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Looking within: Interoceptive sensibility in young adults with psychotic-like experiences

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Abstract

Aim: Interoception is the ability to sense internal bodily changes and research indicates that it may play a role in the development of mental illness. In recent years, preliminary evidence has shown that interoception is impaired in people with psychosis. Interoceptive sensibility, a meta-cognitive aspect of interoception, has never been studied across the psychosis continuum. The present study aimed at assessing interoceptive sensibility in youth with psychotic-like experiences.

Method: We invited a sample of young adults (N = 609; age 19–21 years) to complete an online survey that included a measure of interoceptive sensibility (the Multidimensional Assessment of Interoceptive Awareness-2) and the Community Assessment of Psychotic Experiences-Positive Scale –15 (CAPE-P15). Using the recommended cutoff for the CAPE-P15, the overall sample was divided into two groups (high/low risk for psychosis).

Results: Significant group differences were observed in several dimensions of interoceptive sensibility. A logistic regression analysis indicated that scores in the subscales of Not-Distracting, Not-Worrying, Attention-Regulation, Emotional Awareness, Body Listening, and Trusting significantly predicted increased risk for psychosis.

Conclusion: Abnormal interoceptive sensibility may be a vulnerability marker for psychosis. These results, however, await further validation from additional comprehensive, longitudinal studies. Enhanced interoceptive sensibility has been reported following contemplative training, thus creating opportunities for future interventions to delay or prevent psychotic illness.

KEYWORDS
interoception, PLEs, psychosis, psychotic-like experiences, schizophrenia

1 | INTRODUCTION

Interoception is a broad and multi-faced concept. It generally refers to the subjective experience of internal states and changes in the body resulting from both visceral and somatic afference (Ceunen et al., 2016). Due to its role in sensing and integrating body signals and needs, interoception is thought to contribute to biological homeostasis (Strigo & Craig, 2016), regulation of circadian rhythms, and sleep (Ewing et al., 2017; Wei & Van Someren, 2020). Interoception is also believed to aid perception of the self as a separate entity from the environment and others, thus contributing to social cognition (Fotopoulou & Tsakiris, 2017; Ondobaka et al., 2017; Palmer & Tsakiris, 2018). Studies suggest that interoception is a stable characteristic and that it affects emotional experience (Garfinkel & Critchley, 2013; Löffler et al., 2018).

Research focused on interoception typically measures three distinct dimensions (Garfinkel et al., 2015). First, interoceptive *sensitivity (or accuracy)*, refers to the ability to detect internal bodily changes and is typically measured using objective tests. These include heartbeat detection (i.e., estimating the number of times the heart beats in a

given time), or heartbeat discrimination (i.e., assessing the synchrony of heartbeats with external stimuli). Second, interoceptive *awareness* refers to the metacognitive evaluation of one's own interoceptive sensitivity. This dimension is, by definition, conceptually linked to the first one. Third, interoceptive *sensibility* refers to a self-perceived tendency to focus on and react to internal changes, including both beneficial and maladaptive attentional style. This dimension is typically measured using self-reported questionnaires. The existing interoception literature has mainly focused on interoceptive sensitivity/accuracy, and has highlighted the link between this dimension and several aspects of cognition, including decision making (Werner et al., 2009), representation of interpersonal space (Ferri et al., 2013), and the attribution of affective states from facial expressions (Dirupo et al., 2020). Research surrounding the other dimensions is currently limited.

Recently, the interest in interoception has grown due to its clinical relevance. With its neural substrate in the insular cortex, interoception, has been suggested to play a role in the development of mental illness (Allen, 2020; Barrett & Simmons, 2015; Paulus & Stein, 2006; Savitz & Harrison, 2018). Among mental disorders, psychosis, characterized by clinical, cognitive, and functional impairment, represents one of the most studied. A vast body of literature has described disrupted sleep (e.g., Batalla-Martín et al., 2020; Ong et al., 2020), aberrant sense of self (e.g., Keromnes et al., 2018; Moe & Docherty, 2014; Parnas & Handest, 2003), and impaired social cognition (Green et al., 2015; Vaskinn & Horan, 2020) as core features of psychosis. These deficits, along with anomalous bodily experiences (Nyboe et al., 2016; Stanghellini et al., 2012), and neuroanatomical and functional abnormalities within the insular cortex (Ebisch et al., 2013; Ebisch et al., 2014; Karrer et al., 2019), provide indirect evidence to suggest that interoception may be impaired in those with psychosis. Remarkably, only one study to date has directly investigated the relationship between interoception and psychosis. Using a heartbeat detection task, Ardizzi et al. (2016) found lower interoceptive sensitivity in chronic schizophrenia patients compared to healthy controls. Furthermore, among patients, interoceptive sensitivity was positively associated with the severity of positive psychotic symptoms. While these results provide preliminary evidence of interoception impairment in those with psychosis, the usefulness of heartbeat detection tasks with clinical samples has been questioned. This is largely due to reliance on patients' working memory ability (Yoris et al., 2015), which is notoriously impaired in those with psychosis (Goldman-Rakic, 1996; Harvey & Rosenthal, 2018).

It is widely accepted that psychotic symptoms are observed in the general population along a continuum ranging from non-clinical psychotic-like experiences (PLEs) to full-blown psychosis (e.g., DeRosse & Karlsgodt, 2015; Linscott & van Os, 2010). The presence of PLEs can impact daily functioning and is considered indicative of an increased risk to develop psychosis (Bukenaite et al., 2017; Fisher et al., 2013; Kaymaz et al., 2012; Mossaheb et al., 2012). Similar to patients with psychosis, studies conducted on this population have highlighted abnormal self- and bodily experiences, sleep dysfunction, and impaired social cognition (Andorko et al., 2017; Barragan et al., 2011; Gawęda et al., 2019; Graham et al., 2015; Pionke et al., 2020). Abnormal functioning of the insular cortex has also been reported (Papanastasiou et al., 2020), suggesting that interoception is likely an area worthy of investigation. Specifically, assessing individuals' tendency to focus on, worry about, and react to internal bodily changes (i.e., interoceptive sensibility), may help highlight maladaptive attentional styles (Mehling, 2016) potentially contributing to the development of psychotic symptoms, with important implications for early detection and treatment. Accordingly, Sass and colleagues argue that exaggerated self-focus or 'hyper-reflexivity' can lead to schizophrenia symptomatology (Sass et al., 2013).

To explore the relationship between interoception and PLEs, we invited a non-clinical sample of young adults to complete an online version of two self-report questionnaires. We chose to focus on interoceptive sensibility to capture first-person evaluations of sensibility to bodily signals along with beliefs, emotions, reactions and attitudes associated with them (Mehling, 2016). We hypothesized that more frequent PLEs would be associated with higher interoceptive sensibility. Due to the lack of previous literature assessing the relationship between interoceptive sensibility and psychotic-like experiences, our hypothesis was exploratory.

2 | METHODS

The study was approved by Zayed University Research Ethics Committee (ZU19_040_F). Potential participants were approached through snowball sampling method where the link to the survey was distributed through various social media platforms. Individuals who clicked the link were first provided with study-related information and were then asked to indicate their consent to take part. Inclusion criteria were age between 18 and 25, English-speaker, living in the United Arab Emirates, no past or current history of psychiatric or neurological disorder. The online questionnaire included standard demographic questions, as well as the Community Assessment of Psychic Experiences-Positive Scale-15 (CAPE-P15; Capra et al., 2013), and the Multidimensional Assessment of Interoceptive Awareness-2 (MAIA-2; Mehling, Acree, et al., 2018).

The CAPE-P15 is a 15-item questionnaire with good psychometric properties (Sun et al., 2020), that was designed for the assessment of psychotic experiences in the general population (Capra et al., 2013). Individuals are asked to report their lifetime frequency of sub-clinical PLEs on a four-point Likert scale (1 = never; 2 = sometimes; 3 = often; 4 = nearly always). To account for non-response to any of the 15 items, the weighted total score is calculated as the sum of scores divided by the number of items that were completed. A cutoff of 1.47 has been proposed to identify individuals at ultra-high risk for psychosis with 77% sensitivity and 58% specificity (Bukenaite et al., 2017). The scale also yields three sub-scores measuring frequency of Persecutory Ideation, Bizarre Experiences and Perceptual Abnormalities. The scale additionally includes optional questions relative to the level of distress associated with each item. Since the pre-

sent investigation was part of a larger study including multiple measures, the degree of distress associated with each item/experience was not assessed in order to increase survey response rates.

The MAIA-2 contains 37 statements, with response options on a six-point Likert scale, where never = 0 and always = 5. To measure multiple aspects of interoceptive sensibility, the scale includes eight sub-scales: (1) Noticing refers to the general awareness of body sensations (e.g., 'When I am tense I notice where the tension is located in my body'); (2) Not-Distracting measures the tendency not to ignore sensations of discomfort or pain (e.g., 'I ignore physical tension or discomfort until they become more severe'); (3) Not-Worrying measures the tendency not to experience emotional distress in response to sensation of pain and discomfort in the body (e.g., 'I start to worry that something is wrong if I feel any discomfort'); (4) Attention Regulation refers to the ability to sustain and control attention to body sensations (e.g., 'I can pay attention to my breath without being distracted by things happening around me'); (5) Emotional Awareness measures awareness of the connection between the body and emotional states (e.g., 'I notice how my body changes when I am angry'); (6) Self-Regulation measures the ability to regulate distress by paying attention to body sensations (e.g., 'I can use my breath to reduce tension'); (7) Body Listening refers to using bodily sensations for insight and decision-making (e.g., 'I listen for information from my body about my emotional state'); (8) Trusting measures the tendency to experience one's own body as safe and trustworthy (e.g., 'I trust my body sensations'). Scores for each sub-scale are totalled and averaged giving a range of 0–5 for each sub-scale. Across all sub-scales, greater score indicates higher interoceptive sensibility. This tool has demonstrated good internal consistency and reliability (Mehling, Acree, et al., 2018).

2.1 | Data analysis

Statistical analyses were performed using SPSS version 26 (IBM, Armonk, NY). The recommended CAPE-P15 cutoff of 1.47 (Bukenaite et al., 2017) was used to identify a subgroup of participants at increased risk for psychosis, based on the frequency of PLEs. The cutoff identified the 16% of participants with the highest scores. This group was referred to as the 'High Risk' group. The High-Risk group (N = 94) was compared to the lowest 16% of the distribution (i.e., the 'Low-Risk' group; N = 88). Continuous data was first tested for normality. For the MAIA-2 and CAPE-P15 scores, results of the Shapiro–Wilk test were statistically significant at the p-level of .0001. A t-test and a *Chi-square* test were used to compare normally distributed and categorical demographic variables between groups. Logistic regression was used to test the hypothesis that interoceptive sensibility predicted the severity of PLEs. Prior to conducting logistic regression analysis, we verified that the regression model assumptions were satisfied. Tolerance and VIF for multicollinearity of the predictors were within acceptable range (tolerance across the MAIA-2 subscales ranged from 0.84 to 0.46; VIF ranged from 1.18 to 2.16). The Box–Tidwell test was also non-significant for all of the MAIA-2 subscales.

3 | RESULTS

Data pre-processing procedures identified 12 random responders, which were removed from the initial sample (N = 609) prior to conducting the formal data analysis. The final sample included 597 participants (mean age = 21; SD = 2). The majority of participants (90%) were female and citizens of the United Arab Emirates (89%). The demographic characteristics of the sample are summarized in Table 1.

The average CAPE-P15 score was 1.01 (SD = 0.51; Median = 1.00). The High-Risk group was significantly younger than the Low-Risk group (high-risk: mean age = 20.38; SD = 1.96; low-risk: mean age 21.24; SD = 1.94; t = −2.96; p <.01). Figure 1 highlights the median score per each interoception sub-scale, according to PLE risk group.

Results of the multivariate logistic regression, after adjusting for age, gender and education, indicated that the model was significant (χ^2 = 65.28; p <.0001; Nagelkerke R^2 = .40) and explained 70.3% of the overall variance. Higher risk was predicted by younger age, female gender, and lower scores in the subscales of Non-Distracting, Not-Worrying, Attention Regulation, and Trusting. Furthermore, higher risk was predicted by higher scores in the subscales of Emotional

TABLE 1 Sample characteristics of 597 community-dwelling young adults

Gender	*n* (%)
Male	58 (10)
Female	539 (90)
Age (years)	*M(SD)*
	21 (2)
Highest education level completed	*n* (%)
High school	66 (11)
College	499 (84)
University	32 (5)
Nationality	*n* (%)
Emirati	530 (89)
Gulf/MENA (non-UAE)	44 (7)
Asia	13 (2)
Caucasian	6 (1)
Other	4 (1)
Residing emirate	*n* (%)
Abu Dhabi	212 (35)
Dubai	242 (41)
Sharjah	865(14)
Fujairah	5 (1)
Umm Al Quwain	16 (3)
Ajman	23 (4)
Ras Al Khaimah	14 (2)

Note: Data are presented as *n* (%), mean ± standard deviation as appropriate. Caucasian was comprised of nationalities from the United States of America, Europe, Australia, and New Zealand.
Abbreviation: MENA, Middle East (excluding the United Arab Emirates) and North Africa.

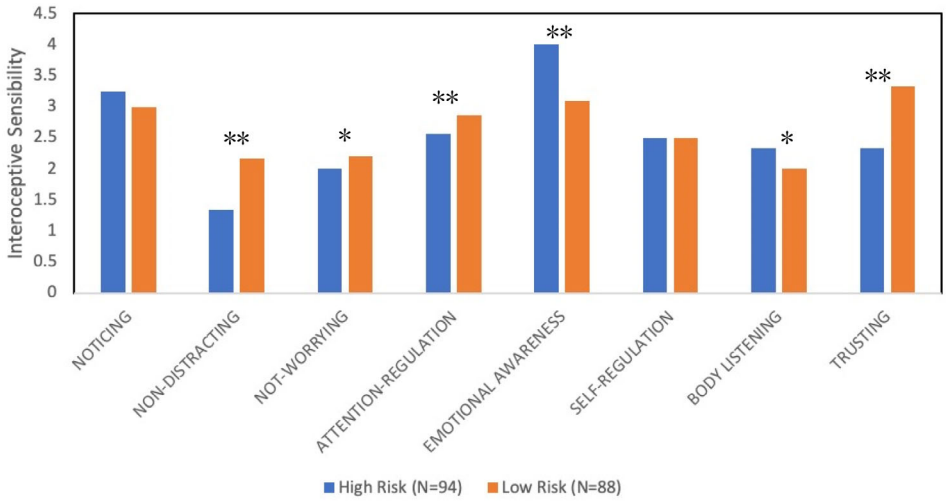

FIGURE 1 Interoceptive sensibility across low-risk and high-risk groups. *p <.05; **p <.01

TABLE 2 Results of the Logistic Regression

	OR	*p*	*95% CI*
Age	0.67	<.01	0.52–0.86
Gender	6.91	<.05	1.44–33.20
Education	1.16	—	0.90–1.49
MAIA-2			
Noticing	0.77	—	0.50–1.19
Non-distracting	0.69	<.01	0.42–0.82
Not-worrying	0.62	<.05	0.41–0.94
Attention-regulation	0.51	<.01	0.31–0.84
Emotional awareness	1.90	<.01	1.20–3.01
Self-regulation	1.00	—	0.66–1.52
Body listening	1.46	<.05	1.05–2.04
Trusting	0.63	<.01	0.47–0.85

Abbreviation: MAIA-2, Multidimensional Assessment of Interoceptive Awareness-2.

Awareness and Body Listening. These results are presented in Table 2.

4 | DISCUSSION

The present study explored, for the first time, interceptive sensibility in a sample of youth with various levels of PLEs. We had hypothesized that more frequent PLEs would be associated with a greater sensibility to interoceptive signals. This hypothesis was only partially supported.

The results of the logistic regression highlighted several interesting effects. First, increased risk for psychosis was predicted by lower scores in the subscales of Not-Distracting, Not-Worrying, and Attention Regulation. In other words, the High-Risk group reported a greater tendency to experience distress and use distraction in response to sensations of physical discomfort, suggesting potentially maladaptive appraisal (e.g., catastrophizing), attentional style, and copying style (avoidance through distraction; e.g., Goubert et al., 2004; Mehling, 2016; Mehling et al., 2009). Lower scores were also observed in the Trusting sub-scale, indicating that individuals in the High-Risk group were less likely to consider their body as a safe place. While there are no previous studies that have directly explored trust in one's own body across the psychosis spectrum, our results appear to be consistent with studies that have reported coenaesthesia and abnormal body perception in healthy individuals who appear to be prone to psychotic experiences (Gawęda et al., 2019; Germine et al., 2013; Graham et al., 2015; Pionke et al., 2020), and among individuals with schizotypal personality (Van Doorn et al., 2018). Similar results have also been observed among help-seeking and clinical samples including individuals at clinical high risk for psychosis (Nelson et al., 2012), and patients with schizophrenia (Klaver & Dijkerman, 2016). This suggests that abnormal body perception might be a common feature across the psychosis spectrum. Furthermore, increased worry, distraction from sensation of body discomfort, and lower trust in one's own body have also been reported among people with a history of suicidal attempts (Rogers et al., 2018), eating disorders (Brown et al., 2017) as well as anxiety (Mehling et al., 2012). This could indicate that these dysfunctions might not be specific to the psychosis continuum but simply reflect a greater risk of psychopathology.

The awareness of the connection between the body and emotional states, and the extent to which an individual uses bodily sensations, relative to emotional states, to make decisions are measured by the Emotional Awareness and Body Listening scales, respectively. Higher scores in these scales predicted psychosis risk. Our results are in line with previous evidence of greater attention to emotions in healthy individual with schizotypal personality (Kerns, 2005). On the other hand, reduced emotional awareness is typically observed in individuals at clinical high-risk for psychosis (e.g., van Rijn et al., 2011) and among psychotic patients (e.g., Kimhy et al., 2012, 2020). This suggests that these deficits could be specific to individuals with clinically-relevant manifestations of psychosis. It is also worth noting that

'emotional awareness' in the literature typically refers to the ability to recognize and distinguish one's own emotions. Interestingly, Torregrossa et al. (2019), using a topographical mapping task, found incongruous and undifferentiated bodily sensations related to emotions in a sample of chronic psychotic patients compared to controls, while the awareness of bodily sensations per se was similar between groups. This highlights the need for future studies to further explore the different aspects of emotional experience across the psychosis spectrum. Furthermore, a study conducted by Mehling et al. (2012) suggested that the mere awareness of emotional body sensations in the absence of the ability to use this awareness to reduce distress, could result in greater anxiety. Notably, the association between anxiety and PLEs is well established in the literature (Cowan & Mittal, 2020).

Taken together, our results suggest that the relationship between interoception and psychotic experiences is not univocal. On one hand, our results highlighted that maladaptive attentional styles and responses to physical discomfort and abnormal body perception (i.e., a lower interoceptive sensibility) predicted psychosis risk in healthy individuals with PLEs. At the same time, psychosis risk was also predicted by greater self-focus on emotion-driven changes in the body (i.e., greater interoceptive sensibility). A recent model of interoception highlighted the need for studies to distinguish between accuracy (the ability to sense interoceptive signals) and attention (the extent to which interoceptive signals are the object of attention; Murphy et al., 2020). Such distinction could explain why an individual may report increased awareness of bodily signals and yet be inaccurate at recognizing them. Or, on the contrary, be accurate at recognizing bodily signals in experimental settings, but be unlikely to pay attention to them in everyday life. Notably, our results should be interpreted in terms of decreased or increased attention towards bodily signals, with no indication about interoceptive accuracy.

Current understanding of interoception emphasizes its role in contributing to a sense of selfhood (Quadt et al., 2018), and in regulating social cognition (Crucianelli & Filippetti, 2020; Tsakiris & Critchley, 2016) as well as sleep (Wei & Van Someren, 2020). Dysfunctions in self-perception, social cognition, and sleep characterize individuals across the psychosis spectrum. Abnormal interoception could be a common denominator for these deficits. For instance, the development of a sense of self is thought to result from the interplay between external events and internal bodily signals (Crucianelli & Filippetti, 2020). A dysfunctional interoception could therefore lead to abnormal sense of self. This seems in line with the hyper-reflexivity hypothesis, posing a link between exaggerated focus on phenomena that are usually implicit, such as bodily sensations, and sense of self in people who experience psychotic symptoms (Sass et al., 2013). Furthermore, according to the 'attentional switching hypothesis' (Arnold et al., 2019), flexibility in shifting attention between external (e.g., social) and internal (e.g., interoceptive emotional) signals, is key to successful social interactions. We could speculate that increased attention towards interoceptive emotional signals may lead to poor social cognition. Similarly, increased attention to interoceptive and exteroceptive signals has been linked to sleep disorders (Espie et al., 2006).

Strengths of the present study include a large sample and a multidimensional assessment of interoceptive sensibility. We do, however, acknowledge that our study has limitations. First, the cross-sectional study design cannot determine if any individual in the High-Risk group went on to develop psychosis. Moreover, our sample was mostly female, limiting the generalizability of our results. It is also worth noting that the interpretation of our results is limited by the lack of clear indications, in the literature, on what should be considered an optimal level of interoceptive sensibility. Furthermore, the use self-report measures may be subject to various reporting biases. Nevertheless, studies have shown that self-reported psychotic experiences can indicate real risk of mental illness (Cowan & Mittal, 2020; van der Steen et al., 2019). Similarly, it has been argued that measuring interoception using self-reports has the advantage to collect first-person evaluations of both sensibility to body signals and also the beliefs, emotions, reactions and attitudes associated with bodily signals, which cannot be measured using heart-rate estimations (Mehling, 2016). Finally, in our study, we did not obtain information surrounding participants' familial risk for psychosis, which would have allowed us to compare interoception between different at-risk groups.

In conclusion, our preliminary findings suggest that abnormal interoceptive sensibility may be a vulnerability marker for psychosis. Our results, however, await replication. Previous studies have shown that interoceptive sensibility can be enhanced through contemplative training, thus creating opportunities for interventions (Bornemann et al., 2015; de Jong et al., 2016; Mehling, Chesney, et al., 2018). Further research is encouraged, to assess both objective and subjective aspects of interoception across the psychosis spectrum using longitudinal study designs.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

DATA AVAILABILITY STATEMENT

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

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