Psychol. Med. 37, 513–527. https://doi.org/10.1017/S0033291706009731.

Crush, E., Arseneault, L., Moffitt, T.E., Danese, A., Caspi, A., Jaffee, S.R., Matthews, T., Fisher, H.L., 2018. Protective factors for psychotic experiences amongst adolescents exposed to multiple forms of victimization. J. Psychiatr. Res. 104, 32–38. https://doi.org/10.1016/j.jpsychires.2018.06.011.

Daudt, H.M., van Mossel, C., Scott, S.J., 2013. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. BMC Med. Res. Methodol. 13, 48. https://doi.org/10.1186/1471-2288-13-48.

David, A.S., Ajnakina, O., 2016. Psychosis as a continuous phenotype in the general population: the thin line between normality and pathology. World Psychiatry 15, 129–130. https://doi.org/10.1002/wps.20327.

De Loore, E., Drukker, M., Gunther, N., Feron, F., Deboutte, D., Sabbe, B., Mengelers, R., van Os, J., Myin-Germeys, I., 2007. Childhood negative experiences and subclinical psychosis in adolescence: a longitudinal general population study. Early Interv. Psychiatry 1, 201–207. https://doi.org/10.1111/j.1751-7893.2007.00027.x.

De Loore, E., Gunther, N., Drukker, M., Feron, F., Sabbe, B., Deboutte, D., van Os, J., Myin-Germeys, I., 2011. Persistence and outcome of auditory hallucinations in adolescence: a longitudinal general population study of 1800 individuals. Schizophr. Res. 127, 252–256. https://doi.org/10.1016/j.schres.2011.01.015.

Debbané, M., Eliez, S., Badoud, D., Conus, P., Flückiger, R., Schultze-Lutter, F., 2015. Developing psychosis and its risk states through the lens of schizotypy. Schizophr. Bull. 41 (Suppl. 2), S396–S407. https://doi.org/10.1093/schbul/sbu176.

Dominguez, M.-G., Saka, M.C., can Saka, M., Lieb, R., Wittchen, H.-U., van Os, J., 2010. Early expression of negative/disorganized symptoms predicting psychotic experiences and subsequent clinical psychosis: a 10-year study. Am. J. Psychiatry 167, 1075–1082. https://doi.org/10.1176/appi.ajp.2010.09060883.

Dominguez, M.D.G., Wichers, M., Lieb, R., Wittchen, H.-U., van Os, J., 2011. Evidence that onset of clinical psychosis is an outcome of progressively more persistent subclinical psychotic experiences: an 8-year cohort study. Schizophr. Bull. 37, 84–93. https://doi.org/10.1093/schbul/sbp022.

Downs, J.M., Cullen, A.E., Barragan, M., Laurens, K.R., 2013. Persisting psychotic-like experiences are associated with both externalising and internalising psychopathology in a longitudinal general population child cohort. Schizophr. Res. 144, 99–104. https://doi.org/10.1016/j.schres.2012.12.009.

El Bouhaddani, S., van Domburgh, L., Schaefer, B., Doreleijers, T.A.H., Veling, W., 2018. Peer status in relation to psychotic experiences and psychosocial problems in adolescents: a longitudinal school-based study. Eur. Child Adolesc. Psychiatry 27, 701–710. https://doi.org/10.1007/s00787-017-1063-2.

Escher, S., Romme, M., Buiks, A., Delespaul, P., Van Os, J., 2002. Independent course of childhood auditory hallucinations: a sequential 3-year follow-up study. Br. J. Psychiatry Suppl. 43, s10–s18.

Fisher, H.L., Caspi, A., Poulton, R., Meier, M.H., Houts, R., Harrington, H., Arseneault, L., Moffitt, T.E., 2013. Specificity of childhood psychotic symptoms for predicting schizophrenia by 38 years of age: a birth cohort study. Psychol. Med. 43, 2077–2086. https://doi.org/10.1017/S0033291712003091.

Fonseca Pedrero, E., Debbané, M., 2017. Schizotypal traits and psychotic-like experiences during adolescence: an update. Psicothema 29, 5–17. https://doi.org/10.7334/psicothema2016.209.

Fonville, L., Cohen Kadosh, K., Drakesmith, M., Dutt, A., Zammit, S., Mollon, J., Reichenberg, A., Lewis, G., Jones, D.K., David, A.S., 2015. Psychotic experiences, working memory, and the developing brain: a multimodal neuroimaging study. Cereb. Cortex 25, 4828–4838. https://doi.org/10.1093/cercor/bhv181.

Howes, O.D., Murray, R.M., 2014. Schizophrenia: an integrated sociodevelopmental-cognitive model. Lancet 383 (9929), 1677–1687. https://doi.org/10.1016/S0140-6736(13)62036-X (Epub 2013 Dec 6. Review).

Jolley, S., Browning, S., Corrigall, R., Laurens, K.R., Hirsch, C., Bracegirdle, K., Gin, K., Muccio, F., Stewart, C., Banerjea, P., Kuipers, E., Garety, P., Byrne, M., Onwumere, J., Achilla, E., McCrone, P., Emsley, R., 2017. Coping with Unusual ExperienceS for 12–18 year olds (CUES+): a transdiagnostic randomised controlled trial of the effectiveness of cognitive therapy in reducing distress associated with unusual experiences in adolescent mental health services: study proto. Trials 18, 586. https://doi.org/10.1186/s13063-017-2326-4.

Kelleher, I., Keeley, H., Corcoran, P., Lynch, F., Fitzpatrick, C., Devlin, N., Molloy, C., Roddy, S., Clarke, M.C., Harley, M., Arseneault, L., Wasserman, C., Carli, V., Sarchiapone, M., Hoven, C., Wasserman, D., Cannon, M., 2012. Clinicopathological significance of psychotic experiences in non-psychotic young people: evidence from four population-based studies. Br. J. Psychiatry 201, 26–32. https://doi.org/10.1192/bjp.bp.111.101543.

Kelleher, I., Keeley, H., Corcoran, P., Ramsay, H., Wasserman, C., Carli, V., Sarchiapone, M., Hoven, C., Wasserman, D., Cannon, M., 2013. Childhood trauma and psychosis in a prospective cohort study: cause, effect, and directionality. Am. J. Psychiatry 170, 734–741. https://doi.org/10.1176/appi.ajp.2012.12091169.

Kelleher, I., Cederlöf, M., Lichtenstein, P., 2014. Psychotic experiences as a predictor of the natural course of suicidal ideation: a Swedish cohort study. World Psychiatry 13, 184–188. https://doi.org/10.1002/wps.20131.

Koutsouleris, N., Kambeitz-Ilankovic, L., Ruhrmann, S., Rosen, M., Ruef, A., Dwyer, D.B., Paolini, M., Chisholm, K., Kambeitz, J., Haidl, T., Schmidt, A., Gillam, J., Schultze-Lutter, F., Falkai, P., Reiser, M., Riecher-Rössler, A., Upthegrove, R., Hietala, J., Salokangas, R.K.R., Pantelis, C., Meisenzahl, E., Wood, S.J., Beque, D., Brambilla, P., Borgwardt, S., PRONIA Consortium, 2018. Prediction models of functional outcomes for individuals in the clinical high-risk state for psychosis or with recent-onset depression. JAMA Psychiatry 75, 1156. https://doi.org/10.1001/jamapsychiatry.2018.2165.

Lancefield, K.S., Raudino, A., Downs, J.M., Laurens, K.R., 2016. Trajectories of childhood internalizing and externalizing psychopathology and psychotic-like experiences in adolescence: a prospective population-based cohort study. Dev. Psychopathol. 28, 527–536. https://doi.org/10.1017/S0954579415001108.

Laurens, K.R., Cullen, A.E., 2016. Toward earlier identification and preventative intervention in schizophrenia: evidence from the London Child Health and Development Study. Soc. Psychiatry Psychiatr. Epidemiol. 51, 475–491. https://doi.org/10.1007/s00127-015-1151-x.

Laurens, K.R., Hobbs, M.J., Sunderland, M., Green, M.J., Mould, G.L., 2012. Psychotic-like experiences in a community sample of 8000 children aged 9 to 11 years: an item response theory analysis. Psychol. Med. 42, 1495–1506. https://doi.org/10.1017/S0033291711002108.

Lee, K.-W., Chan, K.-W., Chang, W.-C., Lee, E.H.-M., Hui, C.L.-M., Chen, E.Y.-H., 2016. A systematic review on definitions and assessments of psychotic-like experiences. Early Interv. Psychiatry 10, 3–16. https://doi.org/10.1111/eip.12228.

Linscott, R.J., van Os, J., 2010. Systematic reviews of categorical versus continuum models in psychosis: evidence for discontinuous subpopulations underlying a psychometric continuum. Implications for DSM-V, DSM-VI, and DSM-VII. Annu. Rev. Clin. Psychol. 6, 391–419. https://doi.org/10.1146/annurev.clinpsy.032408.153506.

Linscott, R.J., van Os, J., 2013. An updated and conservative systematic review and meta-analysis of epidemiological evidence on psychotic experiences in children and adults: on the pathway from proneness to persistence to dimensional expression across mental disorders. Psychol. Med. 43, 1133–1149. https://doi.org/10.1017/S0033291712001626.

Mackie, C.J., Castellanos-Ryan, N., Conrod, P.J., 2011. Developmental trajectories of psychotic-like experiences across adolescence: impact of victimization and substance use. Psychol. Med. 41, 47–58. https://doi.org/10.1017/S0033291710000449.

Mackie, C.J., O'Leary-Barrett, M., Al-Khudhairy, N., Castellanos-Ryan, N., Struve, M., Topper, L., Conrod, P., 2013. Adolescent bullying, cannabis use and emerging psychotic experiences: a longitudinal general population study. Psychol. Med. 43, 1033–1044. https://doi.org/10.1017/S003329171200205X.

Martin, G., Thomas, H., Andrews, T., Hasking, P., Scott, J.G., 2015. Psychotic experiences and psychological distress predict contemporaneous and future non-suicidal self-injury and suicide attempts in a sample of Australian school-based adolescents. Psychol. Med. 45, 429–437. https://doi.org/10.1017/S0033291714001615.

Nelson, B., McGorry, P.D., Wichers, M., Wigman, J.T.W., Hartmann, J.A., 2017. Moving from static to dynamic models of the onset of mental disorder: a review. JAMA Psychiatry 74, 528–534. https://doi.org/10.1001/jamapsychiatry.2017.0001.

Pain, O., Dudbridge, F., Cardno, A.G., Freeman, D., Lu, Y., Lundstrom, S., Lichtenstein, P., Ronald, A., 2018. Genome-wide analysis of adolescent psychotic-like experiences shows genetic overlap with psychiatric disorders. Am. J. Med. Genet. B Neuropsychiatr. Genet. 177, 416–425. https://doi.org/10.1002/ajmg.b.32630.

Pham, M.T., Rajić, A., Greig, J.D., Sargeant, J.M., Papadopoulos, A., McEwen, S.A., 2014. A scoping review of scoping reviews: advancing the approach and enhancing the consistency. Res. Synth. Methods 5, 371–385. https://doi.org/10.1002/jrsm.1123.

Rubio, J.M., Sanjuán, J., Flórez-Salamanca, L., Cuesta, M.J., 2012. Examining the course of hallucinatory experiences in children and adolescents: a systematic review. Schizophr. Res. 138, 248–254. https://doi.org/10.1016/j.schres.2012.03.012.

Sullivan, S.A., Wiles, N., Kounali, D., Lewis, G., Heron, J., Cannon, M., Mahedy, L., Jones, P.B., Stochl, J., Zammit, S., 2014. Longitudinal associations between adolescent psychotic experiences and depressive symptoms. PLoS One 9, e105758. https://doi.org/10.1371/journal.pone.0105758.

Thapar, A., Heron, J., Jones, R.B., Owen, M.J., Lewis, G., Zammit, S., 2012. Trajectories of change in self-reported psychotic-like experiences in childhood and adolescence. Schizophr. Res. 140, 104–109. https://doi.org/10.1016/j.schres.2012.06.024.

Thompson, A., Lereya, S.T., Lewis, G., Zammit, S., Fisher, H.L., Wolke, D., 2015. Childhood sleep disturbance and risk of psychotic experiences at 18: UK birth cohort. Br. J. Psychiatry 207, 23–29. https://doi.org/10.1192/bjp.bp.113.144089.

van Os, J., Linscott, R.J., Myin-Germeys, I., Delespaul, P., Krabbendam, L., 2009. A systematic review and meta-analysis of the psychosis continuum: evidence for a psychosis proneness–persistence–impairment model of psychotic disorder. Psychol. Med. 39, 179. https://doi.org/10.1017/S0033291708003814.

Verdoux, H., van Os, J., Maurice-Tison, S., Gay, B., Salamon, R., Bourgeois, M., 1998. Is early adulthood a critical developmental stage for psychosis proneness? A survey of delusional ideation in normal subjects. Schizophr. Res. 29, 247–254.

Wallace, S., Linscott, R.J., 2018. Intra-individual variability and psychotic-like experiences in adolescents: findings from the ALSPAC cohort. Schizophr. Res. 195, 154–159. https://doi.org/10.1016/j.schres.2017.10.028.

Werbeloff, N., Drukker, M., Dohrenwend, B.P., Levav, I., Yoffe, R., van Os, J., Davidson, M., Weiser, M., 2012. Self-reported attenuated psychotic symptoms as forerunners of severe mental disorders later in life. Arch. Gen. Psychiatry 69, 467. https://doi.org/10.1001/archgenpsychiatry.2011.1580.

Wigman, J.T.W., van Winkel, R., Raaijmakers, Q.A.W., Ormel, J., Verhulst, F.C., Reijneveld, S.A., van Os, J., Vollebergh, W.A.M., 2011. Evidence for a persistent, environment-dependent and deteriorating subtype of subclinical psychotic experiences: a 6-year longitudinal general population study. Psychol. Med. 41, 2317–2329. https://doi.org/10.1017/S0033291711000304.

Wigman, J.T.W., van Winkel, R., Ormel, J., Verhulst, F.C., van Os, J., Vollebergh, W.A.M., 2012. Early trauma and familial risk in the development of the extended psychosis phenotype in adolescence. Acta Psychiatr. Scand. 126, 266–273. https://doi.org/10.1111/j.1600-0447.2012.01857.x.

Wolke, D., Lereya, S.T., Fisher, H.L., Lewis, G., Zammit, S., 2014. Bullying in elementary school and psychotic experiences at 18 years: a longitudinal, population-based cohort study. Psychol. Med. 44, 2199–2211. https://doi.org/10.1017/S0033291713002912.

Yamasaki, S., Usami, S., Sasaki, R., Koike, S., Ando, S., Kitagawa, Y., Matamura, M., Fukushima, M., Yonehara, H., Foo, J.C., Nishida, A., Sasaki, T., 2018. The association between changes in depression/anxiety and trajectories of psychotic-like experiences over a year in adolescence. Schizophr. Res. 195, 149–153. https://doi.org/10.1016/j.schres.2017.10.019.

Yung, A.R., Lin, A., 2016. Psychotic experiences and their significance. World Psychiatry 15, 130–131. https://doi.org/10.1002/wps.20328.

Zammit, S., Kounali, D., Cannon, M., David, A.S., Gunnell, D., Heron, J., Jones, P.B., Lewis, S., Sullivan, S., Wolke, D., Lewis, G., 2013. Psychotic experiences and psychotic disorders at age 18 in relation to psychotic experiences at age 12 in a longitudinal population-based cohort study. Am. J. Psychiatry 170, 742–750. https://doi.org/10.1176/appi.ajp.2013.12060768.