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Mediating role of aberrant salience and self-disturbances for the relationship between childhood trauma and psychotic-like experiences in the general population

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ABSTRACT

Introduction: The relationship between childhood trauma and the risk of psychosis is well established. However, the mechanisms of the relationship are still unknown. We investigated whether two factors involved in the risk of psychosis – self-disturbances and aberrant salience – mediate the relationship between childhood trauma and psychotic-like experiences in the general population.
Methods: We tested parallel mediation models which assume that the relationship between childhood trauma (Childhood Trauma Questionnaire, the CTQ) and psychotic-like experiences (Prodromal questionnaire, PQ-16) is mediated by both self-disturbances and aberrant salience (Aberrant Salience Inventory, the ASI) in a general population sample ($N = 649$). Separate parallel mediation models were calculated for cumulative childhood trauma, exposure to abusive behaviors (emotional, physical and sexual abuse) and neglect (emotional and physical neglect) controlling for gender.
Results: Childhood traumatic life events predicted psychotic-like experiences. Childhood trauma was also related to self-disturbances and aberrant salience. Self-disturbances and aberrant salience were related to psychotic-like experiences. Models of mediation for the relationship between cumulative childhood trauma and neglect and psychotic-like experiences revealed an indirect-only mediation by self-disturbances and aberrant salience. The model for childhood abuse suggested a complementary mediation and was affected by gender.
Conclusions: Our results provide tentative evidence that self-disturbances and aberrant salience are important factors in the translation of childhood trauma into the risk of psychosis in the general population. Causal relationships could not be inferred from this cross-sectional data. Hence, longitudinal studies on a clinical sample are warranted.

1. Introduction

In the last decade, an increasing number of studies have shown that exposure to childhood trauma is an important environmental factor enhancing the risk of psychosis at early stages (Aas et al., 2011; Bechdolf et al., 2010). Indeed, different states from the continuum of psychosis, including psychotic-like experiences in the general population (Kelleher et al., 2013; McGrath et al., 2017; Sun et al., 2017a; Sun et al., 2017b), at risk states for psychosis (Kraan et al., 2015a; Thompson et al., 2009) and full-blown psychotic disorders (Heins et al., 2011; Isvoranu et al., 2017; Schäfer et al., 2006; Spence et al., 2006; Üçok and Bıkmaz, 2007) are related to prior exposure to traumatic events. These findings have been summed up in independent meta-analyses (Bailey et al., 2018; Kraan et al., 2015b; van Dam et al., 2012; Varese et al., 2012b), which confirmed that early exposure to traumatic experiences increases the risk of psychosis. Prospective studies revealed that exposure to early trauma predicts the transition from clinical at risk for psychosis states to full-blown psychosis (Bechdolf et al., 2010; Thompson et al., 2014). Childhood trauma was found to be related to structural and functional brain alterations and basic neurocognitive deficits (Aas et al., 2011; Aas et al., 2012; Berthelot et al., 2015; Hoy et al., 2011). However, only a few studies investigated the role of self-disturbances and information processing biases (i.e., cognitive biases), which have been suggested as important risk factors for psychosis, as potential mechanisms (mediators) of the between childhood trauma and the risk of psychosis.

The development of full-blown psychotic symptoms is preceded by pervasive changes in the structure of experience of the world and the

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self as suggested by phenomenological analyses (Raballo et al., 2009). A renaissance of the interest in the role of disruptions of self in schizophrenia spectrum psychoses has revealed self-disturbances as the very core characteristic of the condition that is present as early as its early manifestation (Nordgaard and Parnas, 2014; Parnas et al., 2016; Parnas et al., 2011). Self-disturbances (e.g., depersonalization, derealization, thought blocking, loss of though ipseity, hyperreflectivity, see Parnas et al. (2005b) for a detailed description) in schizophrenia spectrum disorders have been defined as alterations in basic self-awareness that refer to the most fundamental level of selfhood, that is, the minimal self ('ipseity') (Hur et al., 2014; Parnas and Handest, 2003), that is to say to the implicit, pre-reflective sense of ownership of experience ('myness') and sense of agency. This aspect or level of selfhood is thought to be unstable in schizophrenia spectrum disorders, giving rise to anomalous subjective experiences, which may evolve into frank psychotic symptoms (Parnas and Henriksen, 2014). According to this model, self-disturbances are a core feature of schizophrenia spectrum psychosis (Sass and Parnas, 2003). Indeed, empirical studies confirmed that patients with schizophrenia spectrum disorders have more of these anomalies in the experience of the self (Parnas et al., 2011). In line with theoretical considerations, self-disturbances have also been confirmed among non-clinical samples with elevated psychotic-like experiences (Gawęda et al., 2018c; Gawęda et al., 2018a; Koren et al., 2013). Furthermore, it was found that even among non-help seekers self-disturbances predict prodromal symptoms of psychosis (Koren et al., 2016). In the search for mechanisms of the relationship between early exposure to trauma and the risk of psychosis, studies have shown that self-disturbances are related to traumatic experiences. Haug et al. (2015) found that traumatic events increase self-disturbances in schizophrenia. Recently, it was found that self-disturbances mediate the relationship between traumatic-life events and psychosis proneness in the general population (Gawęda et al., 2018c; Gawęda et al., 2018a). These findings suggest that trauma may have an impact on the risk of psychosis through alterations in the core self.

Exposure to trauma, especially to interpersonal violence (bullying, physical abuse or sexual abuse) may change individuals' information processing patterns (e.g., 'one should not trust people'; 'people may be dangerous'). Some studies have found that childhood abuse is related to a decrease in Theory of Mind among women with PTSD (Nazarov et al., 2014) and in the general population (Germine et al., 2015). The relationship between theory of mind and childhood trauma was also verified among patients with schizophrenia (Mrizak et al., 2016) and was related to disturbances of brain networks engaged in the processing of mental states (Cancel et al., 2017; Quidé et al., 2017). However, none of the studies has linked the aberrant salience and self-disturbances, as suggested by Nelson et al., 2014a, 2014b, in the relationship between childhood trauma and the risk of psychosis.

According to the model proposed by Kapur (2003), the tendency to assign salience to neutral stimuli is due to excessive dopamine release that underlies psychotic symptoms. Indeed, aberrant salience has been related to psychotic symptoms (Ceaser and Barch, 2016; Heinz and Schlagenhauf, 2010; Pankow et al., 2016; Roiser et al., 2009; White et al., 2010). More recently Howes and Murray (2014) suggested that aberrant processing of stimuli results from an excessive pre-synaptic release, which is triggered by exposure to traumatic events. It was suggested that excessive attention to irrelevant stimuli, that is, aberrant salience, may be a neurocognitive basis of such self-disturbances related to the risk of psychosis such as hyper-reflexivity, disturbances of 'common sense' or disruptions in the grip of perceptual field (Nelson et al., 2014a, 2014b). To our knowledge, to date, the relationship between trauma and aberrant salience has not yet been investigated. The hypothesis of the mediating role of aberrant salience in the relationship between self-disturbances and psychosis was also not examined. Combining these two models may reveal the interplay between self-disturbances and aberrant salience and provide an explanatory model for the relationship between exposure to childhood trauma and psychosis proneness.

Hence, for the first time our study aimed to combine the findings showing the role of aberrant salience and self-disturbances in psychosis and hypotheses about the relationship between these factors into one parallel mediation model to better understand the mechanisms of the relationship between childhood trauma and PLEs. We hypothesized that the relationship between childhood trauma and psychotic-like experiences is mediated by both self-disturbances and aberrant salience. Given the fact that self-disturbances and aberrant salience are correlated (Nelson et al., 2014a, 2014b), but that at the same time their causal linkage was only examined in cross-sectional studies and is likely bidirectional (Gawęda et al., 2018b) we investigated parallel mediation models instead of serial mediation models. We analyzed a cumulative exposure to childhood trauma (all measured events), as well as exposure to abusive behaviors (emotional, physical and sexual abuse, PTSD, OCD and neglect (emotional and physical)).

2. Methods

2.1. Participants

Participants were recruited from the WiSo Panel, an academic online service in Germany that provides scientists with the opportunity to advertise research studies to potential participants (Göritz, 2014). Thus, all data were gathered online. The sample consisted of 649 individuals (358 women and 291 men) with no history of psychiatric disorders during their life (psychosis, depression, bipolar, anxiety disorders, eating disorders and personality disorders were considered in a self-report questionnaire on a lifetime diagnosis). Mean age was 51.1 years ($SD = 14.90$) and ranged between 21 and 80 years. The local ethics committee approved the study.

2.2. Measures

2.2.1. Prodromal Questionnaire (PQ-16)

The PQ-16 (Ising et al., 2012) is a self-report questionnaire to screen for psychosis risk operationalized as a presence of psychotic-like experiences. It is a shortened version of the 92-item version of the PQ and consists of items targeting attenuated positive symptoms, negative symptoms, disorganized symptoms and general symptoms along two scales: the presence of the experience – (true vs. false) and distress associated with the experience (4-point Likert scale). In the present study, we focused only on the first scale (present vs. non-present). Most of the items in the PQ-16 refer to the attenuated positive symptoms (e.g., 'My thoughts are sometimes so strong that I can almost hear them; I often hear unusual sounds like banging, clicking, hissing, clapping or ringing in my ears; I have heard things other people can't hear like voices of people whispering or talking'). The PQ-16 has satisfactory psychometric characteristics in the assessment of psychotic-like experiences with a specificity and sensitivity of 87% in discriminating patients meeting the criteria of UHR from those who do not meet UHR criteria (Ising et al., 2012). The total score of PQ-16 was calculated.

2.2.2. Traumatic events (CTQ)

We used the 28 items Childhood Trauma Questionnaire (Bernstein et al., 1994), which poses questions on the presence of different types of traumatic experiences: emotional, physical and sexual abuse, emotional and physical neglect. For the present analysis, we summed the first three subscales into a variable 'childhood abuse'. Similarly, by summing up emotional and physical neglect, we obtained the variable 'childhood neglect'. Items have to be endorsed on a Likert-scale from 1 (never true) to 5 (very often true). The CTQ is often used for investigating exposure to traumatic life experiences in psychiatric disorders and has satisfactory psychometric quality (Karos et al., 2014).

2.2.3. The Aberrant Salience Inventory (ASI)

The ASI (Cicero et al., 2010) was used to quantify the tendency to assign salience to inadequate stimuli. The ASI consists of 29 self-report items with a yes-no (0–1) response format. The original version the ASI has five subscales and good reliability. Studies confirmed that the ASI is related to the higher psychometric risk of psychosis (Cicero et al., 2015; Raballo et al., 2017). In the present study, we used an abbreviated 10-item version of the scale that was prepared based on the results of the study by. Cicero et al. (2010). We choose 10 items with the highest loadings to the total scores of the ASI. Cronbach's alpha for the 10 items ASI was 0.70.

2.2.4. Inventory of Psychotic-like Anomalous Self-Experiences (IPASE)

The IPASE (Cicero et al., 2017) was developed on the basis of phenomenological considerations of basic self-disturbances in psychosis (Parnas et al., 2005). Although the authors based the instrument on the gold-standard in the assessment of the self-disturbances — The Examination of Anomalous Self Experience (EASE) interview (Parnas et al., 2005) — none of the items were directly taken from that instrument. Hence, the IPASE should be considered as an independent tool rather a self-report version of existing clinical interviews. The IPASE consists of 57 items that are clustered into five dimensions, representing qualitatively different aspects of basic self-disturbance: 1) Cognition (e.g., 'It feels like my thoughts are being generated by someone else'); 2) Self-Awareness and Presence ('I feel like my current life is not connected with my life in the future'); 3) Consciousness (e.g., 'I have difficulty telling whether I am experiencing something or just imagining it'); 4) Somatization (e.g., 'I feel like my body has changed') and 5) Demarcation/Transitivism (e.g., 'I wonder whether or not I truly exist'). Recently, the scale has been used in studies on psychosis proneness (Cicero et al., 2017) and among SSD patients (Cicero et al., 2016). In the present study, we used an abbreviated version of the IPASE that contains items with the highest loadings on the total scale. The abbreviated version had 10 items and good reliability with Cronbach's alpha = 0.80.

2.3. Statistics

We analyzed the data using SPSS 24. First, bivariate Pearsons' correlations were calculated to establish a relationship between measured variables. The main mediation analysis was performed based on the PROCESS macro (Preacher and Hayes, 2004). According to Baron and Kenny (1986) approach to mediation, in the first step, we checked in the regression analysis if the direct effect (path c) between independent (childhood trauma) and dependent (psychotic-like experiences) was significant. Second, we checked if the independent variable predicted the proposed mediators (self-disturbances and aberrant salience). Third, mediators were assessed for predictiveness of the dependent variable after controlling for the independent variable. The results were interpreted according to recent advances in mediation analysis (Zhao et al., 2010). Indirect-only mediation (i.e., a full mediation in Baron and Kenny's terminology) occurs in the case that at the same time paths a and b are significant, and the direct effect (path c′) (i.e., the relationship between the independent variable and the dependent variable controlling for mediators) becomes non-significant. Complementary mediation (i.e., partial mediation in Baron and Kenny's terminology) occurs when c′ is significant after including mediators into the model. Given the fact that some studies have shown that some types of trauma are related to the risks of psychosis in particular (Bentall et al., 2012; Sitko et al., 2014), we performed separate analyses for cumulative exposure to childhood trauma (all traumatic events measured using the CTQ), as well as for exposure to abusive behaviors (emotional, physical and sexual abuse) and neglect (physical and emotional). If gender differences occur we considered gender as a covariate in the mediation analysis.

We predicted that aberrant salience and self-disturbances mediate the relationship between childhood trauma and psychotic-like experiences. The analysis was conducted with parallel model 4 in PROCESS. Hence, two mediators (aberrant salience and self-disturbances) were considered in parallel. The parallel model allows testing the role of each mediation while accounting for the shared variation between mediators. Mediators may be correlated, but the causal relationship between them is not considered in the model (Hayes, 2013). If significant differences between men and women occurred, we controlled for gender in the analysis. The significance of the indirect effects was derived based on a bias-corrected bootstrap confidence interval (CI) based on 5.000 bootstraps. Significant indirect effects were reported if CI that did not contain zero.

3. Results

3.1. Sample characteristics

Table 1 presents sample characteristics. We checked for gender differences in all variables. There were no differences on CTQ, $t(647) = 1.632$, $p = 0.103$, IPASE, $t(647) = 0.130$, $p = 0.897$ and PQ-16, $t(647) = 0.994$, $p = 0.321$. However, we found that women had significantly higher scores on ASI than men, $t(647) = 2.837$, $p = 0.005$.

3.2. Correlation analysis

The results from the correlational analysis are presented in Table 2. Significant relationship between the CTQ total scores ($r = 0.27$, $p < 0.001$), as well as between abuse ($r = 0.31$, $p < 0.001$) and neglect ($r = 0.17$, $p < 0.01$) and psychotic-like experiences (PQ-16) were found. Similarly, the CTQ total score was also related to aberrant salience ($r = 0.20$, $p < 0.001$) and self-disturbances ($r = 0.39$, $p < 0.001$). At the same time, we found that psychotic-like experiences significantly correlated with aberrant salience ($r = 0.56$, $p < 0.001$) and self-disturbances ($r = 0.55$, $p < 0.001$).

3.3. Mediated models

3.3.1. Cumulative trauma

All results of the mediation analyses are presented in Fig. 1. Given the gender differences for ASI, gender was included as a covariate in the mediation analysis.

The total effect for the relationship between cumulative childhood trauma and psychotic-like experiences significantly differed from zero,

Table 1
Sample characteristics.

	M	*SD*	Range	Number of items
Sex (F/M)	358/291	–	–	–
Age	51.09	13.96	21–80	–
PQ-16	2.17	2.38	0–16	16
ASI	2.26	2.03	0–10	10
IPASE	15.96	5.96	10–38	10
Cumulative Trauma	36.88	11.58	25–86	25
Neglect	17.40	6.37	10–37	10
Abuse	19.48	6.70	11–64	15
Physical neglect	7.22	2.46	5–17	5
Emotional neglect	10.17	4.59	5–25	5
Sexual abuse	5.65	2.11	2–21	5
Physical abuse	6.27	2.68	4–23	5
Emotional abuse	7.56	3.51	4–23	5

Note: PQ-16 – Prodrome Questionnaire 16 items; ASI – Aberrant Salience Inventory; IPASE - Inventory of Psychotic-like Anomalous Self-Experiences; Cummulative Trauma – total score of the CTQ; Neglect – a summary of physical and emotional neglect subscales of the CTQ; Abuse – a summary of sexual, physical and emotional abuse subscales of the CTQ.

Table 2
Correlational matrix ($n = 649$).

	ASI	IPASE	Cumulative trauma	Neglect	Abuse	Physical neglect	Emotional neglect	Sexual abuse	Physical abuse	Emotional abuse
PQ-16	0.56***	0.55***	0.27***	0.17***	0.31***	0.17***	0.14***	0.18***	0.23***	0.30***
ASI		0.42***	0.20***	0.11**	0.24***	0.11**	0.09*	0.17***	0.15***	0.24***
IPASE	–	–	0.39***	0.36***	0.33***	0.34***	0.32***	0.20***	0.28***	0.30***

* - $p < 0.05$.
** - $p < 0.01$.
*** - $p < 0.001$.

$t(647) = 7.089$, $p < 0.001$, CI [0.04–0.07]. The direct effect became insignificant $t(647) = 1.55$, $p = 0.12$, CI [− 0.028–0.023]. The total effect explained 4.77% of the variance of psychotic-like experiences, while the mediated model explained 44.45% of the variance. CI for all indirect effects CTQ ->ASI ->PQ-16 [CI 0.008–0.024], and the CTQ ->IPASE ->PQ-16 [0.02–0.039] indicate, that both indirect effects were significantly differ from zero. Gender was not a significant predictor in the model.

3.3.2. Mediated models for childhood abuse and neglect

The total effect of neglect on psychotic-like experiences was significant, $t(647) = 4.35$, $p < 0.001$, CI [0.035–0.09] with 3.0% of the variance explained. After including mediators direct effect turned out to be non-significant, $t(647) = 0.43$, $p = 0.66$, CI [−0.02–0.02]. The mediated model explained 44.26% of the variance. All indirect effects were significantly different from zero: Neglect ->ASI ->PQ-16, CI [0.04–0.03], 25.50% variance of the total effect explained, Neglect ->IPASE ->PQ-16, CI [0.03–0.07] 73.16%, variance of the total effect explained. Gender was not a significant predictor in the model.

The total effect of exposure to abusive behaviors on psychotic-like experiences was significant: $t(647) = 8.12$, $p < 0.001$, CI [0.08–0.13], and explained 9.41% of the variance. The direct model remained significant, $t(647) = 3.07$, $p = 0.002$, CI [0.01–0.05] and explained 45.05% of the variance. CI of all indirect effects suggested that all effects were significantly differ from zero, Abuse ->IPASE ->PQ-16, CI [0.03–0.06]; Abuse ->ASI ->PQ-16, CI [0.02–0.04]. We found that gender was a significant predictor in the model. Thus, we re-analyzed the model for men ($n = 358$) and women ($n = 291$) separately.

The model for men revealed the total effect to be significant, $t(287) = 9.07$, $p < 0.001$, CI [0.14–0.21] and explained 22.17% of the variance. The direct model remained significant after mediators were included, $t(289) = 5.60$, $p < 0.000$, CI [0.06–0.14] suggesting complementary mediation. The mediation model explained 48.93% of the variance. Both indirect pathways significantly differed from zero, Abuse ->IPASE ->PQ-16, CI [0.01–0.02] and Abuse ->ASI ->PQ-16, CI [0.01–0.06].

Similarly, the model for women revealed a significant total effect of childhood abuse on PLEs, $t(356) = 3.72$, $p < 0.001$, CI [0.03–0.10] and explained 3.74% of the variance. The direct effect remained significantly different from zero after mediators were included, $t(356) = 0.11$, $p = 0.91$, CI [−0.02–0.02] suggesting indirect-only mediation. The mediated

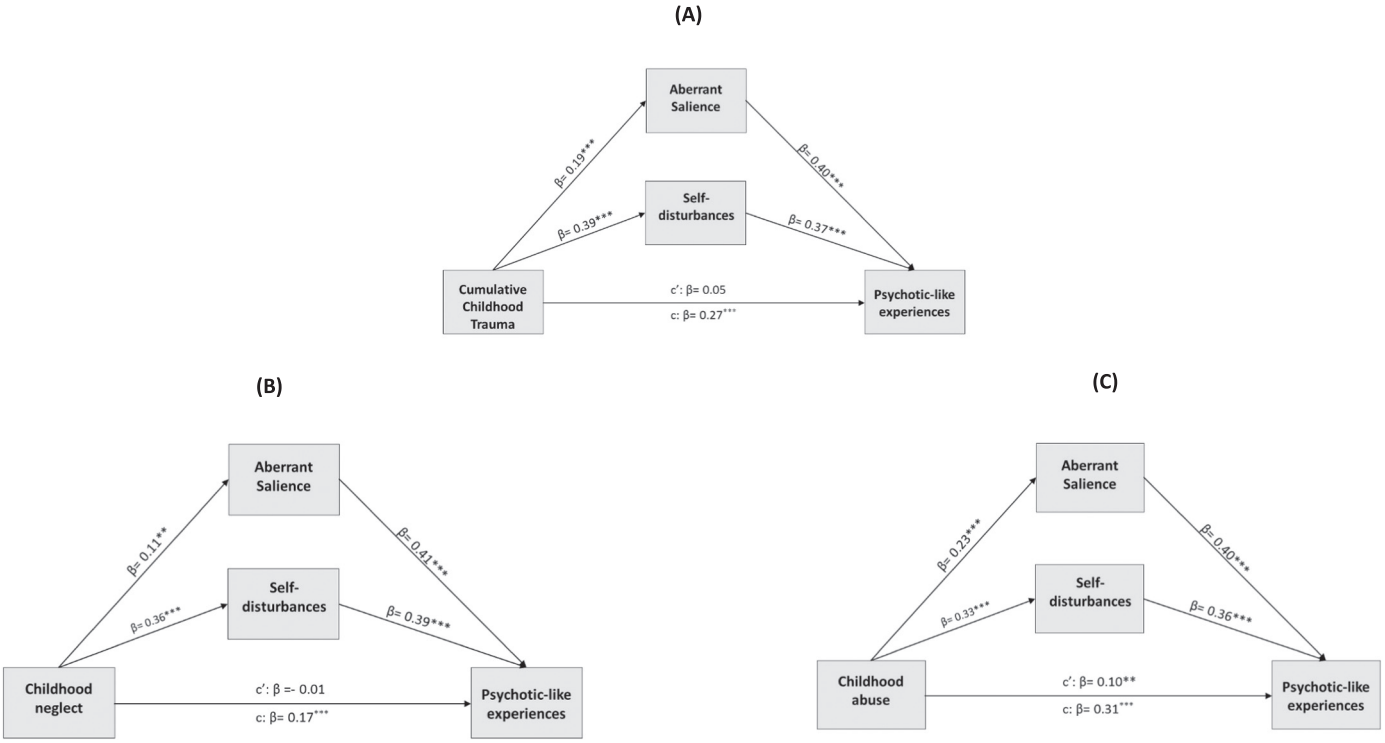

Fig. 1. Mediation models ($n = 649$). (A) The model of the relationship between cumulative childhood trauma (the CTQ total score) and psychotic-like experiences (total score in the PQ-16). Gender was included as a covariate in the analysis. Indirect-only mediation was found. The total effect explained 4.77% of the variance of psychotic-like experiences, while the mediated model explained 44.45% of the variance. (B) The model of the relationship between childhood neglect (the CTQ neglect subscales) and psychotic-like experiences (total score in the PQ-16). Gender was included as a covariate in the mediation analysis. Indirect-only mediation was found. The total effect explained 3% of the variance. The mediated model explained 44.26% of the variance. (C) The model of the relationship between childhood abuse (the CTQ abuse subscales) and psychotic-like experiences (total score in the PQ-16). Complementary mediation was found. The total effect explained 9.41% of the variance. The direct model explained 45.05% of the variance. In this model gender was a significant covariate, and thus separate analyses for men and women were carried out (see Results Section 3.1 and Supplementary Materials for graphic presentation of separate models for men and women).

model explained 45.04% of the variance. Both indirect pathways significantly differed from zero, Abuse ->IPASE ->PQ-16, CI [0.02–0.06] and Abuse ->ASI ->PQ-16, CI [0.01–0.05]. Mediation models for men and women are presented in the Supplementary Materials.

4. Discussion

We tested the hypothesis that self-disturbances and aberrant salience mediate the relationship between cumulative exposure to childhood traumatic events, including abuse and neglect, and psychotic-like experiences in the general population. In line with previous studies (Kelleher et al., 2013; McGrath et al., 2017; Scott et al., 2007; Sun et al., 2017a), we found a significant relationship between exposure to childhood trauma and psychotic-like experiences. When we considered different types of childhood trauma separately, our analysis suggested the strongest relationship between exposure to abusive behaviors (emotional, physical and sexual abuse) and psychotic-like experiences, which corroborates results showing that some traumatic events may have a stronger impact on the risk of psychosis (Bentall et al., 2012; Sitko et al., 2014). The relationship was stronger among women. In line with previous studies, we found a significant relationship between childhood traumatic experiences and self-disturbances (Gawęda et al., 2018c; Gawęda et al., 2018a; Haug et al., 2015). To the best of our knowledge, for the first time, we found significant but weak relation between exposure to childhood traumatic life events and aberrant salience. Finally, the relationships between psychotic-like experiences, self-disturbances and aberrant salience were significant at a moderate effect size.

Our main goal was to shed light on the mechanisms of the relationship between exposure to childhood traumatic life-events and psychotic-like experiences. To date, few studies have investigated this issue and indicate that cognitive factors may play a role. For instance, (Appiah-Kusi et al., 2017) found that dysfunctional cognitive self-schema partially mediated the relationship between clinical risk state for psychosis and exposure to trauma. More recently, it was found that cognitive biases and self-disturbances related to psychosis mediated the relationship between traumatic-life events and psychotic-like experiences in the general population (Gawęda et al., 2018a; Gawęda et al., in press). We concluded that the interplay between exposure to early traumatic events, cognitive biases and disruptions in the structure of the core experience of the self provides the mechanism for developing the risk of psychosis. Our results extend these findings by showing the significant role of aberrant salience in the model. Our analyses suggest that aberrant salience and self-disturbances mediate (indirect-only mediation) the relationship between cumulative childhood trauma and psychotic-like experiences. Regarding the model of the relationship between exposure to abusive behaviors and psychotic-like experiences, we found significant and complementary mediation. In line with prior studies, women were significantly more exposed to childhood abuse as compared to men. However, we found that the relationship between exposure to childhood abuse and psychotic-like experiences is weaker for women than for men. Mediation models revealed that in both genders aberrant salience and self-disturbances are important mediators. However, likely due to the weaker relationship between childhood abuse and PLEs among women, indirect-only mediation was found for women, while complementary mediation was revealed in the model for men. It suggests that due to the stronger direct bond between childhood abuse and PLEs among men other processes should be also considered in this case (e.g., substance use, dysfunctional strategies of emotional regulation). This issue might be of importance for further investigation. The frequency of psychotic-like experiences was predicted by pathways from childhood trauma through aberrant salience and self-disturbances. Thereby, aberrant salience established a stronger relation to abuse than to neglect. At the same time, self-disturbances had the highest correlations to childhood trauma among all variables.

Extending results from previous studies that showed a mediating role of information processing biases related to the content of the belief (e.g., negative self-schema or attention to threat (Appiah-Kusi et al., 2017; Gawęda et al., 2018c; Gawęda et al., 2018a), our findings suggest that childhood trauma and self-disturbances are also related to content non-specific aberrant processing of the salience that leads to assignment of inadequate meaning to the stimuli. It is consistent with a growing body of studies connecting behaviorally measured aberrant salience and psychosis (Katthagen et al., 2016; Pankow et al., 2016) and the risk states for psychosis (Schmidt et al., 2017). Similar results have emerged from studies that used self-report measures showing the relationship between aberrant salience and psychotic-like experiences (Cicero et al., 2015; Cicero et al., 2010; Raballo et al., 2017). Our results suggest that an abusive environment has a stronger influence on aberrant salience that emotional or physical neglect. However, exposure to both abuse and neglect has a similarly sized relationship to self-disturbances. Further studies are required to replicate our findings in clinical samples.

The role of self-disturbances in the model suggests that consequences of the exposure to childhood trauma are beyond cognitive functioning. On the contrary, our results revealed that childhood trauma has a stronger relation with self-disturbances than with aberrant salience. A mediating role of self-disturbances in the relationship between childhood trauma and the risk of psychosis (psychometric risk) is consistent with studies that show that states of dissociation are implicated in the relationship between childhood trauma and psychosis (Perona-Garcelán et al., 2010; Schäfer et al., 2006; Varese et al., 2012a). Indeed, phenomenological analyses suggest that some of the dissociative experiences (e.g., derealization and depersonalization) may be considered as self-disturbances related to schizophrenia spectrum psychoses (Parnas et al., 2005b). However, we used only a global measure of self-disturbances, and thus it was impossible to predict whether aberrant salience and childhood trauma are related to a particular group of these anomalies of experience. Further studies may address this by implementing comprehensive interviews that evaluates a wide range of self-disturbances (e.g., Examination of Anomalous Self-Experience, EASE by Parnas et al., 2005). Furthermore, our results corroborate the hypothesis that aberrant salience represents a cognitive correlate of self-disturbances in psychosis (Nelson et al., 2014b), as suggested by our correlational analysis. Our cross-sectional data precludes causal inferences. However, the causal relationship between aberrant salience and self-disturbances is a matter of further theoretical consideration and empirical investigation. Similarly, the causal models of the relationship between childhood trauma, aberrant salience and other cognitive biases, self-disturbances and the risk of psychosis call for longitudinal studies.

Although we must be cautious about direct implications, the results obtained from models that tested psychometric risk of psychosis in a non-clinical sample have some potential clinical value. First, diagnosis of the risk for psychosis that is based on subclinical symptoms and social functioning declines predict only 22–32% of psychosis in 12–36 month follow-ups (Fusar-Poli et al., 2013). Predictive power may be increased by considering a combination of different factors that are related to the transition to psychosis (Clark et al., 2016). Prior studies (Nelson et al., 2012) and our findings suggest that self-disturbances and information processing biases are potential candidates. Needless to say, although some studies revealed severe forms of traumatic experiences to predict the transition to psychosis (Thompson et al., 2014), other researchers did not find a relationship between exposure to trauma and transition to psychosis (Cannon et al., 2016). By considering exposure to trauma with other processes, for example, self-disturbances and information processing biases, there may be a potential increase in predictive strength. Second, CBT therapy protocols designed to deal with trauma in psychosis may benefit from integration with interventions designed for ameliorating cognitive biases related to psychosis (Eichner and Berna, 2016; Moritz et al., 2014). Cognitive distortions in psychosis are

amenable to even low-intensive clinical interventions (Kowalski et al., 2017; Warman et al., 2013). Theoretical considerations of how to implement the knowledge on self-disturbances in psychosis into CBT protocols (Škodlar et al., 2013) may guide further developments.

Limitations of our study should be considered before conclusions are made. We prepared an abbreviated version of the IPASE and ASI for the study based on the highest loadings of individual items to the total scores as derived from original studies (Cicero et al., 2010; Cicero et al., 2017). Although the abbreviated scales had satisfactory internal consistency in our study, further studies are required to provide more detailed characteristics of the shorter version of the scales. Given the fact that we did not evaluate our sample with clinical interviews designed to verify the criteria for clinical risk of psychosis and that we did not follow-up the sample, we were not able to investigate whether our model predicts the development of clinically relevant risk states. Hence, a generalization of our results to a clinical population is unclear. We considered only the role of self-disturbances and aberrant salience in the model, however, some other variables that were not considered might also play a role. For instance, previous studies have found that both stress sensitization and aberrant salience predicted psychotic symptoms in a clinical sample. Stress sensitization was also linked to the exposure to childhood trauma (Reininghaus et al., 2016; van Nierop et al., 2018). In line with these findings, some authors found that exposure to early trauma may increase the likelihood of exposure to later adversity, which further increases the risk of psychosis (Lataster et al., 2012). Hence, a better understanding of the mechanisms of the relationship between childhood trauma and psychosis may benefit from considering additional factors related to emotional sensitization and later life adversity.

To conclude, our results support the hypothesis that childhood trauma has an indirect impact on psychosis proneness in the general population. Important mediators of the relationship between exposure to childhood trauma and psychosis proneness are self-disturbances and aberrant salience. Although our study did not examine neurobiological changes (e.g., excessive dopamine release), our results may be interpreted as in line with predictions made by Howes and Murray (2014) about the relationship between environmental adversities (e.g., early trauma) and behavioral expression of excessive dopamine release – aberrant salience. Importantly, it seems that anomalies of the self and information processing biases are important factors providing further understanding of how trauma may impact the development of psychosis.

Given the fact that trauma is becoming an important target for clinical interventions for psychotic patients (van den Berg et al., 2016), our model suggests that aberrant salience and self-disturbances are important processes to be addressed in therapy.

Conflict of interest

None.

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CRediT authorship contribution statement

Łukasz Gawęda: Writing - original draft, Conceptualization, Methodology, Formal analysis. **Anja S. Göritz:** Investigation, Writing - review & editing. **Steffen Moritz:** Data curation, Writing - review & editing.

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Łukasz Gawęda: Writing - original draft, Conceptualization, Methodology, Formal analysis. **Anja S. Göritz:** Investigation, Writing - review & editing. **Steffen Moritz:** Data curation, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2018.11.034.

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