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Vulnerability to harm as a foundation of paranoia-like thoughts in a non-clinical population

[Zwiększona podatność na zranienie jako podstawa rozwoju myśli podobnych do paranoicznych w populacji nieklinicznej]

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I sometimes find journeys on public transport difficult. If someone looks at me, it can feel like they're weighing me up. I don't know why. And when they look away – back down to their book or tablet or whatever – it's as though they can't bear to look at me any more. (…) Other times someone might be sitting next to me and it feels like they've done it deliberately to crowd my space – they're leaning into me or rustling their paper really loudly or something. Once I was on the train and the guy next to me was coughing every five seconds, it felt like he was doing it on purpose to annoy me, even though I knew he wasn't.

Melisa (as cited in Freeman et al., 2016)

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1. Abstract

Paranoia is defined as an extreme state of mistrust and suspiciousness toward others. It is characterized by unfounded beliefs that people are the primary source of threat, have hostile intentions, and that their actions are directed to cause deliberate harm. Although paranoid thoughts are typically associated with psychotic disorders, it is increasingly emphasized that such thoughts occur along a continuum: at one end are paranoia-like thoughts, observed to varying degrees in healthy individuals in the general population, and at the other are persecutory delusions characteristic of disorders in clinical contexts. In accordance with this view, paranoia is suggested to have a hierarchical structure, with heightened interpersonal sensitivity at its core. This sensitivity encompasses fears of critical evaluation and social rejection, a sense of vulnerability to harm, and the belief that the world is a dangerous place. While the vast majority of individuals in non-clinical populations experience paranoid thoughts as interpersonal concerns, the sense of vulnerability to harm is considered the foundation upon which persecutory delusions can develop. Therefore, identifying risk factors that may exacerbate perceived vulnerability to social harm appears to be a key direction for future research.

Vulnerability to harm can stem from many sources, including negative beliefs about oneself, other people, and the world in general. The aim of my doctoral dissertation was to examine the roles of two novel factors, i.e., negative body image and misophonia symptoms, in the context of paranoia, and to situate them within a broader context to understand their interrelations with other, previously identified risk factors. This dissertation consists of a series of five articles encompassing correlational studies (Study 1, 2, and 3), an experimental study (Study 4), and an intensive longitudinal study using the experience sampling method (Study 5). It also presents the results in the form of two complex network models of paranoia-related factors from structural (Study 2) and temporal (Study 5) perspectives.

The first study in the series (n = 539) aimed to understand the relationship between negative body image and paranoia-like thoughts. Although global self-esteem in relation to paranoid thinking has frequently been examined in previous research, body image has only recently begun to be considered as a potentially important factor in this context. Previous studies suggested that negative self-perceptions, including those related to physical appearance, may increase feelings of being "inferior" and thus vulnerable to harm from others. However, these findings were preliminary and indicated the need for further research, including validation of the proposed hypotheses. Our results showed that the association between negative body image and paranoia-like thoughts is statistically significant. Moreover, negative affect, low self-esteem, and rejection sensitivity significantly mediated this relationship, thereby supporting the hypothesis of vulnerability to harm as a potential mechanism explaining this link. The findings also showed that higher levels of paranoia were significantly associated with general dissatisfaction with one's body appearance, rather than solely with the perception of the body as being too large, as previously suggested.

The second study (n = 1019) aimed to develop a complex network model of factors associated with

paranoia-like thoughts and to determine the role of negative body image within a broader context. The study employed an extensive battery of questionnaires assessing paranoid ideation, traumatic experiences, sleep quality, rejection sensitivity, negative emotional states, aberrant salience, self-esteem, and, for the first time within a network approach to paranoia, negative body image. The results showed that negative body image, as well as negative emotional states (stress and anxiety), low self-esteem, rejection sensitivity, and childhood emotional neglect were the most central variables in the model, underscoring their potential therapeutic significance.

The aim of the third study (n = 312) was to introduce a novel factor that had not previously been examined in the context of paranoid thoughts. Misophonia (selective sound sensitivity syndrome) is a disorder in which certain sounds, most often those produced by other people, evoke a strong, negative emotional, behavioral, and physiological response. Previous research has shown that misophonic reaction depends on the context in which the triggering sounds occur. One prior study found that the response to misophonic sounds is stronger when hostile intentions are attributed to the person producing them. Misophonic triggers are usually everyday sounds (e.g., eating or breathing sounds), which often makes them difficult to avoid without social isolation. A lack of adaptive emotion regulation strategies may therefore contribute to living in a constant state of stress and anxiety, in a world filled with threatening stimuli, which renders it a dangerous place and the person experiencing misophonia symptoms more vulnerable to harm. This study was exploratory in nature. The results showed that misophonia symptoms are significantly associated with higher levels of paranoia-like thoughts in a non-clinical population, and that this relationship is mediated by difficulties in emotion regulation, elevated anxiety, and a tendency to attribute hostile intentions to others.

The fourth study (n = 487) aimed to empirically verify the relationship between misophonia symptoms and paranoia-like thoughts. To this end, we designed and conducted an experimental study to test whether exposure to common misophonia trigger sounds would increase paranoia-like thoughts - either directly or through negative affect. The results showed that exposure to misophonia trigger sounds led to an increase in paranoia-like thoughts, but this effect did not reach statistical significance, emerging only at the trend level. However, the relationship between exposure to misophonia triggers and the level of paranoia-like thoughts was significantly mediated by an increase in negative affect. The remaining (control) experimental conditions showed a decrease or no change in the level of paranoia-like thoughts following exposure to the experimental stimuli. The findings also indicated that, among various aspects of misophonia, paranoia-like thoughts were most strongly associated with internalizing appraisals, i.e., blaming oneself for the reactions to triggering sounds, thereby highlighting a possible underlying mechanism consistent with the hypothesis that vulnerability to harm forms the foundation for the development of paranoid thoughts.

The fifth and final study in the series (n = 175) employed the experience sampling method and a dynamic, temporal network approach. This study aimed to understand the structure of, and mutual

interactions among various factors that may increase perceived vulnerability to harm, and thus form the basis for paranoid thoughts development. This study also sought to place the key factors of this research cycle (negative body image and misophonia symptoms) within a broader context of variables associated with paranoid thinking. Participants were drawn from the general population and included individuals with low levels of paranoia-like thoughts (n = 103) and those with high levels (n = 72). For seven days, eight times per day, participants completed surveys measuring paranoia-like thoughts, various aspects of social functioning, perceived social rejection, negative affect, negative body image, and misophonia symptoms. Network models were estimated for the total sample and separately for the subgroups differing in levels of paranoia-like thoughts. The results showed that the most central variable in the model was perceived social rejection, which was also the only variable to exhibit a direct, bidirectional association with paranoia-like thoughts. Contrary to our hypotheses, paranoia-like thoughts were not the most strongly predicted variable in the model. Instead, paranoia emerged as the strongest predictor of other variables over time. Between-group comparison analyses revealed that, despite a similar network structure in both groups, individuals with higher levels of paranoia-like thoughts exhibited a greater number of significant, direct connections between variables, and these relationships were stronger, as compared to those in the control group. These findings may suggest the need for early interventions targeting central symptoms within the network.

Drawing on the concept of vulnerability to harm and the conceptualization of mental disorders as complex networks of interrelated factors, the series of studies presented in this doctoral dissertation expands existing knowledge by identifying new risk factors for the development of paranoia-like thoughts in a non-clinical population and situates them within a broader context of interactions with other, previously identified variables.

Key words: paranoia, paranoid thoughts, body image, misophonia, risk factors, vulnerability to harm, network approach to psychopathology, experience sampling

2. Streszczenie

Paranoja definiowana jest jako stan skrajnej nieufności i podejrzliwości wobec innych. Charakteryzuje się nieuzasadnionymi przekonaniami, że ludzie stanowią główne źródło zagrożenia, ich intencje są wrogie, a podejmowane przez nich działania motywowane są wyrządzeniem celowej krzywdy. Mimo że najczęściej kojarzone jako objaw zaburzeń psychotycznych, coraz częściej zaznacza się, że myśli paranoiczne występują na kontinuum, gdzie na jednym krańcu znajdują się myśli *podobne do paranoicznych*, spotykane w różnym nasileniu u osób zdrowych w populacji ogólnej, a na drugim krańcu znajdują się urojenia prześladowcze, charakterystyczne dla zaburzeń w kontekście klinicznym. Zgodnie z tą koncepcją przyjmuje się, że paranoja ma strukturę hierarchiczną, a u jej podstaw leży zwiększona wrażliwość interpersonalna, obejmująca lęk przed krytyczną oceną i odrzuceniem społecznym, poczucie podatności na zranienie oraz przekonanie, że świat jest niebezpiecznym miejscem. Mimo że zdecydowana większość osób z populacji nieklinicznej doświadcza myśli paranoicznych w formie obaw interpersonalnych, zwiększone poczucie podatności na zranienie uznawane jest za fundament, na którym budowane są urojenia prześladowcze. Identyfikacja czynników ryzyka zwiększających poczucie podatności na zranienie społeczne wydaje się zatem kluczowym kierunkiem badawczym.

Podatność na zranienie może mieć wiele źródeł, w tym negatywne przekonania o sobie, o innych ludziach oraz o świecie. Celem mojej rozprawy doktorskiej było zbadanie roli dwóch nowych czynników, tj. negatywnego obrazu ciała oraz symptomów mizofonii, oraz umiejscowienie ich w szerszym kontekście, umożliwiającym zrozumienie ich wzajemnych relacji z innymi, wcześniej zidentyfikowanymi, czynnikami ryzyka. Niniejsza rozprawa doktorska składa się z serii pięciu artykułów, obejmujących badania korelacyjne (Badanie 1, 2 i 3), eksperymentalne (Badanie 4) i podłużne z wykorzystaniem metody próbkowania doświadczeń (Badanie 5), a także prezentujące złożone modele sieci czynników w ujęciu strukturalnym (Badanie 2) i czasowym (Badanie 5).

Pierwsze badanie w cyklu (n = 539) miało na celu zrozumienie związku pomiędzy obrazem ciała i myślami paranoicznymi. Mimo że ogólna samoocena w odniesieniu do myśli paranoicznych była częstym przedmiotem badań, obraz ciała dopiero niedawno zaczął być rozpatrywany jako potencjalnie istotny czynnik w tym kontekście. Dotychczasowe badania sugerowały, że negatywne postrzeganie siebie, w tym swojego wyglądu, może zwiększać poczucie bycia „gorszym" i podatnym na krzywdę ze strony innych osób. Wyniki te miały jednak charakter wstępny i sugerowały potrzebę dalszych badań i walidacji postawionych hipotez. Wyniki naszego badania pokazały, że związek między negatywnym obrazem ciała i myślami podobnymi do paranoicznych jest istotny statystycznie. Ponadto, negatywny afekt, niska samoocena i wrażliwość na odrzucenie społeczne okazały się być istotnymi mediatorami w tym związku, tym samym popierając hipotezę o roli podatności na zranienie jako mechanizmu wyjaśniającego tę zależność. Wyniki pokazały również, że wyższy poziom myśli podobnych do paranoicznych był istotnie związany z ogólnym niezadowoleniem z wyglądu swojej sylwetki, a nie

wyłącznie z postrzeganiem ciała jako zbyt dużego, jak wcześniej sugerowano.

Drugie badanie (n = 1019) miało na celu stworzenie złożonego modelu sieci czynników związanych z myślami paranoicznymi, oraz zrozumienie roli obrazu ciała w szerszym kontekście. W badaniu wykorzystano rozbudowaną baterię kwestionariuszy, mierzących myśli podobne do paranoicznych, traumatyczne doświadczenia, jakość snu, wrażliwość na odrzucenie społeczne, negatywne stany emocjonalne, nieprawidłowe nadawanie znaczenia, samoocenę oraz, po raz pierwszy w podejściu sieciowym w kontekście paranoi, negatywny obraz ciała. Wyniki pokazały, że negatywny obraz ciała, ale również negatywne stany emocjonalne (stres i lęk), negatywna samoocena, wrażliwość na odrzucenie oraz zaniedbanie emocjonalne w dzieciństwie były najbardziej centralnymi zmiennymi w tym modelu, podkreślając ich potencjalne znaczenie terapeutyczne.

Celem trzeciego badania (n = 312) było wprowadzenie nowego, wcześniej niebadanego w kontekście myśli paranoicznych, czynnika. Mizofonia (zespół selektywnej wrażliwości na dźwięki) to zaburzenie, w którym pewne dźwięki, najczęściej te wydawane przez innych ludzi, wywołują silną, negatywną reakcję na poziomie emocjonalnym, behawioralnym oraz fizjologicznym. Wcześniejsze badania pokazały, że reakcja mizofoniczna zależna jest od kontekstu, w jakim pojawiają się awersyjne dźwięki. Jedno z poprzednich badań pokazało, że reakcja na mizofoniczne dźwięki jest silniejsza, kiedy osobie wydającej dane dźwięki przypisywane są wrogie intencje. Bodźce mizofoniczne to najczęściej te pojawiające się w sytuacjach codziennych (np. dźwięki jedzenia lub oddychania), co sprawia, że trudno je unikać, nie izolując się przy tym społecznie. Brak adaptacyjnych technik regulacji emocji może zatem przyczynić się do życia w nieustannym lęku i napięciu, w świecie, w którym nie ma możliwości ucieczki od zagrażających bodźców, czyniąc go niebezpiecznym, a osobę doświadczającą symptomów mizofonii – bardziej podatną na zranienie. To badanie miało charakter eksploracyjny. Wyniki pokazały, że symptomy mizofonii są istotnie związane z większym nasileniem myśli podobnych do paranoicznych w grupie nieklinicznej, a związek ten mediowany jest przez trudności w regulacji emocji, zwiększony poziom lęku oraz tendencję do przypisywania innym wrogich intencji.

Badanie czwarte (n = 487) miało na celu empiryczną weryfikację związku między symptomami mizofonii i myślami podobnymi do paranoicznych. W tym celu zaprojektowano i przeprowadzono badanie eksperymentalne, sprawdzające czy ekspozycja na typowe dźwięki mizofoniczne wpłynie na wzrost myśli podobnych do paranoicznych – bezpośrednio lub poprzez wpływ na negatywny afekt. Wyniki pokazały, że ekspozycja na dźwięki mizofoniczne wpłynęła na wzrost myśli podobnych do paranoicznych, natomiast ten efekt nie był istotny statystycznie, wykazując wzrost jedynie na poziomie trendu. Okazało się jednak, że związek między ekspozycją na dźwięki mizofoniczne a poziomem myśli podobnych do paranoicznych był istotnie mediowany przez wzrost w poziomie negatywnych emocji. Pozostałe (kontrolne) warunki eksperymentalne wykazały spadek lub brak zmiany w poziomie myśli podobnych do paranoicznych po ekspozycji na bodźce eksperymentalne. Wyniki tego badania pokazały również, że spośród różnych aspektów mizofonii, myśli podobne do paranoicznych były

najsilniej związane z internalizacją, tj. obwinianiem siebie za swoje reakcje na poszczególne dźwięki, a zatem negatywnymi przekonaniami na swój temat, podkreślając tym samym możliwy mechanizm leżący u podstaw tego związku, zgodny z hipotezą o podatności na zranienie jako fundamentu dla rozwoju myśli paranoicznych.

Ostatnie, piąte badanie w prezentowanym cyklu (n = 175), zostało przeprowadzone metodą próbkowania doświadczeń (*experience sampling*) oraz zaprezentowane w formie dynamicznych, czasowych, między- i wewnątrzosobowych analiz sieci, mających na celu zrozumienie struktury oraz wzajemnych interakcji między czynnikami mogącymi mieć wpływ na zwiększone poczucie podatności na zranienie jako podstawy rozwoju myśli podobnych do paranoicznych. Celem tego badania było również umieszczenie kluczowych dla tego cyklu czynników (tj. negatywny obraz ciała i symptomy mizofonii) w szerszym kontekście czynników związanych z myślami podobnymi do paranoicznych. W badaniu wzięły udział osoby z niskim poziomem myśli podobnych do paranoicznych (n = 103) oraz osoby z wysokim poziomem (n = 72) z populacji ogólnej. Przez siedem dni, osiem razy dziennie, osoby badane wypełniały ankiety, mierzące myśli podobne do paranoicznych, różne aspekty funkcjonowania społecznego, poczucie odrzucenia społecznego, negatywny afekt, negatywny obraz ciała oraz symptomy mizofonii. Modele sieci zostały oszacowane dla całej próby oraz grup różniących się poziomem myśli podobnych do paranoicznych osobno. Wyniki pokazały, że najbardziej centralną zmienną w zaprezentowanym modelu jest poczucie odrzucenia społecznego, będąc jednocześnie jedyną zmienną wykazującą bezpośredni, dwukierunkowy związek z myślami podobnymi do paranoicznych. Wbrew hipotezom, myśli podobne do paranoicznych nie były najsilniej przewidywaną przez inne czynniki w modelu zmienną. Okazały się jednak najsilniej przewidywać nasilenie innych zmiennych w czasie. Analizy porównań sieci czynników między grupami pokazały, że mimo podobnej struktury połączeń między zmiennymi, istotnych i bezpośrednich związków było więcej oraz były silniejsze w grupie osób doświadczających większe nasilenie myśli podobnych do paranoicznych. Wyniki te mogą sugerować potrzebę wczesnych interwencji skierowanych na centralne w sieci symptomy.

Bazując na koncepcji podatności na zranienie oraz konceptualizacji zaburzeń psychicznych jako sieci powiązanych ze sobą czynników, zaprezentowany w tej rozprawie doktorskiej cykl badań uzupełnia dotychczasową wiedzę o nowe czynniki ryzyka rozwoju myśli podobnych do paranoicznych w populacji nieklinicznej, oraz analizuje je w szerszym kontekście interakcji z innymi, wcześniej zidentyfikowanymi, zmiennymi.

Słowa kluczowe: paranoja, myśli paranoiczne, obraz ciała, mizofonia, czynniki ryzyka, podatność na zranienie, sieciowe podejście do psychopatologii, próbkowanie doświadczeń

3. Introduction

One of the most fundamental questions shaping our perception of the world and guiding our social interactions is: am I safe? Yet, with constant exposure to conspiracy theories and alerts about potential threats in public spaces, it is not unreasonable to believe that danger lurks around every corner. Moreover, the sense of safety extends beyond the mere absence of external threats and also encompasses more personal, self-referential concerns, such as: Am I safe from the judgmental gaze of others? Can I trust that their intentions are genuine, and they will not intentionally harm me through their actions? While a certain degree of caution and vigilance can serve as an effective defense against actual threats, when mistrust and suspicion become widespread and disruptive to daily functioning, they can take the form of paranoid ideation and give rise to adverse mental health consequences.

3.1 Paranoia: From mistrust to persecutory delusions

The state of extreme mistrust and suspiciousness, characterized by strong, implausible beliefs in others' deliberate intentions, a conviction that harm is unavoidable, and a pervasive sense of the world as a dangerous place, is called paranoia (Freeman & Garety, 2000, 2014; Freeman, 2016). Persecutory delusions, i.e., beliefs that harm is going to occur and that others intend to cause it (Freeman & Garety, 2000), are the most common type of delusional beliefs among patients with psychotic disorders (Collin et al., 2023; Pappa et al., 2025). These are followed by delusions of reference, characterized by the erroneous beliefs that external, neutral events, such as the glances, whispers, or laughter of others, are in fact deliberate messages or comments directed towards the individual (Hooker & Park, 2005; Freeman et al., 2021; Bucci et al., 2008; Collin et al., 2023). Although these delusions are hallmark symptoms of psychotic disorders, they also manifest across a wide range of other psychiatric conditions (Varghese et al., 2011; Alsawy et al., 2015; Contreras et al., 2022; Fanti et al., 2023) and extend, in attenuated forms, into the general population. Indeed, a substantial body of research supports conceptualizing paranoia as a continuum, ranging from mild interpersonal mistrust at one end, to fully developed persecutory delusions at the other (Freeman et al., 2005, 2008; Bebbington et al., 2013; Freeman & Loe, 2023). Studies indicate that various forms of paranoid ideation occur in up to 30% of the general population, often characterized by increased mistrust, interpersonal concerns, and ideas of reference (Neidhart et al., 2024; Bebbington et al., 2013; Freeman et al., 2011, 2005). Furthermore, it is estimated that 5-10% of non-clinical individuals experience more severe persecutory-like beliefs, which have an impact on their general functioning. These findings are particularly important given that the occurrence of subclinical psychotic-like experiences has been identified as a risk factor for more severe psychopathological states (Yung et al., 2009; Isaksson et al., 2020; Wilcox et al., 2014; Lindgren et al., 2022), making this an important research target.

3.2 Hierarchy of paranoia

About two decades ago, Freeman and colleagues proposed that paranoia has a hierarchical structure (Freeman et al., 2005). This model posits that at its foundation are social evaluative concerns,

encompassing fears of social rejection, feelings of vulnerability, a sense that the world is potentially dangerous, and beliefs that people generally cannot be trusted. These sensitivities can, in turn, give rise to ideas of reference, such as thoughts that others are talking behind one's back, fears of being observed, or interpreting neutral gazes or gestures as hostile. Depending on the meaning attributed to these experiences, persecutory thoughts and, ultimately, delusions can develop. Initially, individuals may perceive only a mild threat, i.e., beliefs that others intend to cause rather minor distress, such as irritation. At the top of the hierarchy are severe threat beliefs, typically characteristic of clinical persecutory delusions, which may involve convictions of serious harm and significant functional impairment. The hierarchical structure of paranoia has been consistently supported by numerous studies. For instance, Bebbington et al. (2013) identified four key components of paranoia ranked by increasing severity: interpersonal sensitivity, mistrust, ideas of reference, and ideas of persecution. This structure was further validated by recent studies employing a longitudinal ecological momentary assessment (Neidhart et al., 2024) and network approach (Bell & O'Driscoll, 2018). Although we agree that a purely hierarchical model may not fully capture paranoia symptom development (Bell & O'Driscoll, 2018), existing evidence consistently indicates that interpersonal sensitivity, particularly fears of rejection and social evaluation, along with a sense of vulnerability and inferiority, forms a foundation underlying paranoia (Meisel et al., 2018). Therefore, the investigation of factors and mechanisms contributing to this sense of vulnerability is of particular importance.

3.3 Interpersonal sensitivity and vulnerability to harm

Interpersonal sensitivity, initially described as a vulnerability factor for depression (Boyce & Parker, 1989; Wilhelm et al., 2004), is recognized as a key mechanism underlying paranoia (Masillo et al., 2012; McDonnell et al., 2018; Meisel et al., 2018; Hajdúk et al., 2019). It is defined as "an undue and excessive awareness of, and sensitivity to, the behavior and feelings of others, (…) particularly to perceived or actual situations of criticism or rejection" (Boyce & Parker, 1989; Meisel et al., 2018). An important facet of this broader construct is sensitivity to rejection, characterized by the anxious anticipation, ready perception, and intense emotional response to both actual and perceived indicators of social rejection (Berenson et al., 2009; Downey & Feldman, 1996). In accordance with the defensive motivational system framework (Downey et al., 2004), individuals with high rejection sensitivity exhibit increased vigilance towards even subtle signs of rejection, which is further associated with active anticipation, alertness to potential threats, and the interpretation of neutral or ambiguous cues as hostile and indicative of social exclusion (Downey & Feldman, 1996; Berenson et al., 2009; Ehrlich et al., 2015; Kawamoto et al., 2015; Kraines et al., 2018). Low self-esteem has been shown to further exacerbate this bias, as individuals with negative self-views tend to interpret ambiguous social behaviors as signs of disapproval or rejection, which heightens their vigilance for potential interpersonal harm (Leary et al., 1995; Sommer & Baumeister, 2002; Kashdan et al., 2014; Ford & Collins, 2010), and may lead to a generalized perception of the social environment as a source of threat.

Fears of rejection and concerns about social evaluation collectively form the basis for a broader *sense of vulnerability*, i.e., pervasive belief that one is constantly at risk of experiencing harm (Armfield, 2006). Importantly, this schema does not simply arise from the objective characteristics of given stimuli (e.g., someone coughing or laughing), but rather from the meaning that individuals assign to these cues (e.g., interpreting coughing as a deliberate attempt to annoy them or laughing because of their appearance). One of the cognitive vulnerability models describing etiology of fear (Armfield, 2006) proposed that the sense of vulnerability is shaped by the perception of stimuli as: dangerous (capable of causing harm), uncontrollable (beyond one's influence), and unpredictable (whose occurrence cannot be anticipated and thus prevented). Perceived vulnerability, therefore, reflects an individual's sense of susceptibility to negative events, leading to anxiety, vigilance, and avoidant behaviors, further intensifying interpersonal difficulties. In the context of paranoia, it may specifically refer to an increased vulnerability to intentional social threats. In this thesis, the term is operationalized as *vulnerability to harm*, and the primary objective is to better understand the factors and mechanisms that contribute to this vulnerability, forming the basis for paranoia development.

3.4 The cognitive model of paranoia

The current understanding of paranoia posits that persecutory delusions do not arise from a single cause, but rather from complex interactions among multiple factors (Freeman & Loe, 2023), where each is considered as an *'inus condition'* – "an insufficient but non-redundant part of an unnecessary but sufficient condition" (Mackie, 1974, as cited in Freeman & Loe, 2023). In other words, while a single risk factor may increase the probability of paranoid thoughts, the development of the threat belief itself is the result of the interplay of various elements. The cognitive model of paranoia, grounded in the stress-vulnerability framework, proposes that the emergence of symptoms depends on the interaction between biopsychosocial vulnerability factors and stress (Freeman et al., 2002). This *threat-anticipation* model hypothesizes that paranoia is initiated by certain triggers, such as ongoing stress, trauma, drug use, or sleep disturbance. For instance, numerous studies, supported by recent review and meta-analysis (Brown et al., 2024), has shown that sleep disturbance predicts paranoia through increases in negative affect (e.g., Freeman et al., 2012; Reeve et al., 2018; Bagrowska et al., 2022), and the occurrence of perceptual anomalies (e.g., Rehman et al., 2018). These triggers give rise to heightened arousal and an anomalous internal state, manifesting as perceptual disturbances or an aberrant attribution of salience. Essentially, the person feels *different*, which requires an explanation (Freeman, 2007; Freeman et al., 2015). The way these experiences are interpreted depends on numerous factors and involves both emotional and cognitive processes. First, it is hypothesized that paranoia builds upon increased sense of vulnerability to harm, including fears of rejection and negative social evaluation. An extensive body of research, summarized in systematic reviews and meta-analyses (e.g., Kesting & Lincoln, 2013; Tiernan et al., 2014; Humphrey et al., 2021), shows that low self-esteem is associated with higher paranoia. It has been proposed that prior adverse experiences may serve as the

basis for the development of negative beliefs about the self, as well as about others and the world as being hostile and threatening (Gracie et al., 2007; Williams et al., 2018). These beliefs are associated with negative emotional states (i.e., anxiety, worry, rumination), which may provoke fearful explanations, bring implausible ideas to mind, and thus render a paranoid interpretation more likely (Freeman et al., 2002, 2015). Finally, the cognitive model suggests that these interpretations are influenced by cognitive biases, such as jumping to conclusions or failing to consider alternative explanations. Indeed, the tendency towards hypervigilance to threat cues and engagement in behaviors that are oriented towards safety, such as avoidance, prevent the recognition of alternative interpretations that do not involve threat (Freeman et al., 2001). Collectively, these mechanisms are believed to interact in forming the foundation of persecutory beliefs. A sense of vulnerability often plays a central role in activating other processes, which underscores its critical importance and warrants further investigation. Exploring additional factors that enhance this vulnerability, and analyzing their dynamic interplay with other elements is essential, given that existing studies frequently examine individual factors in isolation, thereby restricting our understanding of their complex interactions. In this dissertation, although numerous risk factors are taken into account, the primary focus is on understanding how **negative body image** and, for the first time, **misophonia symptoms** may contribute to paranoia-like thinking by increasing the sense of vulnerability to interpersonal harm.

3.5 Negative body image

A substantial body of research has shown that low self-esteem (Thewissen et al., 2008, 2011; Monsonet et al., 2023) and, more broadly, negative self-beliefs (Lincoln et al., 2010; Kesting & Lincoln, 2013; Jorovat et al., 2025) play a pivotal role in the formation of paranoid thoughts, serving as both predictive factors and underlying mechanisms. One of the fundamental aspects of the general self-view is body image. It is a multidimensional construct encompassing body-related self-perceptions and attitudes (Cash, 2004), and comprises three main interrelated components: cognitive–affective, perceptual, and behavioral (Cash, 2012; Quittkat et al., 2019). Negative body image is characterized by dissatisfaction with one's body, an excessive focus on physical appearance as central to self-worth, engagement in behaviors such as mirror-checking, and the avoidance of situations that may draw attention to body appearance (Jarry, 2012). Despite its profound role in shaping self-perception and its considerable impact on both overall and social functioning (Mond et al., 2013; Merino et al., 2024), body image has been thus far overlooked in paranoia research and has only recently begun to be studied.

According to the paranoia hierarchy (Freeman et al., 2005), ideas of reference build on interpersonal sensitivity. Within this framework, the gestures and behaviors of others are experienced as hostile or threatening, and interpreted as purposely directed towards the individual. Perceiving oneself as vulnerable, inferior, and an easy target for harm, may, therefore, lead individuals to believe that others intend to reject, negatively evaluate or annoy them, simply because of *who they are*. Despite a strong internal conviction of one's own inferiority, there is yet another aspect that is often the subject

of the first and immediate social evaluation: physical appearance. We hypothesized that individuals with a negative body image may initially interpret external social cues, such as gazes, laughter, or whispers, as negative evaluations of their physical appearance (i.e., anticipating harm because of *how they look*). However, at the time the first study in this dissertation cycle was designed and conducted, to the best of our knowledge, only two other studies had specifically examined the link between negative body image and paranoia, providing only preliminary evidence. The first study (Waite & Freeman, 2017), employing data from large, epidemiologically representative cohorts, revealed a significant association between negative body image and paranoid thoughts in a non-clinical general population. Body image was assessed with only one question, and paranoia was assessed with two items. Although this research provided preliminary evidence for the link between body image and paranoia, the analyses were purely correlational and did not employ validated measurement tools. The second study (Marshall et al., 2020) utilized semi-structured interviews to explore the link between body image and paranoia from the first-person perspective of twelve patients with persecutory delusions. The authors hypothesized that body image concerns may exacerbate paranoia by affecting self-esteem, fostering feelings of inferiority, and thereby enhancing perceived vulnerability to harm from others (e.g., fears of rejection). This study offered a plausible hypothesis, consistent with existing theoretical accounts of paranoia (Freeman et al., 2002). However, further research is required to confirm this mechanism on a larger sample, using alternative research methods. Furthermore, a more in-depth examination of various aspects of body image and broader appearance dissatisfaction (not solely tied to excessive weight concerns) within the context of paranoid thoughts seem warranted.

3.6 Misophonia symptoms

While negative body image can fuel a sense of vulnerability through negative beliefs about the *self*, this vulnerability can also stem from negative beliefs about *others* and about the *world* in general. Constant exposure to perceived social threats, especially when they are part of everyday life, cannot be easily avoided, may appear at any moment (*unpredictable*), lie beyond one's control (*uncontrollable*), and have the power to cause harm (*dangerous*), can lead individuals to perceive other people and the external world as inherently dangerous. A factor that has not yet been studied in the context of paranoia, but which exhibits certain features that may contribute to feelings of vulnerability, such as the perception of objectively non-threatening stimuli in social situations as dangerous or harmful, frequent exposure and hypervigilance to specific threat cues, may be misophonia.

Misophonia is defined as “a disorder of decreased tolerance to specific sounds or stimuli associated with such sounds” (Swedo et al., 2022). These stimuli (referred to as triggers) are often everyday sounds, especially (but not exclusively) those made by other people, such as chewing, eating, coughing, breathing and sniffing (Edelstein et al., 2013; Vitoratou et al., 2021). In response to these stimuli, individuals with misophonia may experience a range of strong negative emotional, physiological, and behavioral reactions, including, but not limited to, anger, irritation, anxiety, disgust,

avoidance, and increased heart rate (Edelstein et al., 2013; Schröder et al., 2019; Savard et al., 2022; Swedo et al., 2022). Importantly, misophonic responses are not typically elicited by the loudness of sounds, as is the case in general sensory sensitivities, but rather by specific patterns, contexts, and personal meanings that these sounds hold for an individual (Samermit et al., 2022; Swedo et al., 2022; Siepsiak et al., 2023). For instance, studies have shown that triggering sounds are typically more distressing when produced by family or friends than by strangers or animals (Taylor, 2017; Edelstein et al., 2020; Siepsiak et al., 2023). Moreover, a recent qualitative study (Natalini et al., 2020) indicated that some individuals with misophonia may believe that others *intentionally* produce these sounds, and that belief is experienced as particularly distressing. However, the interpretation of stimuli as hostile and deliberate in the context of misophonia remains underexplored. Preliminary research suggests that misophonia is linked to difficulties in emotion regulation (Guetta et al., 2022; Dixon et al., 2024), which could manifest in the form of blame or hostile attribution bias (Kaufmann et al., 2022), and potentially foster interpersonal threat beliefs. However, this hypothesis requires investigation.

More recently, a new tool has been developed (Vitoratou et al., 2021; Uglik-Marucha et al., 2024) that provides a more comprehensive assessment of various misophonia dimensions, placing particular emphasis on the meanings attributed to the misophonic experience. The S-Five scale captures five distinct aspects of misophonia: *internalizing appraisals* (judgement and self-blame for the reaction to triggering sounds), *externalizing appraisals* (blaming and judging others for causing the reaction), *sense of threat* (fear of negative emotional escalation in response to triggering sounds), *outburst* (fear of verbal or physical aggression towards the source of the stimuli), and *impact* (perceived current and future limitations resulting from reactions to triggering sounds). We hypothesized that each of these dimensions, but particularly externalizing and internalizing appraisals, could serve as a potential source of threat beliefs. Externalizing appraisals in misophonia (blaming others for triggering sounds) align somewhat with the 'poor me' concept of paranoia (Trower & Chadwick, 1995; Tiernan et al., 2014; Marley et al., 2017), in which individuals perceive others as being responsible for causing harm. In contrast, internalizing appraisals (self-blame) correspond to the 'bad me' paranoia concept, characterized by beliefs in one's own flaws and inferiority. In both cases, these appraisals can give rise to a sense of vulnerability, either through negative beliefs about the self, or through negative beliefs about the others. This line of reasoning is also supported by literature identifying six plausible key mechanisms in the development of paranoid thoughts (Freeman & Garety, 2014), including interpersonal sensitivity, worry and negative self-beliefs. As misophonia is typically triggered by everyday sounds encountered in many social situations, it can lead to the experience of constant stress, anxiety, hypervigilance, and an ongoing anticipation of social threat. In accordance with the cognitive model of paranoia, which frames risk factors as '*inus conditions*' (Freeman & Loe, 2023), we hypothesize that misophonia symptoms may be another risk factor, which not only correlates with paranoid ideation, but may also predict it. This could indicate a broader mechanism that reflects living

in a world where ordinary stimuli can seem threatening, and where other people, especially those we are to trust, may be capable of causing harm. Nevertheless, as this connection represents an entirely new research area, many questions remain that will need to be comprehensively addressed over time.

3.7 Network approach to psychopathology

It has now been over a decade since mental disorders were first proposed to be conceptualized as complex networks of interacting symptoms (Borsboom, 2008, 2017). The network approach to psychopathology (Cramer et al., 2010; Bringmann et al., 2013) posits that mental disorders emerge from direct causal relationships among symptoms, which interact and often reciprocally reinforce one another. It has been proposed that symptoms with a high degree of *centrality* (i.e., those with the strongest direct connections to other network elements) are more likely to propagate their activation to other symptoms throughout the network (Borsboom, 2017; Castro et al., 2019). In their pioneering work, Cramer and colleagues (2016) further advanced the network approach to psychopathology, which had previously focused on simply characterizing the structure of symptom interactions within a particular disorder. The conceptualization of mental disorders as *complex dynamic systems*, however, offers a more comprehensive account by explaining the processes that drive changes in these structures over time, and how these dynamics may lead to transitions toward more severe psychological states or disorders (e.g., from subclinical paranoid thoughts to persecutory delusions). According to the network theory (Cramer et al., 2016; Borsboom, 2017), the development of mental disorders occurs through four phases: in Phase 1, no symptoms are present, and their potential connections are dormant; in Phase 2, external triggers, such as adverse events, may induce network activation; in Phase 3, this activation spreads through the network via direct links between symptoms; in Phase 4, strongly connected networks exhibit sustained activation due to feedback relations among symptoms, allowing the network to remain active long after the initial trigger has been removed. This persistent activation is known as *hysteresis*, and it is posited to be the mechanism by which mental disorders arise in strongly connected networks. These dynamics are not expected in networks with weak connectivity, where triggers may evoke temporary reactions, but lack of direct connections between symptoms prevents self-sustenance, causing the system to gradually return to Phase 1. This approach may be especially relevant in the study of subclinical phenomena. It has been proposed that in *vulnerable networks*, even minor disturbances may shift the system toward a more severe state. Such shifts are often preceded by early warning signals (*critical slowing down*), which is reflected in increasingly slow recovery from small perturbations. It has also been hypothesized that the most central symptoms within a network could serve as therapeutic targets, as deactivating a central symptom is suggested to disrupt its connections to other elements and thereby reduce overall network connectivity (Robinaugh et al., 2016). The identification of central nodes is therefore crucial, as early intervention is often key to preventing symptom progression.

In recent years, the network approach has been increasingly applied to the study of paranoia. Consequently, several central factors within paranoia network models have been identified, including

worry about social criticism or rejection (Bell & O'Driscoll, 2018; Januška et al., 2021; Contreras et al., 2022), negative beliefs about others (Hajdúk et al., 2019), feelings of being watched or stared at (Contreras et al., 2022), and loneliness (Januška et al., 2021; Contreras et al., 2022). However, most existing models rely on cross-sectional data, which capture associations among variables measured at a single time point, and therefore limit inferences about temporal dynamics. More recently, attention has shifted to network models that incorporate both temporal and within-person dynamics (Bringmann et al., 2013). Intensive longitudinal data, such as those collected via experience sampling method (ESM) (Myin-Germeys et al., 2018), are used to examine not only average associations across individuals but also the dynamic processes that occur within individuals over time. To the best of our knowledge, despite extensive ESM-based research on paranoia in both clinical and non-clinical contexts (e.g., So et al., 2018; Kasanova et al., 2020; Bell et al., 2023), only one study to date has explicitly incorporated paranoia into a temporal network (Contreras et al., 2020). However, this was a pilot study with a relatively small sample, underscoring a significant gap in the literature in this area.

Against this background, and considering the new risk factors for paranoia to be explored in this dissertation cycle, further research should address existing gaps by examining these factors not only in isolation but also, perhaps most importantly, within the broader context of interacting vulnerability-related elements, employing both structural and dynamic network approaches.

3.8 Research questions and hypotheses

This thesis comprises a series of five studies designed to advance our understanding of the factors and mechanisms underlying paranoia-like thoughts in a non-clinical population. By employing diverse research methods and analytical approaches, it integrates findings from cross-sectional, experimental, and intensive longitudinal studies, introducing novel elements into existing theoretical frameworks and placing them within a broader context of risk factors associated with paranoia.

Study 1: Since negative body image has only recently begun to be studied in relation to paranoia, the existing evidence remains limited and unsystematic. At the time Study 1 was designed and conducted, only two prior studies had explicitly addressed this issue. The first (Waite & Freeman, 2017) identified a potential link between negative body image and paranoid thoughts, but the findings were highly preliminary and lacked the use of standardized measures. The second study (Marshall et al., 2020) proposed a plausible hypothesis explaining this relationship, but it involved a relatively small sample, which limited the generalizability of the findings. Given this context, the first aim of this thesis was to examine the relationship between negative body image and paranoia-like thoughts in a larger non-clinical sample using validated measures, and to test the potential underlying mechanism.

Research Question 1: Is negative body image associated with elevated levels of paranoia-like thoughts, and if so, is this relationship mediated by negative emotions, low self-esteem, and heightened rejection sensitivity? We hypothesized that negative body image would be associated with higher levels of paranoia-like thoughts **(H1a)**, and that this relationship would be sequentially mediated by negative

affect, low self-esteem, and heightened rejection sensitivity **(H1b)**. To further explore this relationship and address gaps in the literature, we formulated two additional exploratory hypotheses. First, given the complex nature of body image, we hypothesized that specific components, namely body image-related attitudes, beliefs, emotions, and behaviors, would play a role and mediate the relationship between body dissatisfaction and paranoia-like thoughts **(H1c)**. Finally, since previous studies have primarily focused on excess weight as an indicator of negative body image, we hypothesized that it is not excess weight alone but broader body dissatisfaction that is linked to paranoia-like thoughts **(H1d)**.

Study 2: Existing theoretical models consistently propose that paranoia develop against the background of interpersonal sensitivity. Although empirical research has identified multiple risk factors that may fuel this sensitivity, they are often studied in isolation, limiting our understanding of their interplay. In Study 2, we integrated negative body image, a novel element, with other established factors in a single network model to examine their interrelationships more comprehensively.

Research Question 2: To what extent are various vulnerability-related factors interconnected within a single paranoia network model, and how integrated is body image within this structure? We hypothesized that all factors – including negative body image – will form a well-connected network with no isolated nodes **(H2a)**. Moreover, we hypothesized that variables more closely related to interpersonal sensitivity (i.e., rejection sensitivity and negative self-views) will exhibit higher centrality than those reflecting other dimensions (e.g., sleep quality) **(H2b)**.

Study 3: Paranoia is associated with hypervigilance, threat anticipation, and the perception of neutral stimuli as dangerous. We hypothesized that misophonia to some extent mirror these processes and thus represent a theoretically plausible contributor to paranoia models. Although misophonia has been associated with various psychiatric conditions, its link to paranoia-like thoughts has not been previously examined. Study 3, therefore, adopts an exploratory approach to investigate this novel relationship and to test a mediation model that may shed light on the potential underlying mechanisms.

Research Question 3: Are misophonia symptoms associated with elevated levels of paranoia-like thoughts in a non-clinical population, and if so, is this relationship mediated by difficulties in emotion regulation, anxiety, and hostile attribution bias? We hypothesized that misophonia symptoms would be associated with higher levels of paranoia-like thoughts **(H3a)**, and that this relationship would be sequentially mediated by difficulties in emotion regulation, anxiety, and hostile attribution bias **(H3b)**.

Study 4: Study 3 provided initial evidence of a significant link between misophonia symptoms and paranoia-like thoughts and outlined a plausible mediation pathway. However, its cross-sectional design limited causal inference. Study 4 employed an experimental approach and a more comprehensive misophonia assessment to identify which misophonia dimensions are most strongly linked to paranoid ideation, and to determine whether exposure to common misophonia trigger sounds increases the level of paranoia-like thoughts, both directly and through negative affect.

Research Question 4: a. Which dimensions of misophonia are most strongly associated with

paranoia-like thoughts? b. Does exposure to common misophonia trigger sounds increase paranoia-like thoughts compared to control stimuli? c. Do negative emotions mediate this effect? We hypothesized that among misophonia dimensions, both externalizing and internalizing appraisals will show the strongest associations with paranoia-like thoughts **(H4a)**. Moreover, we hypothesized that exposure to human-produced trigger sounds paired with matching video will elicit a greater increase in paranoia-like thoughts than non-human sounds or audio-only/video-only control conditions **(H4b)**. Finally, we also hypothesized that negative emotional response will significantly mediate the effect of trigger-sound exposure on paranoia-like thoughts **(H4c)**.

Study 5: Finally, building on previous findings, we integrated negative body image (Studies 1–2), social rejection (Study 2), and misophonia symptoms (Studies 3–4) into a single network model of interpersonal sensitivity, the foundational stage in the paranoia hierarchy (Freeman et al., 2005). To move beyond the constraints of cross-sectional research designs, Study 5 employed intensive longitudinal measures (ESM) and temporal network modeling to explore how these factors dynamically interact to shape interpersonal sensitivity underlying paranoia.

Research Question 5: Within an intensive longitudinal temporal network model of paranoia-related vulnerability factors (i.e., negative body image, rejection sensitivity, and misophonia symptoms), how are these variables interrelated over time, and do they primarily function as predictors, outcomes, or peripheral nodes in relation to paranoia-like thoughts? We hypothesized that all included vulnerability factors will form a well-connected temporal network with no isolated nodes **(H5a)**. Moreover, we hypothesized that negative body image, feeling of social rejection, negative affect, and misophonia symptoms will each significantly predict subsequent increases in paranoia-like thoughts **(H5b)**. Finally, we hypothesized that paranoia-like thoughts will be the most strongly predicted variable (*in-expected influence*) within the temporal network **(H5c)**.

4. Methods and Results

This section provides a concise overview of each study included in this doctoral thesis, with detailed methodology, results, and discussions reported in the respective articles.

Publication 1: Bagrowska, P., Pionke-Ubych, R., & Gawęda, Ł. (2022). Bridging the gap between body image and paranoia-like thoughts. *Journal of Psychiatric Research, 156,* 660-667. https://doi.org/10.1016/j.jpsychires.2022.10.061

Negative self-esteem and social-evaluative concerns are well-established factors in the development of paranoia, yet the role of negative body image, a specific aspect of general self-esteem, remains largely unexplored and supported only by preliminary evidence. In a first-person qualitative study, Marshall et al. (2020) identified negative body image as a potential source of interpersonal threat, having impact on global self-image and increasing feelings of inferiority – factors that may, in turn, foster paranoid thoughts. However, this hypothesis has not yet been investigated using quantitative

methods. Furthermore, previous studies have focused on negative body image stemming from concerns about excess weight, overlooking other forms of body dissatisfaction. To address these gaps, Study 1 employed validated measures to examine the link between negative body image and paranoia-like thoughts in a non-clinical sample, and to investigate its potential mediating mechanisms.

A total of 539 adults (65.5% women) were recruited online via convenience sampling. After providing informed consent, participants were asked to report demographic information, weight and height (to calculate body mass index; BMI), and a history of psychiatric diagnoses. In the next step, they were asked to complete a series of questionnaires measuring paranoia-like thoughts (Freeman et al., 2021), body image (Franzoi & Shields, 1984), negative affect (Watson et al., 1988), self-esteem (Rosenberg, 1965), rejection sensitivity (Downey & Feldman, 1996), and body image-related attitudes, beliefs, emotions, and behaviors (Głębocka, 2009). To assess the level of body dissatisfaction (Mutale et al., 2016), participants were asked to select from a series of silhouettes the figure that most resembled their own body and the one they most wished to have. Based on these scores, they were classified into one of three groups: those desiring a smaller body, a larger body, or their current size. The results supported **H1a**, showing that negative body image was significantly linked to higher levels of paranoia-like thoughts. Consistent with **H1b**, this association was sequentially mediated by negative emotions, low self-esteem, and increased rejection sensitivity. A parallel mediation analysis further examined specific body image-related dimensions, such as emotional-cognitive aspect, behaviors, social criticism, and stereotypes, and found that only social criticism (i.e., critical comments and lack of perceived acceptance) significantly mediated the relationship between negative body image and paranoia-like thoughts (**H1c**). Finally, in line with **H1d**, individuals who desired either a smaller or larger body size reported higher levels of paranoia-like thoughts than those satisfied with their current figure. Furthermore, individuals showing discrepancy between their actual BMI and the silhouette they identified as most representative of their own also exhibited elevated paranoia-like thoughts.

The study confirmed that negative body image is significantly associated with paranoia-like thoughts in a non-clinical sample, and negative emotions, low self-esteem, and increased rejection sensitivity may form a potential mechanism underlying this relationship. It also underscored the central role that social-evaluative concerns play in this context. Importantly, the observed effects may reflect broader dissatisfaction with one's appearance – or even distorted body perceptions – rather than concerns solely about excess weight, in driving paranoia. Although the present findings bring new knowledge, the cross-sectional study design limits causal interpretations. Therefore, it is recommended that future research employ longitudinal and experimental approaches to test the proposed mechanisms.

Publication 2: Bagrowska, P., Nelson, B., & Gawęda, Ł. (2025). The central role of negative emotional states, rejection sensitivity and negative self-beliefs in a complex non-clinical paranoia network model. *Social Psychiatry and Psychiatric Epidemiology*. https://doi.org/10.1007/s00127-025-02964-7

Contemporary models describe paranoia as arising from hierarchical processes, with increased

sense of vulnerability at its core. Although previous research has identified numerous factors that may contribute to this vulnerability, these are typically examined in isolation. In accordance with the network approach to psychopathology, it seems crucial to examine how various paranoia risk factors interact and where the potential vulnerability-related elements, such as negative body image, fit within a single network model. Building on existing theoretical accounts and findings from Study 1, Study 2 integrated negative body image with other key factors into a comprehensive network model to explore their interrelationships and determine their relative centrality within the broader paranoia network.

A total of 1019 adults (57.4% women) were recruited online via convenience sampling and Computer-Assisted Web Interviews (CAWI). After providing consent and demographic information, participants were asked to complete an extensive battery of measures assessing paranoia-like thoughts (Freeman et al., 2021), rejection sensitivity (Downey & Feldman, 1996), childhood traumatic experiences (Styła & Makoveychuk, 2018), sleep quality (Buysse et al., 1989), self-esteem (Rosenberg, 1965), body image (Franzoi & Shields, 1984), depression, anxiety and stress symptoms (Lovibond & Lovibond, 1995), perseverative thinking (Ehring et al., 2011), worry (Meyer et al., 1990) and aberrant salience (Cicero et al., 2010). An undirected network model comprising 27 nodes, each representing a total or subscale score, was then estimated. In line with **H2a**, the network was fully connected with no isolated nodes. Centrality analyses identified stress, anxiety, childhood emotional neglect, rejection sensitivity, low self-esteem, and negative body image as the most central nodes in the network, thereby supporting **H2b**. Paranoia-like thoughts were directly linked to rejection sensitivity, low self-esteem, anxiety, childhood traumatic experiences, and aberrant salience. Importantly, anxiety emerged as one of the most common cross-nodes linking other factors, such as sleep quality, with paranoia-like thoughts. Finally, the shortest paths analyses revealed that the association between negative body image and paranoia was mediated solely by low self-esteem, suggesting a more direct route from negative body image to paranoia, rather than the longer chain of mediators as proposed in Study 1.

This study employed a network approach to construct a comprehensive model of factors related to paranoia-like thoughts. The analysis identified negative emotional states, increased rejection sensitivity, and negative self-beliefs (including low self-esteem and negative body image) as the most central nodes potentially driving the network's dynamics, highlighting these factors as promising targets for therapeutic intervention. Rather than relying solely on cross-sectional data, future network models should employ more ecologically valid approaches, such as experience sampling, to capture the temporal interplay and the potential propagation of symptoms over time.

Publication 3: Bagrowska, P., Pionke-Ubych, R., & Gawęda, Ł. (2022). Do they make these sounds to hurt me? The mediating role of emotion regulation, anxiety and hostile attributions in the relationship between misophonia and paranoia-like thoughts. *Schizophrenia Research, 250,* 137-142. https://doi.org/10.1016/j.schres.2022.11.005

Misophonia is characterized by intense emotional and physiological reactions to specific

auditory stimuli. These are typically everyday sounds produced by other people, such as breathing or chewing. Given the frequently unavoidable nature of such sounds, they have the potential to induce a state of constant stress and anxiety in social situations. Paranoia involves perceiving the world as a dangerous place and other people as potential threats capable of causing harm. Previous research shows that individuals with misophonia symptoms report difficulties with emotional regulation, experience elevated anxiety, and may interpret misophonia-triggering sounds as hostile and intentional, thus reflecting paranoid attributions of harm. Despite these similarities, no study has yet examined the relationship between misophonia and paranoia. Therefore, Study 3 adopted an exploratory approach to investigate this association for the first time and to propose a potential underlying mechanism.

A total of 312 adults (64.7% women) were recruited online via convenience sampling. After providing informed consent and demographic information, participants completed self-report questionnaires assessing paranoia-like thoughts (Freeman et al., 2021), misophonia symptoms (Siepsiak et al., 2020), difficulties in emotion regulation (Gratz & Roemer, 2004), anxiety (Spitzer et al., 2006), and hostile attribution bias (Combs et al., 2007). Supporting **H3a**, misophonia symptoms turned out to be significantly associated with higher levels of paranoia-like thoughts in a non-clinical sample. Consistent with **H3b**, this relationship was mediated by difficulties in emotion regulation, increased anxiety, and hostile attribution bias.

This study provided the first evidence of a link between misophonia symptoms and paranoia-like thoughts, and highlighted a plausible, coherent mechanism that could underlie this relationship. Specifically, difficulties in emotion regulation and elevated anxiety may result in individuals attributing blame for their misophonic reactions to others' hostile intentions, potentially leading to the generalization of the perception of the world and other people as threatening. However, given the cross-sectional nature of the study, and despite the directional model being tested, it is not possible to draw causal conclusions, and experimental studies are required to validate these preliminary findings.

Publication 4: Bagrowska, P., Siepsiak, M., Nalberczak-Skóra, M., & Gawęda, Ł. (2024). Exacerbation of paranoia-like thoughts following exposure to common misophonia trigger sounds. *Schizophrenia Research, 274,* 290-298. https://doi.org/10.1016/j.schres.2024.10.005

Study 3 provided initial evidence for a correlation between misophonia symptoms and paranoia-like thoughts. However, its correlational design leaves open the question of whether misophonia simply co-occurs with paranoia, or whether it can also function as an autonomous predictor of paranoia-like thoughts in its own right. Moreover, it remains unclear which misophonia dimensions - hostile attribution bias as suggested in Study 3 or other symptom domains - drive this effect. In order to address these questions, Study 4 employed an experimental approach to investigate whether exposure to common misophonia-triggering sounds results in the exacerbation of paranoia-like thoughts, either directly or indirectly via increased negative affect. A multidimensional misophonia scale was also used to identify the aspects most strongly associated with paranoia.

A total of 487 participants were recruited online via the CAWI method and, after providing consent, were asked to report their demographic information and a history of psychiatric diagnoses. Participants were invited to complete questionnaires assessing paranoia-like thoughts (Freeman et al., 2021) and misophonia symptoms across five dimensions - externalizing appraisals, internalizing appraisals, perceived threat, outbursts, and functional impact (Vitoratou et al., 2021). For the experimental manipulation, a task was created using stimuli from an open-access audiovisual database (Samermit et al., 2022). Participants were randomly assigned to one of four conditions: (1) original audiovisual sources (OVS), pairing common misophonia-trigger sounds with their original visual cues; (2) positive attributable audiovisual sources (PAVS), using the same sounds but paired with not typically triggering visual cues (e.g., eating sounds with tearing-paper visuals); (3) sound-only, presenting the OVS sounds without videos; or (4) video-only, presenting the OVS videos without sounds. Prior to and following this manipulation, all participants completed brief state measures of paranoia-like thoughts (six items derived from Freeman et al., 2015) and negative affect (eight items from the S-Five scale; Vitoratou et al., 2021). The results replicated the findings from Study 3, demonstrating that misophonia symptoms are associated with higher levels of paranoia-like thoughts in an independent sample. Among the five misophonia dimensions, internalizing appraisals exhibited the strongest association with paranoia, followed closely by the impact and outburst subscales, while externalizing appraisals demonstrated the weakest link, thus partially contradicting **H4a**. It was observed that exposure to misophonia triggers (condition 1) produced an increase in paranoia-like thoughts, though this trend did not reach statistical significance, thereby not fully supporting **H4b**. Conditions 2 and 3 resulted in a decrease in paranoia, and condition 4 revealed no significant change. Finally, in line with **H4c**, an increase in negative affect significantly mediated the effect of trigger exposure on paranoia-like thoughts.

This study demonstrated that misophonia symptoms may not merely correlate with paranoia, but can actively intensify paranoia-like thoughts through negative emotional modulation. Contrary to the hypothesis formulated in Study 3, which highlighted the role of hostile attributions, these results did not fully support that mechanism. However, new measures may be necessary to adequately capture this dimension in paranoia research. Importantly, the finding that internalizing appraisals, linked to negative self-views and feelings of inferiority, exhibited the strongest association with paranoia-like thoughts, may be indicative of a broader sense of vulnerability that underlies paranoia.

Publication 5 (preprint)**:** Bagrowska, P., & Gawęda, Ł. (2025). 'Rejection makes me suspicious': Complex temporal network approach to the dynamics of real-time paranoid thoughts and psychological vulnerability. https://doi.org/10.31219/osf.io/mkqf3_v1

Previous studies employed correlational and experimental study designs, as well as cross-sectional network modeling, in order to examine novel factors hypothesized to contribute to the sense of vulnerability underlying paranoia. Building on these findings, Study 5 integrated these plausible

vulnerability-enhancing factors into a single network model. Using ecologically valid experience sampling data and temporal network modelling, Study 5 aimed to assess both within- and between-subject temporal effects of these factors on paranoia and explore their dynamic interactions over time.

A total of 175 adults (58.3% women) from a non-clinical population provided informed consent and participated in this study, which formed part of a larger project. Participants were assigned to either the low-paranoia (LP; $n = 103$) or high-paranoia (HP; $n = 72$) group based on baseline level of paranoia-like thoughts (Freeman et al., 2021). All participants underwent comprehensive semi-structured clinical interviews assessing psychiatric (Sheehan et al., 1998) and attenuated psychotic symptoms (Yung et al., 2005). Subsequently, participants completed a seven-day ESM procedure, receiving eight surveys per day, resulting in a total of 56 assessments of paranoia-like thoughts, social stress, perceived social safety, feelings of social rejection, stressful events, negative affect, body image, and misophonia symptoms. Finally, multilevel vector autoregression analysis was performed to estimate temporal, contemporaneous, and between-subject network models for the total sample and subgroups separately. In line with **H5a**, the temporal networks were found to be fully connected with no isolated nodes (except social safety in the LP model). The findings indicated that **H5b** was only partially supported – paranoia-like thoughts were directly predicted only by perceived lack of social safety and feelings of social rejection (the latter showing a bidirectional link). Negative affect and misophonia symptoms predicted paranoia only in the LP group, but the low levels of paranoia-like thoughts in this group limit interpretation of the results. Contrary to **H5c**, paranoia was not the most strongly predicted variable in the model (*in-expected influence*). Instead, it exhibited the strongest predictive effect (*out-expected influence*), significantly predicting subsequent increases in social rejection, negative affect, negative body image (total sample), and social stress (HP group). In the LP group, paranoia did not significantly predict any other variable. In contemporaneous networks, paranoia was directly associated with social rejection, negative affect, reduced social safety, and misophonia symptoms in both the total sample and HP group. Between-subject analyses revealed direct associations between paranoia and negative affect, social rejection, and social safety, with the link to negative body image mediated by social rejection and negative affect. Although LP and HP models shared a largely similar structure, the HP network displayed a greater number and strength of significant associations.

This study emphasized the central role that feelings of social rejection may play in shaping paranoia network dynamics. Contrary to our initial hypothesis, the network factors largely emerged as consequences of paranoia-like thoughts rather than as their direct predictors. Notably, social rejection was the most strongly predicted variable, suggesting that other factors may first alter rejection sensitivity, thus laying the foundation for paranoia development. Furthermore, although the overall network structure was comparable across groups, the number and strength of symptom connections were greater in individuals with high paranoia-like thoughts. This pattern suggests that early intervention targeting the most central symptoms could prevent the progression to more severe states.

5. General Discussion

The primary objective of this dissertation was to examine factors that may increase perceived vulnerability to harm and, in turn, contribute to the development of paranoia-like thoughts in a non-clinical population. This thesis comprises five studies, each conducted with an independent sample, and employs a range of diverse research methods, including correlational and experimental designs, ecologically valid, intensive longitudinal data collected via experience sampling method, as well as both static (structural) and dynamic (temporal) network modeling. This multilevel approach identified novel correlates of paranoia and situated them within the broader context of other related factors.

Given the limited prior evidence regarding the role of negative body image in paranoid thoughts, the first two studies further examined this relationship. Using validated measures and a relatively large sample, we confirmed a statistically significant association. Furthermore, consistent with a hypothesis derived from first-person qualitative interviews (Marshall et al., 2020), our quantitative study revealed that negative affect, low self-esteem, and heightened rejection sensitivity significantly mediated this relationship, highlighting vulnerability to harm as a potential underlying mechanism. Negative self-beliefs may give rise to feelings of inferiority and vulnerability to social harm, but negative beliefs about one's appearance may further intensify these processes. As physical appearance is often the primary focus of social evaluation, negative body image may increase the sense of being an easy target for criticism or rejection, and bias interpretations of ambiguous, seemingly neutral social cues as hostile or threatening (e.g., perceiving others' gazes or laughter as resulting from their body appearance). Indeed, the social criticism subscale (Głębocka, 2009), which assesses perceived social acceptance and critical comments about one's appearance, emerged as the key mediator between negative body image and paranoia. Importantly, our findings indicate that paranoia-like thoughts are linked to a broader dissatisfaction with body appearance, extending beyond perceptions of excessive weight or size. Our study revealed that higher levels of paranoia-like thoughts were associated with perceiving one's body as either larger or smaller than desired. However, we acknowledge that body dissatisfaction extends beyond body size. A limitation of this study, and an important avenue for future research, is the need to examine paranoia in relation to other sources of body dissatisfaction, such as skin conditions (e.g., acne) or facial features (e.g., nose size or shape). Our preliminary results also suggests that not only a negative body image, but also a potentially distorted body image (perceiving the body as different than actual) may be relevant. Indeed, this effect was subsequently confirmed in a community sample of women (Malcolm et al., 2022). Nevertheless, further research is warranted to validate and extend these findings. The results of Study 1 should be interpreted in light of several other limitations. Although directional mediation models were tested and a specific sequence of variables was proposed, these should be regarded as data-supported hypotheses only, as correlational data cannot establish causality, and alternative models are also plausible. For instance, rather than body image being a predictor of paranoia, paranoid thoughts may be a predictor of negative body image. Indeed, over time, two studies

(including one of ours) (Bagrowska et al., 2023; Toh et al., 2023) have examined these potential reverse associations. While these models are still based on correlational data, they suggest the possibility of a bidirectional relationship and warrant further investigation with this aspect in mind.

While several studies examining the relationship between negative body image and paranoia have been published in recent years (Malcolm et al., 2022; Waite et al., 2023; Toh et al., 2023), our research is, to date, the first to situate body image within a broader framework of paranoia-related factors. In the structural network model (Study 2), negative body image was not only one of the most central factors but also one of the most central bridge nodes (i.e., variables linking two larger clusters of nodes or symptoms). The shortest path analyses further showed that the association between negative body image and paranoia was mediated by negative general self-esteem (Study 2) or negative affect (Study 5). In line with the network approach to psychopathology (Borsboom, 2017), these results may cautiously suggest that interventions aimed at improving body image (potentially as part of the overall self-view, including general self-esteem) may positively influence other factors within the network and, perhaps, paranoid thoughts themselves, representing a promising direction for future research.

The next two studies in this cycle examined symptoms of misophonia, a factor that had not previously been studied in relation to paranoia-like thoughts. The first misophonia study (Study 3) was purely exploratory in nature. As hypothesized, misophonia symptoms were significantly associated with paranoia-like thoughts in a non-clinical sample, and this relationship was mediated by difficulties in emotion regulation, elevated anxiety, and a tendency toward hostile attribution bias. The proposed model posits that difficulties in regulating emotions elicited by misophonia triggers may intensify anxiety, which in turn activates defensive strategies such as attributing hostile intent to those producing triggering sounds. This mechanism has the potential to exacerbate feelings of vulnerability to social harm and contribute to a generalized perception of the world as threatening and other people as a source of intentional harm, thus providing a potential basis for paranoia development. However, this model remains hypothetical, as the cross-sectional design prevents drawing causal conclusions. As was the case in Study 1, although a directional model was tested and the specified sequence of variables yielded significant results, these findings should be interpreted with caution, as alternative models are plausible. One such alternative explanation appeared in the subsequent study conducted within this dissertation.

Study 4 was experimental in nature and employed a more comprehensive measure of misophonia. Contrary to the hypothesis proposed in Study 3, externalizing appraisals (i.e., blaming others for producing triggering sounds) were not central to paranoia-like thoughts. Instead, internalizing appraisals (i.e., self-blame for reactions to triggering sounds and feelings of inferiority) emerged as the key factor. Thus, beyond negative beliefs about others and the external world as potentially hostile and threatening, a second explanatory pathway involves negative beliefs about the self - perceiving oneself as weak, different, or disliked by others, and therefore more vulnerable to negative social evaluation, social rejection, and other forms of harm. However, it is important to note that the ‘Externalizing’

subscale did not fully capture the construct we hypothesized to be most relevant to paranoia. In the S-Five scale (Vitoratou et al., 2021), externalizing appraisals refer to attributing blame to other people for producing triggering sounds because they are perceived as selfish, bad-mannered, or unaware that such sounds may cause harm. What we sought to measure, but was not reflected in this scale, was the perceived intention of those producing the triggering sounds. The definition of paranoia (Freeman & Garety, 2000) includes two core criteria: the belief that harm will occur and that the harm is intentional. Accordingly, perceived intentionality could not be established in this study, and future research should include items that directly assess perceived intentions and hostility to clarify whether externalizing or internalizing appraisals better explain their association with paranoia.

Another aspect of this study was to investigate whether exposure to common misophonia triggers would increase paranoia-like thoughts, both directly and indirectly through negative affect. The results indicated that only the first condition (i.e., misophonia trigger sounds paired with corresponding videos of people producing those sounds) led to an increase in paranoia-like thoughts, although this effect was only a trend and did not reach statistical significance. In that condition, however, exposure significantly increased negative affect, which in turn mediated the link between misophonia stimuli and increased paranoia-like thoughts. In the other conditions, paranoia either declined or remained unchanged, highlighting the crucial role of social context. Taken together, these findings suggest that misophonia symptoms may precede and contribute to increased paranoid thoughts, rather than merely co-occurring with them. The mediating role of negative affect aligns with prior research showing that various triggers can heighten paranoia through negative emotions (Kramer et al., 2014; Rehman et al., 2018). However, the absence of a statistically significant direct effect requires investigation. One possible explanation is that the experiment was conducted online, which may have influenced the results. As outlined in the theoretical introduction, a sense of vulnerability may arise from exposure to stimuli that are perceived as dangerous, unpredictable, and uncontrollable (Armfield, 2006). In our study, exposure occurred in an artificial setting in which the presentation of unpleasant sounds was both predictable and under participants' control (i.e., possibility to mute the audio or discontinue participation at any time). Replicating the experiment under more ecologically valid conditions, such as in virtual reality settings, may yield stronger effects. Future studies should also incorporate measures of participants' beliefs about those producing the triggering sounds in the experimental task. This limitation prevented a direct examination of intentionality and hostility as potential mechanisms linking misophonia and paranoia. It is important to note that our findings do not imply that misophonia is a sufficient or necessary factor in the development of paranoid ideation. Instead, these findings may reflect a broader mechanism involving multiple sources of vulnerability, particularly those embedded in social contexts. Future research should compare the roles of misophonia and other sensory sensitivities in relation to paranoid thoughts and, more broadly, to psychotic-like experiences, such as auditory hallucinations. It would also be valuable to assess misophonia in clinical populations, such as patients with persecutory

delusions, and, conversely, to evaluate the severity and content of paranoid thoughts among individuals who meet provisional diagnostic criteria for misophonia (Schröder et al., 2013), clarifying the relationship across the continuum of symptom severity.

Finally, two studies in this dissertation employed a network approach to examine the broader interplay among various risk factors associated with paranoia-like thoughts. The first, a cross-sectional study of more than 1000 individuals, applied a network approach to map the structure of variables derived from the cognitive model of paranoia and, for the first time, included negative body image within such broader framework. The findings highlighted interpersonal sensitivity (encompassing negative self-beliefs, high rejection sensitivity, negative emotional states, and specific subtypes of childhood traumatic events) as the most central variables, thus supporting our hypotheses and results from prior non-clinical paranoia network models (Bell & O'Driscoll, 2018; Hajdúk et al., 2019; Januška et al., 2021). Moreover, these variables were also identified as central bridge nodes within the network, with anxiety most frequently linking otherwise distinct symptom clusters. These central variables warrant evaluation as plausible therapeutic targets in future studies. Consistent with theoretical accounts (Freeman et al., 2002), these vulnerability-enhancing factors may constitute a common mechanism that, when reinforced by negative affect, worry, and a tendency toward aberrant salience, links triggering factors to paranoia-like threat beliefs. Importantly, the network integrated multiple risk factors, encompassing not only vulnerability elements, but also sleep quality, childhood trauma, aberrant salience, and related constructs. These variables formed a coherent structure with no isolated nodes, underscoring the complexity of the processes involved. Given the focus of this dissertation, however, a notable limitation of this study is that it did not include a measure of misophonia.

The fifth and final study in this series employed a more advanced temporal network approach, allowing for a more nuanced examination of moment-to-moment and within-subject dynamics among vulnerability-related factors in the context of real-life paranoia-like thoughts. Compared to Study 2, this network mapped a narrower set of factors that we hypothesized to be specifically related to the sense of vulnerability underlying paranoia, including misophonia symptoms, negative body image, feelings of social rejection, lack of perceived social safety, and negative affect. This configuration has not previously been investigated in the context of paranoia, and this was the first ESM and temporal network study to include misophonia and body image in general. The results revealed that feelings of rejection played a central role and, as a sole variable, exhibited a bidirectional association with paranoia-like thoughts. Negative affect, in turn, was the most frequent mediator linking paranoia with other variables. Contrary to our hypothesis, paranoia was not the most strongly *predicted* variable in the model, which was expected to intensify a general sense of vulnerability and predict increases in paranoia-like thoughts. Instead, paranoia emerged as the most central *predictor* of changes in other variables over time, including negative body image. These findings suggest a potential bidirectional nature of the associations, in which predictors and outcomes can alternate the roles. It is important to

note that the levels of paranoia were relatively low in this sample, which may affect the interpretation, and studies in clinical groups with more severe symptoms are recommended to validate these findings.

Particularly important findings from this study concern the network group comparison. Although statistical tests identified only a few significant differences in overall network structure, the high paranoia network displayed more and stronger connections between variables. In other words, higher levels of paranoia were associated with increased network connectivity. These results can be cautiously interpreted within the complex dynamic systems framework (Cramer et al., 2016), which emphasizes self-sustaining activation of symptoms within a network (i.e., hysteresis) in the development of mental disorders. In the low paranoia group, the network exhibited rather weak connectivity, with only a few direct links between variables. Paranoia-like thoughts were only weakly predicted by two variables, and paranoia did not predict any other symptom, indicating no bidirectional relations that could activate each other. In contrast, in the high paranoia group, additional links between variables appeared, including between paranoia and social rejection, and several relations became bidirectional, indicating mutually reinforcing dynamics. In this group, paranoia also showed a significantly stronger autoregressive effect, potentially maintaining its own activation over time. Consistent with the concept of critical slowing down, this pattern may indicate a gradual decline in coping capacity as symptoms develop, which could potentially progress toward more severe psychological states if left untreated (van de Leemput et al., 2014). Interventions targeting the most central variables, such as social rejection and negative affect, could weaken symptom interconnections, reduce overall network connectivity, and help prevent further progression. Future research should compare networks across subsequent points on the paranoia continuum, including individuals at high risk (UHR) and patients with persecutory delusions. Such analyses would clarify the temporal progression of symptoms and reveal potential structural changes that could guide targeted interventions. A critical aspect of interpreting network analysis is the selection of included variables. Although both models were grounded in prior research and aligned with theoretical accounts, the selection of variables is always somewhat subjective. This choice has implications, as the addition or omission of certain variables can alter centrality rankings and, consequently, interpretations. For instance, our temporal network did not measure global self-esteem, which prior work identified as an important mediator between body image and paranoia, thereby significantly limiting the conclusions that can be drawn. Additionally, other sensory sensitivities, along with assessments of the context and meanings attributed to triggering sounds, could be important for understanding how momentary misophonia symptoms relate to paranoia-like thoughts. Undoubtedly, a range of other unmeasured factors could impact these network models. The results should therefore be viewed as a provisional representation of more complex underlying processes.

In addition to the limitations of individual studies discussed above, there are several other issues that should be considered. The first four studies relied on convenience sampling, solely or in combination with the CAWI method. In four of the five samples, there was an overrepresentation of

women, and all samples predominantly consisted of currently employed individuals, with secondary or higher education, which limits the generalizability of the findings to the wider population. Moreover, although these studies were intended to recruit non-clinical individuals, each included a relatively large proportion of participants who reported having received a psychiatric diagnosis at some point in their lives. Although similar lifetime prevalence rates have been reported in other general population studies (Remes et al., 2016; Salari et al., 2020), the reliance on self-reported diagnoses complicates the characterization of our samples and raises questions about whether *non-clinical* is the most accurate term. Another limitation concerns the cross-sectional nature of several studies in this cycle. Although Studies 1 and 3 proposed theoretical mediation models that suggested directional relationships, causal inference would require longitudinal or experimental designs as alternative models are equally plausible. Furthermore, in retrospect, Studies 1 and 2 would have benefited from a broader assessment of body image, as the Body Esteem Scale (Franzoi & Shields, 1984) focused primarily on body esteem and omitted other body image dimensions. In the ESM study, body image, misophonia, and social rejection were each assessed using a single item, highlighting the need for their validation in independent samples. Finally, all studies would benefit from including measures of cognitive biases, which would enable the understanding of cognitive processes underlying the links between examined risk factors and paranoia. The studies (particularly those employing a network approach) also lacked an assessment of loneliness, despite growing evidence that loneliness can serve as a predictor of psychotic-like experiences, including paranoia (e.g., Lamster et al., 2017; Misiak et al., 2024).

5.1 Conclusions

This dissertation identified novel risk factors and advanced our understanding of the sense of vulnerability as a basis for paranoia-like thoughts. We showed that negative body image is significantly associated with paranoia-like thoughts and, within a broader network of paranoia-related factors, emerges as one of the most central elements, thereby highlighting a promising target for future interventions. Furthermore, we demonstrated that misophonia symptoms are not only associated with paranoia-like thoughts but, via their impact on negative affect, may also contribute to increases in such thoughts. Importantly, both sensitivity to social rejection and real-life feelings of social rejection played a crucial role in paranoia-like thinking, constituting central factors in both structural and temporal network models. Finally, consistent with a complex dynamic systems framework, higher levels of paranoia-like thoughts were found to be associated with greater connectivity within the symptom network, suggesting a risk of symptom propagation over time. Our findings add novel elements to the cognitive model of paranoia and highlight the need to explore new factors alongside existing constructs included in the model, as they may represent important intervention targets (e.g., not only general self-esteem, but also body image in the context of negative self-beliefs). Taken together, these findings offer a coherent, network-informed explanation of selected vulnerability-enhancing factors in the context of paranoia and provide a basis for future research and clinical practice.

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7. Appendices

7.1 Publication 1

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Bridging the gap between body image and paranoia-like thoughts

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ABSTRACT

A feeling of vulnerability is believed to be one of the foundations upon which paranoia is built. Factors that may increase vulnerability include negative affective states, low self-esteem and high social rejection sensitivity. Body image, which is one aspect of the overall self-esteem, has recently been shown to be associated with paranoia. However, little is known about factors underlying this association. In this online study conducted on a non-clinical sample (n = 539, 65.5% of female), self-report data assessing paranoia-like thoughts, body image, self-esteem, negative emotions, rejection sensitivity as well as various attitudes and beliefs related to body appearance were collected. The results revealed a significant serial mediation effect of negative emotions, self-esteem and rejection sensitivity in the relationship between body image and paranoia-like thoughts. Parallel mediation analysis showed an effect of social criticism as the only one of four studied groups of beliefs related to body appearance in the relationship between paranoia-like thoughts and body image. Moreover, paranoia-like thoughts were increased in people who were not satisfied with their body, both as a result of feeling too thin and overweight. To conclude, body image is an important factor related to paranoia-like thoughts, through its association with increased vulnerability and negative general self-view. The findings highlight the importance of negative emotions, low self-esteem and high rejection sensitivity, as well as the role of critical comments and lack of perceived acceptance as potential (socially-focused) mechanisms paving the way from negative body image to paranoia-like thoughts.

1. Introduction

Body image is defined as "the picture we have in our minds of the size, shape and form of our bodies; and to our feelings concerning these characteristics and our constituent body parts" (Slade, 1988). Hence, whether positive or negative, body image depends mainly on how the body is perceived and what feelings are associated with it (Slade, 1994). A negative or disturbed body image can cause serious psychological consequences (Noles et al., 1985), including poorer quality of relationships with other people (Cash et al., 2004). This, however, is a result of many factors, of which trust is perceived as one of the most important. Still, people differ in the level of trust they place in others. One of the most severe mental states characterized by a very high level of distrust towards people is paranoia (Freeman et al., 2005).

Following the hierarchy of paranoia (Freeman et al., 2005), paranoid thoughts build on feelings of vulnerability that can be developed through negative affective states, low self-view (Freeman, 2016), and interpersonal sensitivity (Meisel et al., 2018). Rejection sensitivity, one aspect of the overall interpersonal sensitivity, defined as anxious expectation, overreacting, and easily perceiving social rejection cues (Downey and Feldman, 1996), was found to be associated with social threat anticipation, which is considered as one of the core mechanisms of paranoia (Berenson et al., 2009). Negative self-schemas, understood as cognitive generalizations about the self (Markus, 1977), as well as critical views about the self were found to be present in people with persecutory delusions (Kesting and Lincoln, 2013). The association between negative self-esteem and paranoid thoughts have been very often highlighted in previous studies (e.g. Thewissen et al., 2011; Monsonet et al., 2020; Martinez et al., 2021). More recently, the role of negative body image, which is a part of the general self-concept including both self-esteem (evaluative component) and self-schemas (cognitive component) (Tiernan et al., 2014), has been investigated in the context of paranoia (Waite and Freeman, 2017; Marshall et al., 2020; Waite et al., 2022).

To the best of our knowledge, there are only a few studies investigating body image and paranoia together. First of them, conducted on two large epidemiological datasets, revealed that body image concerns are associated with both mild and severe paranoia (Waite and Freeman,

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2017). However, potential factors explaining this association were not investigated in this study. Another research explored body image concerns in patients with persecutory delusions and provided remarkable insight into patients' body image-related experiences (Marshall et al., 2020). The results revealed that negative body image can be viewed as a potential path to paranoia - negative feelings about one's own body can lead to negative self-image and feelings of inferiority, which sequentially contribute to increased feelings of vulnerability. This, in turn, has been found to form the basis on which paranoid ideations are built (Freeman et al., 2005; Freeman, 2016). The authors pointed to the patients' perception of their own appearance as a source of threat, which may explain the relationship between negative body image and an increased vulnerability. While this research has raised important and as yet undiscovered issues, it was conducted in a relatively small sample. The most recent study examined body esteem in relation to psychological correlates in patients with persecutory delusions and healthy controls (Waite et al., 2022). The results showed that body image concerns are associated with paranoia, depression, psychological wellbeing and life quality, again pointing to the importance of this factor in the context of paranoia.

The definition of body image consists of several components: perceptual (the way people see themselves), cognitive (thoughts and beliefs about own body), emotional (emotions towards own body) and behavioral (behaviors related to own body) (Banfield and McCabe, 2002). However, to date, there are no studies that investigate body image in the context of paranoia, considering all the components together. Moreover, existing research has been focused on obesity or excess weight in patients with psychosis, due to the elevated rates of obesity and antipsychotic-induced weight gain in this group of patients (Marshall et al., 2020; Bak et al., 2014). However, still little is known about individuals with a negative body image as a result of unwanted thinness rather than obesity.

Our study aimed at investigating the factors that may contribute to uncovering the black box between body image and paranoia-like thoughts in a healthy, non-clinical population. We proposed to test two mediation models: serial mediation model, based on the results of the existing research and the theoretical hypothesis proposed by Marshall et al. (2020), which aimed at assessing the path from body image through negative emotions, self-esteem and rejection sensitivity to paranoia-like thoughts, and parallel mediation model, which investigated how various beliefs, attitudes, emotions and behaviors related to body appearance mediate the relationship and translate from the negative body image to increased paranoia-like thoughts. Serial mediation analysis was performed as we assumed a causal chain linking all three mediators, with a specific direction from negative body image to paranoia-like thoughts. On the other hand, a parallel mediation analysis was conducted as it was intended to test four related, yet distinct aspects of body appearance-related beliefs as potential mediators between body image and paranoia-like thoughts. The aim was to examine whether all factors play the same/different function or whether they do not play any role at all. Since this has not been studied before, and is still essential to understand the role of body image (which is a complex construct) in the context of paranoia-like thoughts, we applied an exploratory approach. Finally, we sought to check whether the level of paranoia-like thoughts differs between people who are and who are not satisfied with their current body appearance (in both directions – too thin or overweight). The focus on unwanted thinness rather than excess weight is particularly novel.

2. Material and methods

2.1. Participants

The sampling method used in this study was a convenience sample. Participants were recruited online via social media using paid advertising on Facebook and the „snowball" method. This study was addressed to adults over 18 years old, which was the only inclusion criterion employed. A total of 539 individuals (65.5% of women) took part in this study. All subjects signed online consent form to participate in the study, which was approved by the Ethics Committee of the Institute of Psychology of the Polish Academy of Sciences and performed in accordance with the latest version of the Declaration of Helsinki.

2.2. Measures

Green Paranoid Thoughts Scale - Revised (R-GPTS) (Freeman et al., 2021) is an 18-item scale measuring the level of paranoia-like thoughts that consists of two subscales – evaluating ideas of reference and ideas of persecution. Polish adaptation (Kowalski et al., 2020) was used (Cronbach's alpha = 0.93).

Body Esteem Scale (BES) (Franzoi and Shields, 1984) is a 35-item scale measuring attitudes and feelings towards specific parts or features of the body. It consists of three subscales for males: Physical attractiveness, Upper body strength, Physical condition (Cronbach's alpha = 0.83–0.87), and three subscales for females: Sexual attractiveness, Weight concern, Physical condition (Cronbach's alpha = 0.78–0.88). The subscale scores were calculated separately for men and women, and for the purpose of our analyses, we also calculated a total score for all participants together and added gender as a covariate. The total score consists of the averaged sum of items calculated separately for women (32 items, Cronbach's alpha = 0.91), for men (31 items, Cronbach's alpha = 0.93) and for people who stated their gender as other all items were included (35 items, Cronbach's alpha = 0.91). This gave us a total score variable for subjective body image based on items that can vary in importance between genders. The Polish version was used (Lipowska and Lipowski, 2013).

Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988) was used to measure the level of negative emotions on a 10-item subscale (Cronbach's alpha = 0.91). A Polish version of the scale was used (Brzozowski, 2010).

Rosenberg Self-Esteem Scale (SES) (Rosenberg, 1965) is a 10-item self-report questionnaire, widely used to assess global self-esteem. We used the Polish version of the scale (Łaguna et al., 2007), where Cronbach's alpha was 0.91.

Rejection Sensitivity Scale (RSQ) (Downey and Feldman, 1996) measures the level of sensitivity to rejection. It consists of 18 hypothetical situations, each of which requires answers to two questions – about rejection concerns and the level of expected acceptance. We translated the original scale into Polish using the standard back translation method (Cronbach's alpha = 0.9).

The body image questionnaire according to Głębocka (KWCO) (Głębocka, 2010) is a 40-item scale, assessing various attitudes, beliefs, emotions and behaviors related to different aspects of body appearance on four subscales: Cognition-emotion (Cronbach's alpha = 0.94) is used to measure opinions about own body appearance, also built through the prism of the environment; Behavior (Cronbach's alpha = 0.8) contains statements related to behaviors undertaken towards own body with particular emphasis on weight control; Social criticism (Cronbach's alpha = 0.81) aims to determine the subjective level of acceptance of the person by the environment, which is reflected in critical comments about their appearance; Pretty-ugly stereotype (Cronbach's alpha = 0.87) measures the degree of internalization of contemporary "beauty standards", i.e. the beliefs that "pretty" people have a happy life and good qualities.

Body Dissatisfaction Scale (BDS) (Mutale et al., 2016) is a pictorial scale measuring the level of body dissatisfaction. It includes nine female and nine male images that gradually increase in weight - from very thin to obese. Participants were asked to answer two questions – which silhouette most resembled their own (1–9) and which silhouette they wished to have the most (1–9). The discrepancy between the two indicated the participants' body dissatisfaction score. Based on the body dissatisfaction scores, the participants were assigned to one of three

groups – people who would like to have a larger body size than actual (n = 44), smaller (n = 281) or the same (actual = desired ± 1 silhouette) (n = 194). In our study, women could only see female bodies (1–9), men could see male bodies (1–9), and participants with "other" gender could see all eighteen bodies (1–18). However, the latter sometimes indicated their actual body look on the male scale and the desired one on the female scale (or the other way around). Hence, it was impossible to calculate an accurate body dissatisfaction score for this group and it was removed from this analysis (n = 20).

Body mass index (BMI) is a ratio obtained from a person's weight and height. All participants were asked to enter their actual weight and height, which were then used to calculate the BMI.

2.3. Statistical analyses

Statistical analyses were performed in SPSS 27. Two-tailed Pearson's correlation analyses were performed to explore the relationships between paranoia-like thoughts, body image, negative emotions, self-esteem, rejection sensitivity, BMI and beliefs and attitudes related to body appearance on four dimensions. We also performed Pearson's correlation analysis to investigate the relationship between body dissatisfaction score and paranoia-like thoughts. Multiple comparisons were corrected with the false discovery rate (FDR) method (Benjamini and Hochberg, 1995). Due to the relatively high percentage of people who declared having a diagnosis of any mental disorder in their lifetime (45.3%) (assessed with a single item: "Have you ever been diagnosed with any mental disorder?"), we decided to test group differences between individuals with and without a diagnosis in the main studied variables (paranoia-like thoughts and body image). Student's t-test was used to test group differences (participants with and without diagnosis of mental disorders) on the body image and paranoia-like thoughts. One-way ANCOVA was used to explore group differences (participants who wanted to have different or the same body size as actual) on the level of paranoia-like thoughts. Serial mediation analysis carried out using the model 6 in the PROCESS macro (Preacher and Hayes, 2004), following the bootstrapping procedure with 5000 resample, was performed to investigate the mediating effect of negative emotions, self-esteem and rejection sensitivity on the relationship between body image and paranoia-like thoughts. Parallel mediation analysis, performed using the model 4 in PROCESS, aimed at examining the mediating effect of attitudes and beliefs on four dimensions of perceived body appearance (emotion-cognition, behavior, social criticism and stereotypes) on the relationship between body image and paranoia-like thoughts.

3. Results

Demographic data and sample characteristics are presented in Table 1. The results of the correlation analysis are shown in Table 2. The mean level of paranoia-like thoughts was 14.59 (SD = 13.73). The mean BMI in the sample was 24.62 (SD = 5.96) and included four main categories: underweight (BMI <18.49) (n = 51), healthy weight (BMI 18.5–24.99) (n = 282), overweight (BMI 25.0–29.9) (n = 120) and obese (BMI >30.0) (n = 84).

3.1. Comparison of body image and paranoia-like thoughts between people with and without declared diagnosis of psychiatric disorders

The independent samples t-tests revealed that both the level of paranoia-like thoughts and body image (as measured with BES) differed significantly between participants who did and who did not declared having a diagnosis of psychiatric disorders throughout life. Diagnosed individuals (M = 16.74, SD = 14.89) had a higher level of paranoia-like thoughts than non-diagnosed (M = 12.82, SD = 12.44) ($t(537) = 3.331$, $p < 0.001$). Similarly, people who declared having a diagnosis (M = 3.49, SD = 1.07) had more negative body image than people without a

Table 1
Participant demographics (n = 539).

	N (%)		M (SD)	Range
Sex		Age	33.44 (12.03)	18–70
Female	353 (65.5)	R-GPTS (paranoia)	14.59 (13.73)	0–72
Male	166 (30.8)	Reference	9.21 (7.42)	0–32
Other	20 (3.7)	Persecution	5.38 (7.58)	0–40
Education		PANAS (negative emotions)	24.91 (9.21)	10–49
Primary	10 (1.9)	BES (body image)	3.77 (1.12)	1.3–6.8
Vocational	4 (0.7)	SES (self-esteem)	16.55 (6.69)	0–30
Secondary	173 (32.1)	RSQ (rejection sensitivity)	14.00 (7.10)	1.2–42.8
Higher	352 (65.3)	KWCO: emotion-cognition	45.43 (15.84)	16–80
Professional situation		KWCO: behavior	15.14 (4.51)	5–25
Employed	358 (66.4)	KWCO: social criticism	13.53 (4.76)	6–30
Unemployed	52 (9.6)	KWCO: stereotypes	45.78 (8.62)	15–65
Retired	24 (4.5)	BMI	24.62 (5.96)	14.5–52.2
Student	169 (31.4)			
Psychiatric diagnosis	244 (45.3)			
Anxiety disorder	113 (21.0)			
Depression	193 (35.8)			
Bipolar disorder	22 (4.1)			
Schizophrenia	1 (0.2)			
OCD	16 (3.0)			
Personality disorder	44 (8.2)			
Eating disorder	36 (6.7)			
SUD	7 (1.3)			
ADS	9 (1.7)			
Other	36 (6.7)			
Medication use	262 (48.6)			
Antidepressants	228 (42.3)			
Anti-anxiety drugs	133 (24.7)			
Antipsychotics	25 (4.6)			
Sleeping pills	71 (13.2)			
Other	30 (5.6)			
Substance use	213 (39.5)			
Cannabis/hashish	205 (38.0)			
(Meta) amphetamine	70 (13.0)			
MDMA (ecstasy)	66 (12.2)			
Cocaine	35 (6.5)			
Heroin	6 (1.1)			
LSD	55 (10.2)			
Psilocybin	42 (7.8)			
Legal highs	24 (4.5)			
Other	21 (3.9)			

Note: OCD – obsessive-compulsive disorder, SUD – substance use disorder, ADS – alcohol dependence syndrome, R-GPTS - Green Paranoid Thoughts Scale - Revised, PANAS - Positive and Negative Affect Schedule, BES – Body Esteem Scale, SES – Rosenberg Self-Esteem Scale, RSQ – Rejection Sensitivity Scale.

Table 2
Correlational matrix (n = 539).

	R-GPTS sum	R-GPTS reference	R-GPTS persecution	BES	PANAS negative	SES	RSQ	KWCO emo-cog	KWCO behavior	KWCO soc. criticism	KWCO stereotype	BMI
R-GPTS sum	–	0.914***	0.917***	−0.403***	0.593***	−0.541***	0.538***	0.441***	0.212***	0.631***	0.222***	0.084
R-GPTS reference	0.914***	–	0.676***	−0.413***	0.589***	−0.594***	0.549***	0.465***	0.203***	0.617***	0.230***	0.065
R-GPTS persecution	0.917***	0.676***	–	−0.325***	0.498***	−0.398***	0.438***	0.344***	0.184***	0.539***	0.177***	0.088*
BES	−0.403***	−0.413***	−0.325***	–	−0.407***	0.567***	−0.470***	−0.612***	−0.568***	−0.505***	−0.264***	−0.280***
PANAS negative	0.593***	0.589***	0.498***	−0.407***	–	−0.599***	0.515***	0.391***	0.264***	0.509***	0.185***	−0.022
SES	−0.541***	−0.594***	−0.398***	0.567***	−0.599***	–	−0.612***	−0.466***	−0.368***	−0.604***	−0.211***	0.080
RSQ	0.538***	0.549***	0.438***	−0.470***	0.515***	−0.612***	–	0.442***	0.300***	0.575***	0.252***	0.079
KWCO emo-cog	0.441***	0.465***	0.344***	−0.612***	0.391***	−0.466***	0.442***	–	0.347***	0.520***	0.449***	0.415***
KWCO behavior	0.212***	0.203***	0.184***	−0.568***	0.264***	−0.368***	0.300***	0.347***	–	0.324***	0.094*	0.220***
KWCO soc. criticism	0.631***	0.617***	0.539***	−0.505***	0.509***	−0.604***	0.575***	0.520***	0.324***	–	0.212***	0.199***
KWCO stereotype	0.222***	0.230***	0.177***	−0.264***	0.185***	−0.211***	0.252***	0.449***	0.094*	0.212***	–	0.191***
BMI	0.084	0.065	0.088*	−0.280***	−0.022	0.080	0.079	0.415***	0.220***	0.199***	0.191***	–

Note: R-GPTS - Green Paranoid Thoughts Scale - Revised, BES – Body Esteem Scale, PANAS - Positive and Negative Affect Schedule, SES – Rosenberg Self Esteem Scale, RSQ – Rejection Sensitivity Questionnaire.
* <0.05, ** <0.01, *** <0.001. Significance after the FDR corrections.

diagnosis (M = 4.01, SD = 1.11) (t(537) = −5.446, p < 0.001).

3.2. Body Dissatisfaction Scale (BDS) analysis

The pictorial scale is presented in Fig. 1 (following Mutale et al., 2016).

First, we performed Pearson's correlation analysis to investigate the relationship between the body dissatisfaction score (the numerical difference between actual and desired bodies) and paranoia-like thoughts. The results revealed a significant positive relationship (r = 0.276, p < 0.001), which means that the higher the body dissatisfaction, the higher the level of paranoia-like thoughts. Then, to explore the body image distortion in the context of paranoia-like thoughts, we checked for a relationship of the difference between calculated (declared weight and height) and perceived actual BMI (chosen figure illustrating a given BMI value) and the level of paranoia-like thoughts. The results showed small but significant correlation (r = 0.116, p = 0.008) – the higher discrepancy between calculated and perceived as actual BMI, the higher the level of paranoia-like thoughts. Additional descriptive analyses of body dissatisfaction and distortion scores are available in the Supplementary materials.

The results of one-way ANCOVA examining the difference in the level of paranoia-like thoughts between individuals who would like to have different or the same body size, with age, gender and the diagnosis of psychiatric disorder added as covariates, revealed a significant group effect ($F(2, 513) = 17.238$, $p < 0.001$, $\eta_p^2 = 0.06$). Pairwise comparisons showed a significant difference between individuals who would like to have a smaller ($p < 0.001$) or larger ($p = 0.036$) body size and individuals whose actual body size is equal to desired – people who wanted to have a smaller (M = 16.94, SD = 14.71) or larger (M = 17.34, SD = 13.8) body size had higher levels of paranoia-like thoughts than the latter group (M = 10.3, SD = 10.45). The differences between participants who declared the desire to have a larger and smaller body size were not significant ($p > 0.05$). Age ($p < 0.001$) and lifetime diagnosis ($p = 0.005$) were significant variables in this model, as opposed to gender, which was an insignificant covariate ($p = 0.642$). Lower age and diagnosis predicted higher levels of paranoia-like thoughts. BMI was not included in the model as a covariate because the body shape of figures on this scale was based on BMI values. Moreover, the perceived actual body size and BMI were highly correlated (Mutale et al., 2016).

As there was a notable difference in the number of participants within groups, we also performed a nonparametric test (Kruskal-Wallis) to ensure the effects. The results, similarly, revealed a significant group effect, hence we decided to report an ANCOVA as initially planned.

3.3. Serial mediation analysis

Fig. 2 presents the results of the serial mediation analysis. The purpose of this analysis was to investigate the role of negative emotions, self-esteem and rejection sensitivity in the relationship between body image (BES) and paranoia-like thoughts. The results revealed that the standardized total effect of body image on paranoia-like thoughts significantly differed from zero (β = −0.347, 95% CI = −5.247 to −3.239, p < 0.001). The direct effect of body image on paranoia-like thoughts was non-significant (β = −0.03, 95% CI = −1.405 to 0.671, p = 0.488), which means that the mediation is indirect-only (Zhao et al., 2010). The total standardized indirect effect was significant (β = −0.317, 95% CI = −0.379 to −0.256), with a significant serial mediation effect being observed from body image via negative emotions, self-esteem and rejection sensitivity to paranoia-like thoughts (β = −0.013, 95% CI = −0.02 to −0.006). All the other indirect pathways from body image to paranoia-like thoughts were also significant: via negative emotions only (β = −0.128, 95% CI = −0.171 to −0.087), via self-esteem only (β = −0.07, 95% CI = −0.112 to −0.031), via rejection-sensitivity only (β = −0.027, 95% CI = −0.051 to −0.008), via negative emotions and self-esteem (β = −0.022, 95% CI = −0.037 to

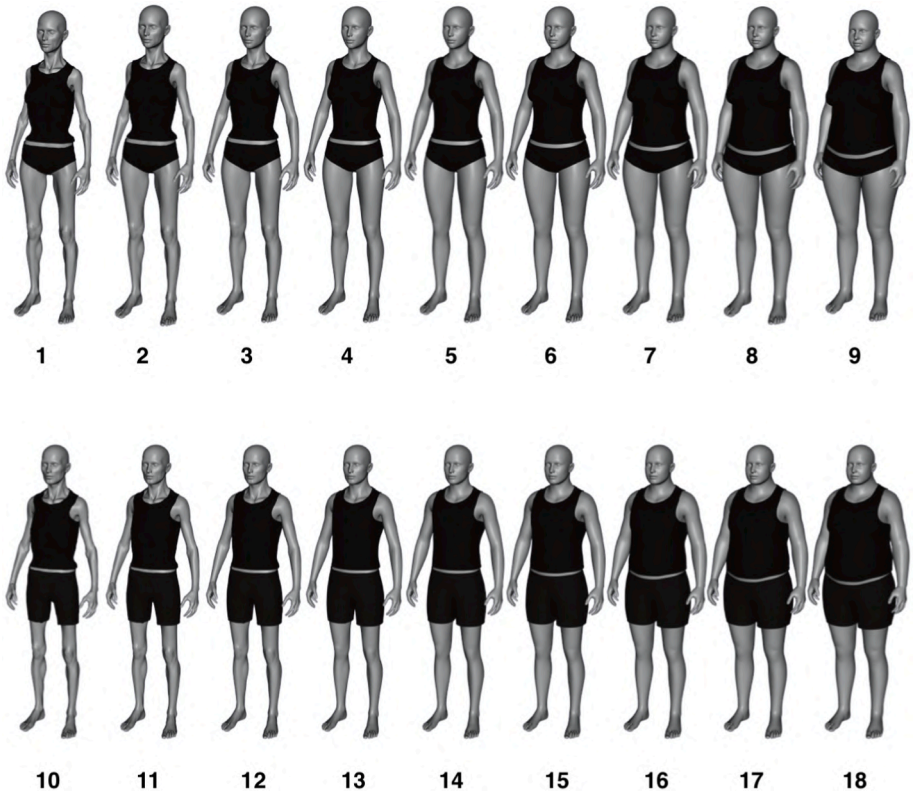

Fig. 1. Body Dissatisfaction Scale. Adapted from Mutale et al. (2016).

Fig. 2. Serial mediation analysis. The mediating role of negative emotions, self-esteem and rejection sensitivity in the relationship between body image and paranoia-like thoughts.
Note: * <0.05, ** <0.01, *** <0.001.

−0.009), via negative emotions and rejection sensitivity (β = −0.018, 95% CI = −0.029 to −0.008) as well as via self-esteem and rejection sensitivity (β = −0.04, 95% CI = −0.06 to −0.021). The total effect explained 22.88% of the variance in paranoia-like thoughts, and the mediated model explained 46.1% of the variance. Age (p = 0.001), gender (p > 0.05), BMI (p = 0.001) and lifetime diagnosis of psychiatric disorders (p > 0.05) were included as covariates in the model. Lower age and greater BMI predicted higher levels of paranoia-like thoughts. Excluding people who stated their gender as other did not affect the overall results, thus data of all participants were included in this analysis.

3.4. Parallel mediation analysis

Fig. 3 presents the results of the parallel mediation analysis, which aimed at investigating the mediating effect of various attitudes and beliefs concerning four aspects of body appearance (emotion-cognition, behavior, social criticism and pretty-ugly stereotypes) on the relationship between body image (BES) and paranoia-like thoughts. The standardized total effect of body image on paranoia-like thoughts was significant ($\beta = -0.347$, 95% CI $= -5.247$ to -3.239, $p < 0.001$). Analyzing the role of the four mediators separately, it turned out that body image is indirectly related to paranoia-like thoughts mainly through its relationship with the beliefs on the social criticism subscale, which was the only significant mediator in this model. A 95% bias-corrected confidence interval based on 5000 bootstrap samples revealed that the standardized indirect effect through the social criticism subscale ($\beta = -0.228$, 95% CI $= -0.282$ to -0.178), was significant. In contrast, the indirect effects through the emotion-cognition ($\beta = -0.048$, 95% CI $= -0.101$ to 0.001), behavioral ($\beta = 0.02$, 95% CI $= -0.02$ to 0.061) and stereotypes ($\beta = -0.016$, 95% CI $= -0.036$ to 0.0001) dimensions were not significant. Moreover, body image was indirectly related to paranoia-like thoughts, even taking into account all four components together ($\beta = -0.272$, 95% CI $= -0.347$ to -0.196). To investigate if mediation is complementary or indirect-only, we checked for a standardized direct effect of body image on paranoia-like thoughts. It was non-significant ($\beta = -0.075$, 95% CI $= -2.068$ to 0.244, $p = 0.122$), which means that the mediation is indirect-only (Zhao et al., 2010). The total effect explained 22.88% of the variance in paranoia-like thoughts, while the mediated model explained 45.41% of the variance. Covariates such age ($p < 0.001$), gender ($p > 0.05$), BMI ($p > 0.05$) and lifetime diagnosis of psychiatric disorders ($p > 0.05$) were included in the model. Lower age predicted higher levels of paranoia-like thoughts. Similar to the results of serial mediation analysis, excluding participants with "other" gender did not change the overall results, thus all data was included.

Since it is recommended to analyze the results of BES separately on its subscales, we also performed the mediation analyses, with each subscale serving individually as an independent variable. These analyses, performed separately on the sample of men and women, revealed a similar pattern of results to the ones described above (Supplementary Materials 1,3). Considering the large number of participants who declared having a diagnosis of psychiatric disorder, we also performed the mediation analyses separately on the group of people with and without the diagnosis. These again showed a similar pattern of results (Supplementary materials 2,4).

4. Discussion

Negative body image, in the context of paranoia-like thoughts, has only recently begun to be studied. So far, we have learned that body image and paranoid thoughts are interrelated, and we have obtained a plausible hypothesis explaining the link (Waite and Freeman, 2017; Marshall et al., 2020). However, there were still many unknowns that needed to be addressed.

In this study, we tested the hypothesis that negative self-esteem and feeling of vulnerability play an important role in explaining the relationship between body image and paranoia-like thoughts. We found that negative emotions, self-esteem and rejection sensitivity, in that sequence, form a coherent explanatory mechanism, thus providing

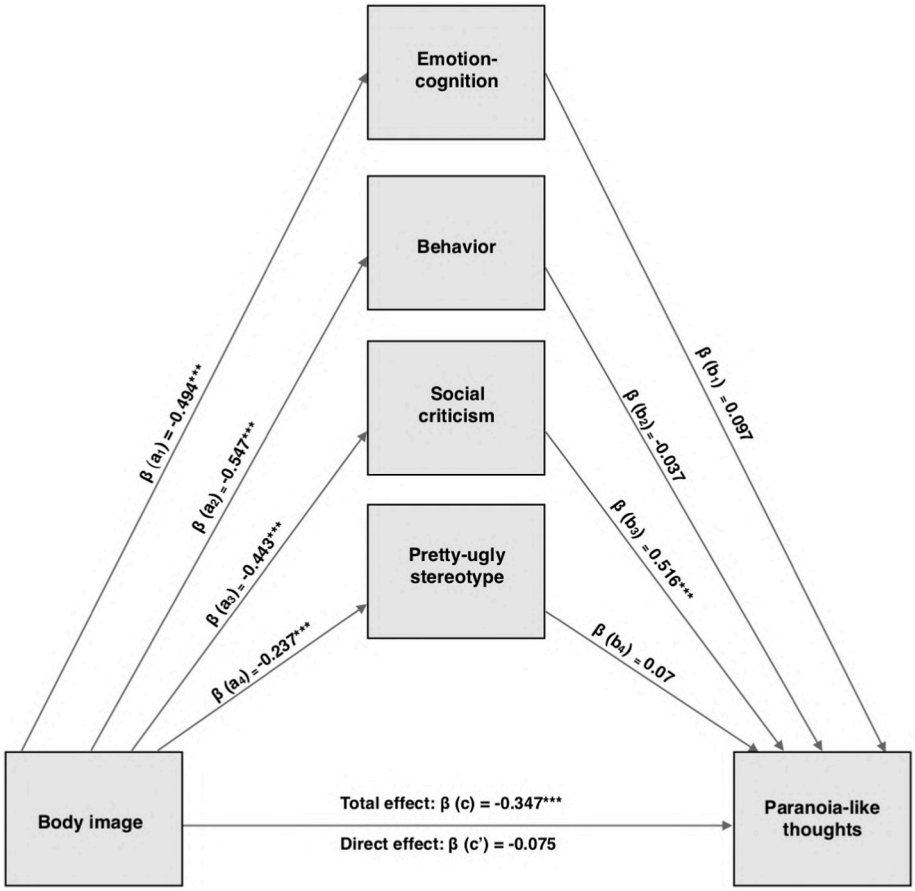

Fig. 3. Parallel mediation analysis. The mediating role of beliefs, attitudes, emotions and behaviors defining four aspects of body appearance (emotion-cognition, behavior, social criticism and pretty-ugly stereotypes subscales) in the relationship between body image and paranoia-like thoughts.
Note: * < 0.05, ** < 0.01, *** < 0.001.

consistent evidence to support the aforementioned hypothesis. Namely, negative body image can increase the overall level of negative emotions and thus negatively affect self-esteem (in line with previous studies, e.g. McCaulay et al., 1988). Individuals with low self-esteem, in turn, were shown to expect more rejection and allocate more attention to rejection-related cues than do individuals with high self-esteem (Dandeneau and Baldwin, 2004). This can lead further to an increased general sensitivity to social rejection (Gyurak and Ayduk, 2007; Orth et al., 2008; Zhou et al., 2020), making a person more vulnerable to harm. Social fear and feelings of vulnerability, in turn, can directly increase the level of paranoia-like thoughts (Meisel et al., 2018; Freeman et al., 2005). Although the mediation model assumes a specific sequence of paths, it is probably a feedback loop mechanism in which each of the factors interacts with each other. Paranoia-like thoughts are closely related to negative feelings and, through its association with difficulties in emotion regulation (Westermann et al., 2013), may lead to lower self-esteem and further adversely affect (among others) body image. This, however, calls for further investigation.

Furthermore, four groups of beliefs, attitudes and behaviors related to body appearance were studied as explanatory links between body image and paranoia-like thoughts. Subjectively perceived level of acceptance or sense of being rejected by others as well as the presence of critical comments about own body appearance, reflected on the "social criticism" (and thus most related to the social context) subscale, was the only mediator of the relationship between body image and paranoia-like thoughts. In other words, for the negative body image to translate into paranoia-like thoughts, social context must be considered in particular. On the other hand, activities taken to modify or control body weight or beliefs in stereotypes about the connection between physical appearance and life quality, turned out not to play an important role in this relationship. Since they do not directly expose a person to social interaction or evaluation, they may have a lesser effect as paranoia is known to be closely tied to an interpersonal context (Freeman et al., 2008).

The pictorial Body Dissatisfaction Scale provided us with a range of very insightful information. People with higher dissatisfaction with their own body, as well as people who perceive their body size as different than it actually is, have more paranoia-like thoughts. This could mean that people who have more paranoia-like thoughts may have negative but also distorted body image (seeing their own body larger or smaller than actual). However, this may take the form of a feedback mechanism again and therefore requires further research. Additionally, we examined whether paranoia-like thoughts may be related to a negative body image due to excessive weight only or to a negative body image in general, taking into account the feeling of being too thin as well. We found that paranoia-like thoughts are higher in individuals who are dissatisfied with their body appearance and wish to have a different body size - whether smaller or larger, which leads to the conclusion that it is not just the increased weight that determines the relationship, but rather general dissatisfaction felt towards own body. Future research into other forms of body dissatisfaction (e.g., perceived body defects that might be subject to social evaluation) in the context of paranoia is warranted.

Although our study was to be conducted on a non-clinical sample, a large percentage of people (45.3%) reported having been diagnosed with psychiatric disorders during their lifetime. This may be the result of collecting data through our official Experimental Psychopathology social media account that usually reaches people interested in topics related to mental health or those who look for psychological help themselves (which may also explain the high percentage of declared medication, as these subjects largely overlap). This, however, provided us with additional valuable information. It turns out that although people who declared having a diagnosis show a greater level of paranoia-like thoughts and have more negative body image, the pattern of results for the proposed explanatory mechanisms is similar in both groups (see Supplementary materials 2,4), which may indicate that the mechanisms are working independently of potentially higher initial levels of vulnerability (e.g. due to diagnosis and possible negative psychological consequences). However, the diagnosis was self-reported and has not been further investigated. Therefore, these conclusions should be treated with caution. Even though our study was largely non-clinical, we can cautiously assume that our results may have potential clinical implications, e.g., the development of awareness to pay more attention to the social or interpersonal context in diagnosing and treating eating or other body-related mental disorders.

This study has limitations. Although the directional models were tested, the presented study was cross-sectional, hence it is not possible to establish causal relationships. This, however, is likely to take the form of a feedback loop where both a negative body image can exacerbate paranoia-like thoughts and increased paranoia-like thoughts can affect the perceived body image. There was also an overrepresentation of women (65.5%) in the sample, which makes it difficult to generalize the results to a wider population. While BDS has been shown to have good construct validity and test-retest reliability (Mutale et al., 2016), computer-generated stimuli may not be ecologically valid enough. Moreover, the scale ends at just over 100 kg, which may exclude those with larger body sizes and cause lower values to be selected. Similarly, calculated BMI was based on self-reported weight and height, which may be, to some point, biased.

To conclude, body image is an important factor contributing to the conceptualization of paranoia-like thoughts. We emphasized the importance of negative emotions, low self-esteem and high rejection sensitivity, as well as the role of critical comments and the lack of perceived acceptance by others as potential (socially-focused) mechanisms paving the way from negative body image to paranoia-like thoughts.

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Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

CRediT

PB: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Visualization; Writing - original draft. **RPU:** Formal analysis; Methodology; Writing - review & editing. **ŁG:** Conceptualization; Funding acquisition; Supervision; Writing - review & editing.

Declaration of competing interest

The authors have declared that there are no conflicts of interest in relation to the subject of this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2022.10.061.

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7.2 Publication 2

Bagrowska, P., Nelson, B., & Gawęda, Ł. (2025). The central role of negative emotional states, rejection sensitivity and negative self-beliefs in a complex non-clinical paranoia network model. *Social Psychiatry and Psychiatric Epidemiology*. https://doi.org/10.1007/s00127-025-02964-7

Social Psychiatry and Psychiatric Epidemiology
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RESEARCH

The central role of negative emotional states, rejection sensitivity and negative self-beliefs in a complex non-clinical paranoia network model

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Abstract

Purpose Existing theoretical models suggest that paranoid thoughts develop against the background of increased interpersonal sensitivity, thus heightening feelings of vulnerability, social evaluative concerns, and fears of social rejection. However, the complex interrelatedness among the risk factors contributing to the development of paranoid thoughts remains poorly understood.

Methods A total of 1019 adults from the non-clinical population participated in a study that employed anetwork approach to explore the complex interactions between paranoid thoughts and severalrisk factors, including traumatic childhood experiences, sleep quality, rejection sensitivity, negative self-views, negative emotional states, and aberrant salience.

Results The results revealed that negative emotional states, mainly stress and anxiety, low self-esteem, negative body image, increased rejection sensitivity, and emotional neglect in childhood werethe most central nodes in the network. Furthermore, aside from the experience of emotionalneglect, these variables were also identified as the strongest bridge factors within the network.

Conclusion The findings offer new insights into the risk factors associated with the development ofparanoid thoughts, suggesting potential triggers that could propagate other symptoms withinthe paranoia network. The results indicate that interventions targeting self-esteem, negativebody image, anxiety, and rejection sensitivity may prevent the progression of paranoidthoughts into more severe forms.

Keywords Paranoid thoughts · Vulnerability · Interpersonal sensitivity · Network analysis

Introduction

Paranoia is a state of excessive distrust and suspicion, characterized by holding implausible beliefs about being watched or persecuted by others [27, 28, 36]. Although paranoia is one of the main symptoms of psychotic disorders, paranoid thoughts are also prevalent within the general population [32, 36]. Subclinical psychotic experiences typically resolve over time, but some may develop into clinical disorders, highlighting the importance of researching these symptoms in non-clinical samples, in line with the psychosis continuum model [47, 62, 70].

Paranoia has been suggested as having a hierarchical structure [32], with concerns about social evaluation, increased vulnerability, and fears of rejection at its core. These elements lead to ideas of reference, characterized by the sense of being observed and talked about. At higher levels of this hierarchy, ideas of persecution (i.e., beliefs that others intentionally try to cause harm) emerge. Similarly, Bebbington et al. [4] identified key components of paranoia as being interpersonal sensitivity, mistrust, ideas of reference and ideas of persecution, thereby supporting the above structure. More recent study that have adopted a network approach [6] has confirmed the four-component

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model, and emphasized the central role of worry about criticism or social rejection in the development of non-clinical paranoid thoughts. Nevertheless, while research findings are relatively consistent, it has also been suggested that a mere hierarchical model may be insufficient to fully capture the complexity of paranoia [6].

The cognitive model of paranoia by Freeman et al. [33] posits that persecutory delusions arise from triggering factors, including sleep disturbances [2, 34, 46, 64, 65], traumatic life events [40, 55, 56], and chronic stress [49, 52, 61]. These lead to an anomalous internal state, manifested by unusual sensory perception, or the aberrant assignment of salience to elements of one's experiences [45, 69]. This model implies that the individual feels changed or different in some way to their previous states, which requires an explanation. Delusions represent a cognitive effort to make sense of these aberrant salient experiences [45]. The interpretation of reality in this state, which gives rise to unusual thought content, is influenced by a number of factors. For instance, negative emotional states enhance threat anticipation [30]. Worry can lead to implausible ideas, further intensifying distress [29, 35, 71]. Negative self-beliefs, such as low self-esteem [51, 75–74] or a negative body image [54, 76, 77], render a person more vulnerable to harm and more sensitive to rejection [1]. Given the consistency of theoretical models concerning the foundation of paranoid thoughts, it is evident that examining the interplay of various factors that may increase an individual's vulnerability to harm—and, consequently, their susceptibility to developing paranoid thoughts—is essential.

Recently, several studies employed a network approach to understanding paranoia [6, 18, 41, 43]. The findings consistently show that increased sense of vulnerability is a key aspect of paranoia network models. Several central factors within the networks have been identified, including fears of criticism or social rejection [6, 18], perceptions of being talked about by others [41], and loneliness [18, 43]. However, to the best of our knowledge, no study employing a network approach has comprehensively explored the factors potentially contributing to an increased feeling of vulnerability within the paranoia hierarchy.

The network approach to psychopathology suggests that mental disorders develop from the dynamic interactions between various symptoms [10, 38]. For instance, sleep disturbances can lead to increased negative affect and anxiety, impacting self-beliefs and further fostering paranoid thoughts, i.e. activation of one symptom can trigger the activation of other symptoms [19, 20]. Network analysis allows for the simultaneous examination of multiple interacting variables, thereby enabling a comprehensive representation of the overall symptom network structure. In strongly connected networks, the activation of a single symptom may influence the activity of other symptoms over time, even after the initial symptom has attenuated [12, 14, 67]. Therefore, identifying the most influential factors and understanding their role in the spread of other symptoms, thus contributing to the development of paranoid thoughts, appears to be crucial for designing effective treatment strategies [66]. Hence, the present study aimed to employ a network approach to explore factors associated with paranoid thoughts in accordance with the established theoretical models. The objective was to understand the interplay between factors that may potentially contribute to early-stage paranoid thoughts (interpersonal sensitivity/feeling of vulnerability), which may help to inform treatments that prevent the development of paranoid thoughts towards higher levels of the paranoia hierarchy.

Methods

Participants

A total of 1019 adults (57.4% of female) from the Polish general population were invited to participate in the study. The data was collected between January and March 2023 in two ways—via a survey link shared on social media (the so-called snowball method) and via a survey panel using the CAWI (Computer-Assisted Web Interview) method. Individuals under the age of 18 or those who did not respond to all survey questions were excluded from further analysis, resulting in no missing data. No further exclusion criteria were applied. The study was approved by the Ethics Committee of the Institute of Psychology of the Polish Academy of Sciences in Warsaw (no. 24/XI/2022) and was conducted in accordance with the latest version of the Declaration of Helsinki.

Measures

The revised Green et al., *Paranoid Thoughts Scale* (R-GPTS) [37] was used to assess the intensity ofparanoid thoughts in the past month on two subscales– ideas of reference and persecution. Responses were rated on a Likert scale ranging from 0 to 4, with a total score range of 0 to 72. Higher scores indicate higher levels of paranoid thoughts (Cronbach's alpha = 0.94).

Rejection Sensitivity Questionnaire (RSQ) [20] measured the level of sensitivity to social rejection. It consists of 18 hypothetical situations that require answers to questions regarding concerns of being rejected and expected acceptance by others, both rated on 7-point Likert scales. The total score is calculated as the average of these responses,

ranging from 1 to 49, with higher scores indicating higher rejection sensitivity (Cronbach's alpha = 0.92).

Childhood Experiences Questionnaire (CEQ-58) [72] aimed at assessing exposure to various childhood adverse experiences on seven subscales—physical abuse, mental abuse, physical neglect, emotional neglect, sexual abuse, environmental instability and negative experiences with peers. Items were rated on a 5-point Likert scale (1 to 5), with total scores ranging from 1 to 290. Higher scores indicate greater exposure to adverse childhood experiences (Cronbach's alpha = 0.85).

The Pittsburgh Sleep Quality Index (PSQI) [15] was used to assess the subjective sleep quality and quantity in the past month. It consists of seven subscales, each rated 0–3, which refer to various sleep quality components, such as subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication and daytime dysfunction. The total score ranges from 0 to 21, with higher scores indicating poorer sleep quality (Cronbach's alpha = 0.77).

Rosenberg Self-Esteem Scale (SES) [68] was used to evaluate global self-esteem. Items were rated on a 4-point Likert scale (0 to 3), with total scores ranging from 0 and 30. Higher scores indicate better self-esteem (Cronbach's alpha = 0.89).

The Body Esteem Scale (BES) [26] aimed at evaluating feelings of satisfaction towards specific parts or features of a body. It consists of three separate subscales for males and females. However, for the purpose of this study, we calculated a total score value based on the averaged sum of items (each rated on a 5-point Likert scale) for women (32 items), for men (31 items) and for people who stated their gender as other (all 35 items). The total score ranges from 1 to 7, with higher scores indicating more positive body image (Cronbach's alpha = 0.94).

Depression Anxiety Stress Scales (DASS-21) [53] was used to measure the levels of anxiety, stress and depression experienced in the past month, with items rated on a 4-point Likert scale (0–3), yielding a total score ranging from 0 to 63. Higher scores indicate higher levels of anxiety, stress and depression The results are presented on three separate subscales (Cronbach's alpha = 0.95).

The Perseverative Thinking Questionnaire (PTQ) [21] measured individual tendency to repetitive negative thinking, i.e., typical response for negative emotional states. Items were rated on a 5-point Likert scale (0–4), with total scores ranging from 0 to 60. Higher scores indicate higher levels of perseverative thinking (Cronbach's alpha = 0.97).

The Penn State Worry Questionnaire (PSWQ) [60] was used to measure the trait of worry. Items were rated on a 5-point Likert scale (1–5), with a total score ranging from 0 to 80. Higher scores indicate higher levels of worry (Cronbach's alpha = 0.94).

The Aberrant Salience Inventory (ASI) [17] was used to assess aberrant salience and psychosis proneness. Along with a recent meta-analysis [59], the results were presented in line with the three-factor structure: enhanced interpretation and emotionality, unveiling experiences and sharpening of senses. Items were scored as 0 or 1, yielding a total score ranging from 0 to 21, with higher scores indicating greater levels of aberrant salience (Cronbach's alpha = 0.93).

Statistical analysis

Statistical analyses were performed using SPSS 29 and R software (R version 4.3.0, RStudio version 2023.03.1 + 446) [63].

Network estimation. First, the undirected network estimation was performed. Each node (depicted as a circle) represents a variable, which is the sum of the individual items that comprise a total score for a given variable or, where possible and relevant, the individual subscale scores. The variables in the network included paranoid thoughts (both reference and persecution ideas—R-GPTS subscale scores), rejection sensitivity (RSQ total score), seven types of childhood traumatic experiences (CEQ-58 subscale scores), sleep quality and quantity (PSQI subscale scores), self-esteem (SAS total score), body image (BES total score), negative emotional states including stress, anxiety and depression (DASS-21 subscale scores), perseverative thinking (PTQ total score), worrying (PSWQ total score) and three dimensions of aberrant salience (ASI subscale scores). In the network model, nodes belonging to a given group (e.g. all sleep quality subscales) are assigned the same color. Each node is also assigned an individual number. For clarity, a legend is provided on the side, which, in addition to the colors, contains numbers with the variable names, e.g. "1" means "Ideas of Reference". Nodes are connected with each other by edges (depicted as lines), which indicate a partial correlation between the two variables. Thicker lines indicate stronger relationships, blue lines indicate positive relationships, and red lines indicate negative relationships. The absence of an edge between two nodes means no correlation, when all other variables are taken into account. L1-penalized regression (Least Absolute Shrinkage and Selection Operator; LASSO) for parameter reduction was applied to increase model parsimony and mitigate spurious relationships. The Extended Bayesian Information Criterion (EBIC) [23, 25] was applied with a default tuning parameter (λ) of 0.5, using the R-package *bootnet* (version 1.5.5) [22]. The network model was visualized using the R package *qgraph* (version 1.9.5) [24], with a layout based on the Fruchterman-Reingold algorithm that places strongly connected nodes in the

center of the network and weakly connected nodes closer to the periphery. The accuracy of the edge-weights was evaluated using non-parametric bootstrapped 95% confidence intervals (2500 iterations) on edge weights, employing the *bootnet* package to examine sampling variability in edge-weights. Additionally, bootstrapped difference tests were conducted between all pairs of edge weights to determine whether the edge-weights exhibited significant differences from one another.

Node centrality and network stability. In order to understand the relative importance of each node in the network structure, several centrality indices were calculated: strength (how strongly each node is directly connected to other nodes), betweenness (how important each node is in the average path between two other nodes), and closeness (how well each node is indirectly connected to other nodes) [9, 22]. A recently introduced centrality metric, i.e., expected influence, operates in a manner analogous to strength, yet uniquely considers the directional nature of edges between nodes [66]. This implies that, in contrast to strength centrality, which relies on absolute values, expected influence distinguishes between positive and negative values in its calculation. Given that betweenness and closeness have been identified as less stable indicators [13, 22], and that strength centrality takes into account only absolute values, we have chosen not to interpret these measures in the main text. As previously emphasized in the literature [66], in particular in the case of a higher proportion of negative values (in our study about 20%), a more appropriate measure for assessing the importance of a node in the network is the expected influence. Accordingly, expected influence will be regarded as the main indicator of centrality, with estimates of the other indicators included in the Supplementary Materials without further interpretation.

Furthermore, bridge nodes (nodes/symptoms that serve as connectors between two larger clusters of nodes/symptoms, such as two distinct mental disorders) were identified using bridge centrality indices [44]. These include bridge strength (how well a node is connected to otherclusters), bridge betweenness (how often a node lies on the shortest path between two nodes from different clusters), bridge closeness (the average distance from a node to all other nodes outside its own cluster), and bridge expected influence (similar to bridge strength, but with a distinction between positive and negative values, not just absolute values). Bridge expected influence (1-step) is calculated by summing up all the edge values connecting a node to all other nodes outside its own cluster. The bridge expected influence (2-step) index is analogous to the 1-step index, but additionally considers the indirect impact a node may exert on other clusters via other nodes. Consistent with the above, the main text focuses on the interpretation of the bridge expected influence, while estimates of the remaining indicators will be presented in the Supplementary Materials.

To assess the stability of all centrality indices, the case-dropping bootstrapping procedure with 2500 iterations was carried out using the *bootnet* R package. This resulted in a correlation-stability coefficient (CS coefficient) that should be above 0.5 (preferably 0.7), and the results were also presented in a visual format. In addition, bootstrapped difference tests were conducted.

Additionally, node predictability, defined as the proportion of variance in each node explained by its directly connected neighboring nodes, was calculated using the *mgm* R package [42].

Results

Table 1 presents the sample characteristics and descriptive statistics of all the measures employed in the study. The correlation matrix with all 27 variables can be found in the supplementary materials (S1). In the sample, 43.1% and 42.5% of individuals reported experiencing *at least* elevated levels of ideas of reference and persecution, respectively, based on the clinical cut-offs proposed by Freeman et al. [37]. Among those, 11.6% reported ideas of reference at a moderately severe level, 6.4% at a severe level, and 4.8% at a very severe level. The proportion of study participants reporting ideas of persecution as moderately severe was 13.2%, while 10.1% reported it as severe and 3% as very severe.

Network estimation

Figure 1 presents the estimated network model comprising 27 nodes. The network is well connected, with no isolated nodes. A total of 151 non-zero edges (43.02% of the possible 351 edges) were identified, with an average weight of 0.058. One hundred and twenty-three (81.46%) edges were positive and 28 (18.54%) were negative. Figures showing the accuracy of edge weights (S2) and bootstrapped difference tests between all edge weights (S3) can be found in the Supplementary Materials. The results of all edges and plotted edges are reported in Appendix 1a and 1b, respectively. Nodes with the highest predictability were stress ($R^2 = 0.75$) and depression ($R^2 = 0.74$). A complete list of predictability values can be found in the Supplementary Materials (S0).

Expected influence centrality

Estimates of node expected influence can be found on Fig. 2a. The analysis revealed that stress (20) and anxiety (21) were the most influential positive nodes in the network, and self-esteem (18), rejection sensitivity (3), emotional

Table 1 Sample characteristics (N = 1019)

	N (%)		M (SD)	Range
Gender		**Age**	35.62 (14.37)	18–81
Female	585 (57.4)	**R-GPTS** (paranoia)	16.33 (15.23)	0–72
Male	400 (39.3)	Reference	9.54 (7.77)	0–32
Other	34 (3.3)	Persecution	6.79 (8.57)	0–40
Education		**RSQ** (rejection sensitivity)	13.95 (6.92)	1–47
Primary	38 (3.7)	**CEQ-58** (trauma)	121.96 (20.32)	58–290
Vocational	33 (3.2)	Physical abuse	13.66 (6.04)	8–40
Secondary	395 (38.8)	Mental abuse	15.65 (7.7)	8–40
Higher	553 (54.3)	Physical neglect	18.56 (3.68)	8–40
Professional situation		Emotional neglect	22.42 (6.08)	8–40
Employed	630 (61.8)	Sexual abuse	10.62 (4.31)	9–45
Unemployed	110 (10.8)	Environmental Instability	20.38 (3.87)	9–45
Retired	97 (9.5)	Negative experiences with peers	20.66 (3.91)	8–40
Student	300 (29.4)	**PSQI** (sleep quality)	6.58 (3.4)	0–19
Neurological disorders	59 (5.8)	Subjective sleep quality	0.38 (0.57)	0–2
Intellectual disability	16 (1.6)	Sleep latency	1.62 (0.99)	0–3
Psychiatric disorders	385 (37.8)	Sleep duration	0.81 (0.75)	0–3
Symptoms currently	304 (29.8)	Sleep efficiency	0.61 (0.96)	0–3
Medication use	440 (43.2)	Sleep Disturbance	1.18 (0.55)	0–3
Medication use currently	244 (23.9)	Sleep Medication	0.49 (0.95)	0–3
		Daytime dysfunction	1.49 (0.94)	0–3
		SES (self-esteem)	16.87 (6.28)	0–30
		BES (body image)	3.85 (1.19)	1–7
		DASS-21 (negative emotional states)	23.70 (15.24)	0–63
		Stress	18.34 (11.15)	0–21
		Anxiety	12.08 (10.38)	0–21
		Depression	16.98 (12.02)	0–21
		PTQ (perseverative thinking)	26.29 (15.48)	0–60
		PSWQ (worry)	53.74 (15.39)	16–80
		ASI (aberrant salience)	11.33 (8.03)	0–29
		Enhanced interpretation and emotionality	6.43 (4.61)	0–15
		Unveiling experience	2.87 (2.27)	0–8
		Sharpening of senses	2.03 (1.81)	0–6

R-GPTS—Green et al., Paranoid Thoughts Scale– Revised; RSQ– Rejection Sensitivity Questionnaire; CEQ-58– Childhood Experiences Questionnaire; PSQI– The Pittsburgh Sleep Quality Index; SES– Rosenberg Self-Esteem Scale; BES– The Body Esteem Scale; DASS-21– Depression Anxiety Stress Scales; PTQ– The Perseverative Thinking Questionnaire; PSWQ– The Penn State Worry Questionnaire; ASI– The Aberrant Salience Inventory

neglect in childhood (7) and negative body image (19) had the highest standardized negative scores. Bootstrap analysis revealed high stability of the expected influence centrality measure with a CS value of 0.75 (see S4 in the Supplementary Materials). The difference test (Fig. 3a) revealed that the weight of stress (20) and self-esteem (18) edges were significantly different than the weights of all the other edges in the network, and rejection sensitivity (3), emotional neglect (7) and negative body image (19) were significantly different from most of the other nodes in the model. The exact raw and standardized expected influence values for each node can be found in the Supplementary Materials (S5).

Bridge expected influence centrality

Estimates of the bridge expected influence step-1 and step-2 are shown in Figs. 2b and c, respectively. The results revealed that across all domains, perseverative thinking (23), stress (20) and anxiety (21) were the most influential positive bridge nodes (for both 1-step and 2-step estimates) in the network, while self-esteem (18), negative body image (19) and rejection sensitivity (3) had the highest negative bridge expected influence values. Pearson's correlation analysis confirmed a very strong correlation between both (step-1 and step-2) steps of the bridge expected influence estimated values ($r = 0.964$, $p < 0.001$). A CS value of 0.75, obtained from the bootstrap analysis, likewise indicated a high stability of these estimates (S6). The results of the difference test (Fig. 3b) show that the weights of the edges of perseverative thinking (23), stress (20) and anxiety (21) are significantly different from other edges in the network, except for each other. Self-esteem (18) was found to be significantly different from all other nodes, and negative body image (19) was found to be significantly different from most of the other nodes in the network, with the exception of rejection sensitivity (3) and childhood emotional neglect (7), which are also among the most influential nodes in the entire network

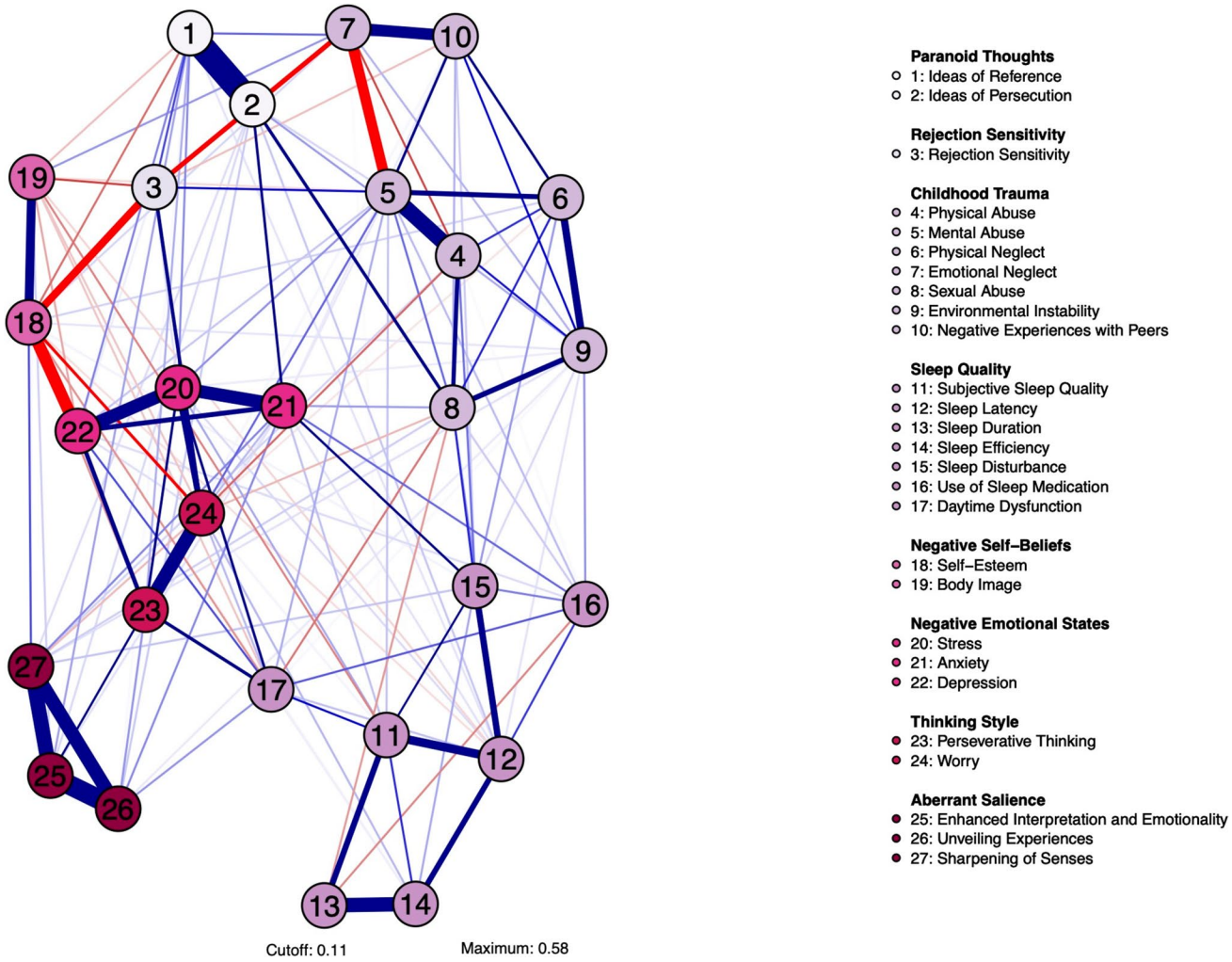

Fig. 1 The estimated network model

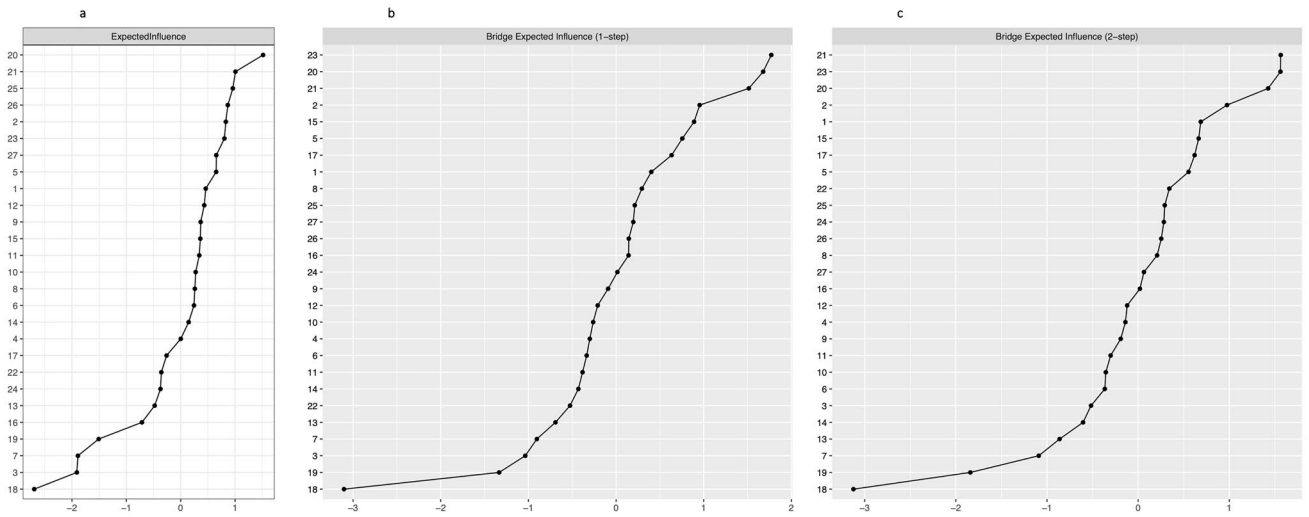

Fig. 2 The expected influence (**a**), bridge expected influence (1-step) (**b**) and bridge expected influence (2-step) centrality indices

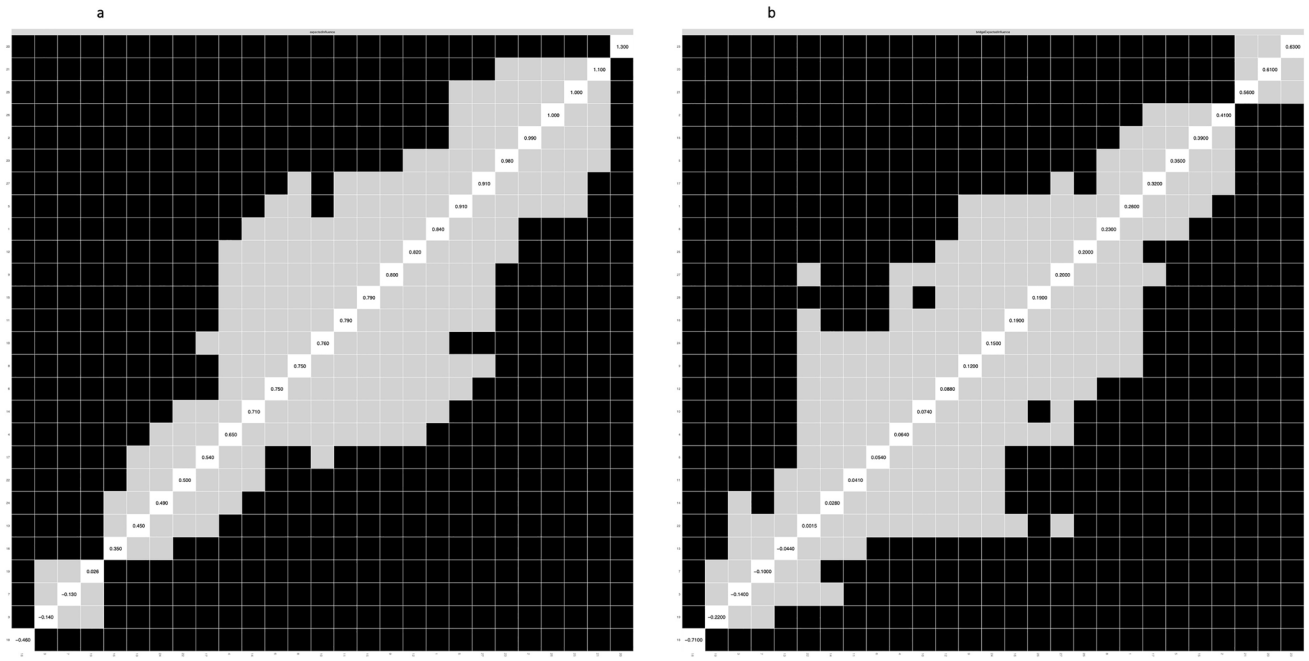

Fig. 3 Bootstrapped between-node differences in the expected influence (**a**) and bridge expected influence (1-step) (**b**) centrality indices. Black boxes indicate statistically significant differences

model. For raw and standardized bridge expected influence values, please refer to the Supplementary Materials (S5).

Shortest pathways

Of all 25 variables, 6 direct links to paranoid thoughts were found. Rejection sensitivity (3), negative experiences with peers (10), self-esteem (18) and enhanced interpretation and emotionality (25) were directly related to ideas of reference (1), and sexual abuse (8) and anxiety (21) to ideas of persecution (2) (Figs. 4a-f). With the exception of sexual abuse and negative experiences with peers in childhood, the remaining five types of traumatic experiences were linked to paranoid thoughts via at least one other trauma element, with sexual abuse (8) being the most common cross node. Most of the shortest pathways from sleep quality (11–17) to paranoid thoughts were through anxiety (21). Negative body image (19) was linked to ideas of reference through self-esteem (18). Negative emotional states and worrying thinking styles most often intersected with stress (20) and anxiety (21) on the pathway to paranoid thoughts. Aberrant salience items (25–27) had direct associations (25) or passed through other aberrant salience subscales and anxiety (21). All of the remaining network models showing the shortest pathways between the factors in each domain and paranoid thoughts (i.e. ideas of reference and ideas of persecution) can be found in the Supplementary Materials (S7).

Discussion

The present study, conducted on a large non-clinical sample, used a network approach to examine the interrelationships between factors that may be associated with interpersonal sensitivity and feeling of vulnerability, potentially contributing to paranoid thoughts. The analysis revealed the most influential variables in the non-clinical paranoia network, consistently emphasizing the central role of negative emotional states, negative self-beliefs, and rejection sensitivity in driving the network dynamics. These findings are in line with the existing cognitive models of paranoia (e.g., [33]), which posit that such emotional and cognitive vulnerabilities interact with environmental stressors to drive the development and maintenance of paranoid thinking.

The most influential factors in the network are those with the strongest connections to other factors. In the present study, these include high levels of stress and anxiety, negative self-esteem, negative body image, elevated rejection sensitivity, and emotional neglect in childhood. According to the network approach to psychopathology [10, 19] which suggests that psychiatric disorders are networks comprising symptoms and causal links between them, it is proposed that highly central symptoms (nodes in the network) have the potential to spread the activation of other symptoms. For example, adverse life events may activate higher levels of stress, which can then affect sleep quality, fatigue, and, consequently, unusual thought content. Indeed, the activation of social stress has been shown to induce a decrease in

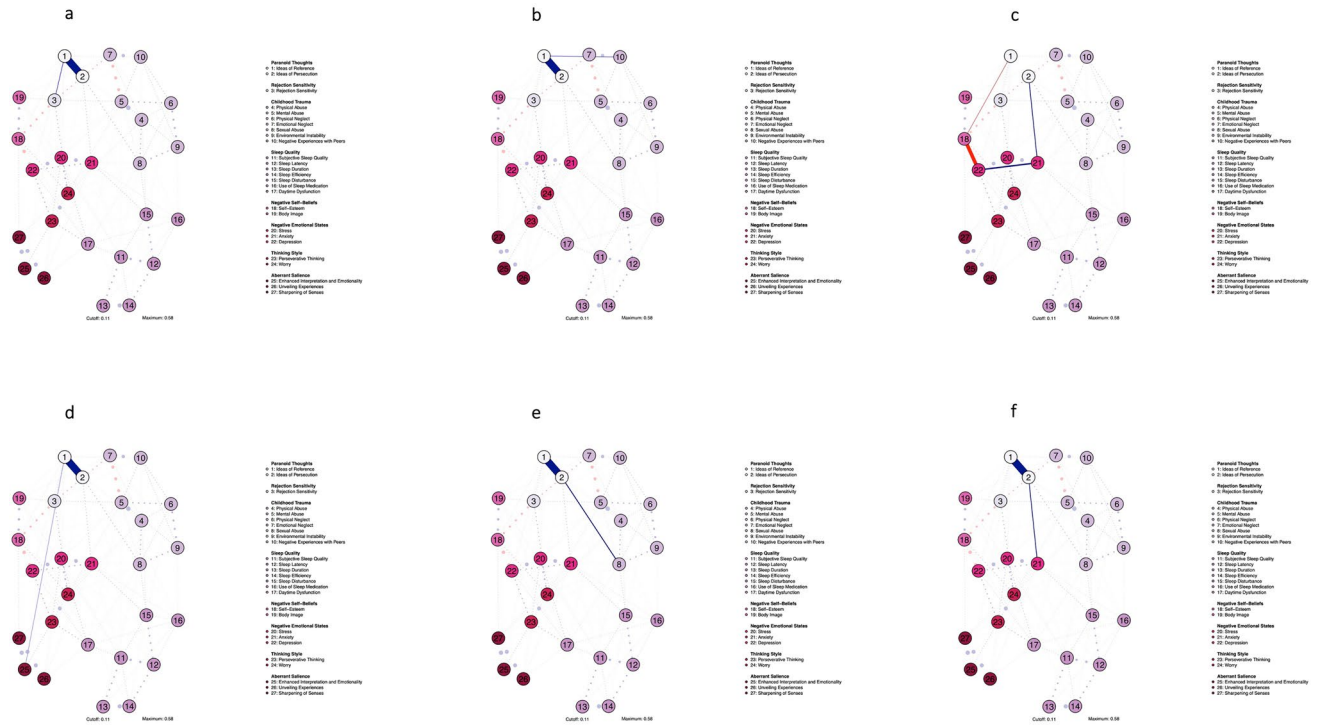

Fig. 4 The shortest pathways between nodes 3, 10, 18, 25, 8, 21 and paranoid thoughts– ideas of reference (1) and ideas of persecution (2)

self-esteem, subsequently resulting in an escalation of paranoid thoughts [48]. Similarly, deactivating a highly influential symptom (for instance, through a symptom-targeted intervention) can decrease the negative impact of other connected symptoms. This proposal is supported by a study that simulated single-node intervention, finding that the centrality of a node strongly predicted its observed influence, i.e. deactivation of a symptom targeted for intervention resulted in changes in the other symptoms within the network [66].

One of the most central factors examined in this study was negative body image. Previous studies have employed a number of interventions targeting numerous predictors of paranoid thoughts, which have been proven effective in improving self-esteem [8], reducing negative affect [50], addressing sleep disturbances [11] and interpersonal sensitivity [5]. However, the understanding of negative body image in the context of paranoia remains limited, even though it has been suggested that body image can be an important intervention target for people experiencing persecutory delusions [76]. It has been proposed that the relationship between body image and paranoid thoughts may be bidirectional [3]. Negative body image may contribute to the development of paranoid thoughts by increasing the feeling of vulnerability, which is thought to underlie paranoia [54, 77]. On the other hand, individuals with high levels of paranoid thoughts may interpret others' stares or comments as criticism of their appearance since body image is often quickly judged in social situations. This may further exacerbate feelings of inferiority and affect body image [3]. In the present study, the examination of the shortest paths between nodes showed that the relationship between negative body image and referential ideas is mediated by negative self-esteem, which itself is directly related to paranoid thoughts. Therefore, future research using a network approach could explore and compare the effects of interventions targeting both general self-esteem and body image to reduce paranoid thoughts and observe changes and differences in the overall network dynamics. It is of particular importance to highlight that body image and self-esteem are also identified as factors with the highest *bridge centrality*, indicating that they serve as the strongest connectors (bridges) between different symptom clusters. The bridging factors may play a crucial role in psychiatric comorbidity [19], underscoring the need for increased attention to address them in future research.

In addition to negative self-beliefs, rejection sensitivity was identified as another highly influential factor in the network model of non-clinical paranoia. Importantly, it was not only one of the most central factors but also one of the strongest bridging factors, directly linked to paranoid thoughts in the shortest path analysis. This finding aligns with the results of previous paranoia network models, which indicated that concerns about social criticism or rejection [18], or perceived social rejection [43], are one of the most central nodes of the network. Rejection sensitivity is a component of overall interpersonal sensitivity, a trait marked by

excessive sensitivity to the actions and feelings of others, especially in situations involving social criticism or rejection, whether real or perceived [58]. A recent meta-analysis suggests that a history of childhood maltreatment, especially emotional abuse, is a significant risk factor for the development of rejection sensitivity [39]. In the current network model, emotional neglect in childhood was identified as one of the most influential factors. Additionally, negative experiences with peers in childhood were directly linked to paranoid thoughts. These findings are in line with previous research indicating that interpersonal sensitivity acts as a mediator in the relationship between childhood bullying and paranoid thoughts [56], whichemphasizes the importance of examining the impact of the interaction between early adverse experiences and increased interpersonal sensitivity on paranoia, in line with existing theoretical frameworks [31].

In the estimated non-clinical paranoia network model negative emotional states, especially anxiety and stress, play a particularly significant role. The results showed that anxiety is one of the most central and bridging factors in the network. Moreover, in addition to being directly linked to ideas of persecution, anxiety is one of the most common cross-nodes linking paranoid thoughts with other risk factors, such as sleep disturbances or aberrant salience experiences. In other words, anxiety has been shown to activate other symptoms, such as poor sleep quality, which in turn has been linked to paranoid thoughts, consistent with previous studies [65]. The increased levels of depression and anxiety have also been demonstrated to significantly mediate the relationship between self-esteem and paranoia [7], thereby further emphasizing the complex and interconnected nature of the various risk factors identified thus far for the development of paranoid thoughts.

Limitations and future directions

The findings of this study should be viewed in light of several limitations. Firstly, the data collected for this study is correlational, meaning that the network model only shows potential connections between variables, without establishing cause-and-effect relationships. More recently, more ecologically valid methods, such as the Experience Sampling Method (ESM), have been used to develop more complex network models that consider spatial and temporal relationships between factors and capture moment-to-moment symptom fluctuations. This approach provides a deeper understanding of network dynamics. Therefore, creating a similar model using ESM data would be highly beneficial for investigating the factors contributing to increased interpersonal sensitivity, which forms the basis for paranoid thoughts. Another limitation of the study is the reliance on self-report measures without formal clinical assessment of participants' mental state, as well as the absence of IQ measurement. While the study targeted the general population, the recruitment process relied on two different sources (social media and research panel), which may limit the representativeness of the sample. Furthermore, it is possible that individuals from different points on the psychosis continuum were included in the sample. It would be valuable to investigate differences in the network dynamics of factors related to interpersonal sensitivity between non-clinical individuals, those at risk of developing psychosis, and patients with schizophrenia to understand the significance of specific symptoms across different groups on the paranoia continuum. In our sample, 37.8% of individuals reported having been diagnosed with a mental disorder at some point in their lives, most commonly depression (28.6%) and anxiety (23.5%). These findings are consistent with recent epidemiological and cross-national studies, which report similar prevalence rates [57, 78]. However, as the diagnoses were self-reported and not independently verified, it is unclear whether they reflect formal clinical assessments or self-diagnoses. While this information provides some insight into the potential proportion of clinically relevant cases within our sample, the data do not support a reliable comparison between non-clinical and potentially clinical groups. Such analyses should therefore be the subject of future research using accurate and clinically verified diagnostic data. Furthermore, although the current model includes multiple factors associated with paranoid thoughts and is based on theoretical considerations, the existing literature identifies many other factors (e.g., cognitive biases) that should be explored in a more comprehensive network analysis. Incorporating additional factors into the network model may alter its dynamics. Hence, further research is needed to determine the potential impact of including additional relevant factors in the network model and validate the replicability of the results of this study. Finally, given the central role of stress and anxiety in the network and prior research indicating that emotional responses to stress may differ by gender [16], it is important to emphasize the need for future studies to examine sex differences in affective processes related to psychotic-like experiences. Investigating these differences could bring valuable knowledge into how paranoia develops and manifests across genders, potentially informing the development of more personalized prevention strategies.

In conclusion, the findings of this study align with existing theoretical frameworks of paranoia and highlight the role of increased rejection sensitivity, negative emotional states, and negative self-views—including self-esteem and body image, a novel addition to paranoia network models—in fostering the development of paranoid thoughts. These

factors were identified as both central and bridging elements within the network, affecting its dynamics and potentially triggering the spread of other symptoms. The findings suggest that by focusing therapeutic interventions on these pivotal factors, it might be possible to avert the progression from heightened interpersonal sensitivity to more acute forms of paranoid thinking, such as referential or persecutory delusions.

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Author contribution P.B. conceptualized the study, developed the methodology, administered the project, conducted the investigation, performed formal analysis, created visualizations, curated data, and wrote the original draft. B.N. contributed to the writing by reviewing and editing the manuscript. Ł.G. supervised the project, acquired funding, and contributed to the writing by reviewing and editing the manuscript.

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Data availability The data that support the findings of this study are available from the corresponding author [PB] upon reasonable request.

Declarations

Conflict of interest The authors have declared that there are no conflicts of interest in relation to the subject of this study.

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7.3 Publication 3

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Do they make these sounds to hurt me? The mediating role of emotion regulation, anxiety and hostile attributions in the relationship between misophonia and paranoia-like thoughts

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ABSTRACT

Misophonia is a complex syndrome in which selective auditory stimuli, such as sounds of breathing, sniffing or eating, trigger an intense, negative emotional response. Previous studies have shown that the symptoms of misophonia coexist with a number of mental disorders, such as OCD, depression and anxiety. However, still little is known about other mental states that may be present in this context. A total of 312 people from the non-clinical sample participated in an online correlational study, which aimed at investigating whether there is a significant association between misophonia symptoms and paranoia-like thoughts, as well as to examine what factors might underlie this potential relationship. The results revealed that misophonia positively correlates with paranoia-like thoughts. A serial mediation analysis showed that difficulties in regulating emotions, anxiety and hostile attributions are significant mediators in the relationship between misophonia and paranoia-like thoughts. Importantly, these mediators, above all, form a potential coherent explanatory mechanism underlying this association. Hence, our results highlight the important role of socio-cognitive factors in the conceptualization of misophonia and its relation to paranoia-like thoughts.

1. Introduction

Misophonia ("hatred of sounds"), first described by Jastreboff and Jastreboff (2001), is a fairly new, complex neurophysiological and behavioral syndrome (Ferrer-Torres and Giménez-Llort, 2022), where a range of selective auditory stimuli (mainly sounds made by other people) cause an intense, negative and unbearable emotional reaction in the individual. In response to specific stimuli (called "triggering" or "misophonic" sounds), such as nasal (e.g., breathing, sniffing) or eating sounds (e.g., chewing) (Vitoratou et al., 2021), a person manifests a strong physical (e.g., increased heart rate) (Ferrer-Torres and Giménez-Llort, 2021) and/or unpleasant emotional reaction (e.g., anger, anxiety, disgust, avoidance or hatred) (Brout et al., 2018). Although misophonia is not formally classified as a psychiatric disorder as there are still insufficient diagnostic criteria to formulate such a diagnosis (Ferrer-Torres and Giménez-Llort, 2022), a recent review suggests that "misophonia, or some syndrome in which misophonia is a key feature, may represent a new mental disorder" (Taylor, 2017). Recent studies have shown that misophonia is associated with reduced life quality, comorbidity, high intensity of negative emotions, as well as behaviors that may affect interpersonal relationships in the long term (Claiborn et al., 2020).

It has been hypothesized that misophonic responses are both biological and shaped by environmental influences (Brout et al., 2018). The existing literature emphasizes that misophonia is activated in response to a specific context rather than to a given sound itself (Edelstein et al., 2013). For instance, it has been shown that misophonia symptoms evoke a more negative emotional reaction when a particular sound is made by a family member or a close friend (Edelstein et al., 2013). Avoiding triggering situations (i.e., safety behaviors; as proven common in misophonia), while initially preventing exposure and cue-related distress, can often result in social withdrawal, and thus significantly impact daily and interpersonal functioning (Jager et al., 2020). Although avoidance and escape strategies are most commonly reported in misophonia, approach-oriented behaviors, such as confronting others or adopting a hostile attitude, are also being noted (Schadegg et al., 2021). A recent qualitative study found that individuals suffering from misophonia perceived that other people purposely emit these triggering sounds "to underline their maladaptive interpersonal schemas" (Natalini et al., 2020). Moreover, it has been shown that when a person thinks

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other people are *intentionally* making the triggering sounds, an even more intense negative emotional response takes place (Reid et al., 2016; Natalini et al., 2020). Therefore, assigning hostile intentions to other people seems not only to occur, but also to exacerbate the symptoms of misophonia.

One of the most extreme states associated with high levels of disturbing thoughts that someone has hostile intentions and is deliberately trying to hurt the person is called paranoia (Freeman et al., 2005). According to the hierarchy of paranoia (Freeman et al., 2005) and the existing theoretical models of delusions (Freeman et al., 2002), paranoia-like thoughts can be (among others) built on or triggered by a constant stress, continual anxiety or social concerns, including feelings of vulnerability and worrisome thoughts that the world (or other people) could be potentially dangerous. Recent studies have shown that the presence of a hostile attribution bias (the tendency to interpret the actions of others as intentional and hostile rather than accidental or benevolent intention) is related to paranoia and may also act as a significant predictor of paranoid thoughts (Buck et al., 2020; Combs et al., 2007). While the symptoms of misophonia have been found to be associated or coexisting with a number of other psychiatric disorders such as anxiety, depression, obsessive-compulsive disorder (OCD) or eating disorders (Ferrer-Torres and Giménez-Llort, 2022), they have never been, to the best of our knowledge, investigated in the context of paranoia-like thoughts, which are fairly common in the general population (Freeman et al., 2011).

Since negative emotional states (including anxiety), difficulties in regulating emotions and assigning hostile intentions to other people turn out to be significant correlates of misophonia (Cassiello-Robbins et al., 2020; Reid et al., 2016), and are also significant predictors of paranoia-like thoughts (Buck et al., 2020; Westermann et al., 2013), they share a common theoretical background. As the suffering associated with the symptoms of misophonia concerns the presence of selective sounds (often, these are everyday sounds that cannot be easily avoided without being completely isolated from other people, i.e. breathing or eating sounds, especially made by people in the closest environment), people suffering from misophonia live in a state of constant, extreme stress which can make them feel vulnerable to harm in the long term. Vulnerability, on the other hand, is thought to be the foundation upon which paranoia-like thoughts are built (Freeman et al., 2005). Therefore, it is crucial to examine whether these two distressing mental states are interrelated and to understand the potential mechanisms underlying this association.

Safety behaviors (such as avoidance or escape) undertaken to avoid triggering stimuli associated with misophonia can maintain its symptoms and lead to difficulties in coping or regulating emotions over time (Guetta et al., 2022). Emotion regulation is defined by strategies and the ability to monitor, evaluate and modify one's emotional reaction, mainly in terms of its intense and temporal characteristics (Thompson, 1994). Difficulties in regulating (i.e. identifying, understanding, or modulating) emotions, can lead, however, to many negative outcomes (Bjureberg et al., 2016). Recent studies have shown that difficulties in regulating emotions are associated with increased symptoms of misophonia (Cassiello-Robbins et al., 2020; Guetta et al., 2022). Escape or avoidance behaviors, as emotion regulation or prevention strategies, in response to triggering stimuli can amplify the negative emotional response and, in turn, lead to increased anxiety and distress. This is also in line with another theoretical model in which emotion regulation plays an important role in the etiology of anxiety disorders (Cisler et al., 2010). An elevated anxiety, on the other hand, has been found to be associated with increased hostility (Hertsgaard and Light, 1984; Tellawi et al., 2016).

Hence, the purpose of this study was to investigate, for the very first time, whether there is an association between misophonia symptoms and paranoia-like thoughts in a non-clinical sample. In the next step, we intended to propose a theoretical model that could explain this potential relationship and open the door to further experimental research on this phenomenon in the future. Therefore, we created and tested an exploratory, serial mediation model in which the relationship between misophonia and paranoia-like thoughts is mediated by emotion regulation, anxiety and hostile attributions. People experiencing misophonia symptoms have difficulty regulating their own negative emotions caused by, e.g. misophonic sounds. This, in turn, can further elevate their anxiety levels, leading to the attribution of hostile intentions to those making the triggering sounds (i.e. assuming they are making the sounds on purpose). This, if left untreated and not employing adaptive coping strategies, can further turn into increased levels of paranoia-like thoughts and a generalization of these hostile attributions by assuming that other people may want to intentionally hurt them (making sounds that are triggering or in another way). In this article, we will attempt to verify this exploratory, theoretical hypothesis.

2. Methods

2.1. Participants

The sampling method used in this study was a convenience sample. As this study was part of another, larger project, it was addressed to adults aged 18 to 40 years, which was the main inclusion criterion employed. Participants were recruited online through social media advertising and the "snowball method". The online advertisement contained a link redirecting to the target survey, which was placed on the Qualtrics platform. The participant's task was to answer all the survey questions. A total of 312 subjects (64.7 % female) signed an online consent form and took part in the online study which was approved by the local ethics committee and was conducted in accordance with the latest version of the Declaration of Helsinki.

2.2. Measures

Green Paranoid Thoughts Scale - Revised (R-GPTS) (Freeman et al., 2021) is a self-report 18 item-scale that measures the level of paranoia-like thoughts (based on last month's experiences) on two subscales – ideas of reference and ideas of persecution. The total score can range from 0 to 72, where higher scores indicate higher levels of paranoia-like thoughts. Cronbach's alpha for this scale in our study was 0.93.

MisoQuest – A questionnaire for assessing decreased sound tolerance (Siepsiak et al., 2020a, 2020b) is a newly developed self-report questionnaire for measuring the severity of misophonia symptoms based on the last month's experiences. It contains 14 items loaded into one factor. The total score can range from 14 to 70, with higher scores indicating higher levels of misophonia symptoms. A clinical cut-off point was proposed for 61 of 70 points. Cronbach's alpha in our study was 0.95.

Difficulties in Emotion Regulation Scale (DERS) (Gratz and Roemer, 2004) measures the level of emotion regulation problems on a 36-item self-report scale. The total score ranges from 36 to 180, where the higher scores indicate greater difficulties with emotion regulation. Cronbach's alpha for this scale in our study was 0.96.

The Ambiguous Intentions Hostility Questionnaire (AIHQ) (Combs et al., 2007) measures hostile social-cognitive biases. In this scale, participants are presented with five written vignettes that describe ambiguous social situations. After each scenario, the participant is asked to complete a self-report scale regarding intention, blameworthiness and own anger towards the person(s) in response to the given situation. Participants are also asked to answer two open-ended questions about their interpretation of the person's motives and how they would react to the situation. The self-report items, when added together, form a "blame score." Open-ended questions are scored by an independent scorer and form two other subscales: "hostility bias" and "aggression bias". We only use a "blame score" in our study, which has been shown to have a good internal consistency among both schizophrenia patients and controls, as well as to be related to clinically-rated hostility and suspiciousness (Buck et al., 2017). The total score can range from 5 to 80, with higher scores

indicating an increased tendency to perceive the intentions of others as hostile. Polish version of the scale was used (Zajenkowska et al., 2020). Cronbach's alpha for this scale in our study was 0.89.

Generalized Anxiety Disorder 7 (GAD-7) (Spitzer et al., 2006) is a 7-item self-report scale measuring the severity of generalized anxiety symptoms. The total score ranges from 0 to 21, where higher scores indicate higher levels of generalized anxiety. Cronbach's alpha for this scale in our study was 0.91.

2.3. Statistical analyses

Statistical analyses were performed in SPSS 27. Two tailed Pearson's correlation analyses were conducted to explore the relationships between paranoia-like thoughts, misophonia symptoms, emotion regulation, hostile attributions and anxiety. Student's *t*-test was used to test group differences (participants with and without diagnosis of mental disorders) in misophonia symptoms and paranoia-like thoughts. The one-way ANOVA was used to explore the differences in misophonia symptoms and paranoia-like thoughts between genders. Serial mediation analysis carried out using the model 6 in the PROCESS macro (Preacher and Hayes, 2004), following the bootstrapping procedure with 5000 resample, was performed to investigate the mediating effect of emotion regulation, anxiety and hostile attributions in the relationship between misophonia symptoms and paranoia-like thoughts. Due to the relatively high percentage of people who declared having a diagnosis of mental disorders in their lifetime (30.4 %), and also due to a significantly higher proportion of women (64.7 %) than men (33.3 %) in the sample, both the diagnosis and gender were added as covariates to the mediation model.

3. Results

Sample characteristics can be found in Table 1. A post-hoc power analysis, with a sample size of 312 and alpha level set to $p < 0.05$, was performed using G*Power3 (Faul et al., 2007). The post hoc analysis revealed a power of 0.82, indicating adequate sample power for this study. The mean value of misophonia in our sample was 30.81 (SD = 13.65), which indicates slightly lower (yet comparable) results than in case of healthy subjects (M = 35.32, SD = 12.67) in another study using the same scale (Siepsiak et al., 2022).

The results of the correlation analyses are presented in Table 2. Significant correlations were found between all studied variables. Misophonia was positively correlated with paranoia-like thoughts ($r = 0.497$, $p < 0.001$), which means that the higher the intensity of misophonia symptoms the higher the level of paranoia-like thoughts.

3.1. Serial mediation analysis

Fig. 1 presents the results of the serial mediation analysis. The purpose of this analysis was to investigate the role of difficulties in emotion regulation, anxiety and hostile attributions in the relationship between misophonia and paranoia-like thoughts.

The results revealed that the standardized total effect of misophonia on paranoia-like thoughts significantly differed from zero ($\beta = 0.504$, 95 % CI = 0.352 to 0.521, $p < 0.001$). The direct effect of misophonia on paranoia-like thoughts also was significant ($\beta = 0.309$, 95 % CI = 0.185 to 0.349, $p < 0.001$), which means that the mediation is complementary. The total standardized indirect effect was significant ($\beta = 0.196$, 95 % CI = 0.135 to 0.261), with a significant serial mediation effect being observed from misophonia via emotion regulation, anxiety and hostile attributions to paranoia-like thoughts ($\beta = 0.01$, 95 % CI = 0.001 to 0.016). All the other indirect pathways from misophonia to paranoia-like thoughts were also significant: via emotion regulation only ($\beta = 0.053$, 95 % CI = 0.012 to 0.1), via anxiety only ($\beta = 0.041$, 95 % CI = 0.01 to 0.079), via hostile attributions only ($\beta = 0.031$, 95 % CI = 0.01 to 0.06), via emotion regulation and anxiety ($\beta = 0.042$, 95 % CI = 0.01 to

Table 1
Participant demographics (n = 312).

	N (%)		M (SD)	Range
Sex		Age	29.17 (6.25)	18–40
Female	202 (64.7)	R-GPTS (paranoia)	11.21 (11.82)	0–69
Male	104 (33.3)	Reference	7.56 (6.44)	0–31
Other	6 (1.9)	Persecution	3.66 (6.30)	0–38
Education		MisoQuest (misophonia)	30.81 (13.65)	14–69
Primary	7 (2.2)	DERS (emotion regulation)	83.99 (25.62)	36–151
Vocational	1 (0.3)	AIHQ (hostile attributions)	41.71 (12.16)	15–79
Secondary	94 (30.1)	GAD-7 (anxiety)	7.33 (4.72)	0–21
Higher	210 (67.3)			
Professional situation				
Employed	227 (72.8)			
Unemployed	23 (7.4)			
Retired	2 (0.6)			
Student	102 (32.7)			
Psychiatric diagnosis	95 (30.4)			
Anxiety disorder	46 (14.7)			
Depression	68 (21.8)			
Bipolar disorder	1 (0.3)			
Schizophrenia	1 (0.3)			
OCD	8 (2.6)			
Personality disorder	16 (5.1)			
Eating disorder	5 (1.6)			
SUD	1 (0.3)			
ADS	0 (0)			
Other	17 (5.4)			
Medication use	118 (37.8)			
Antidepressants	102 (32.7)			
Anti-anxiety drugs	52 (16.7)			
Antipsychotics	5 (1.6)			
Sleeping pills	18 (5.8)			
Mood stabilizers	17 (5.4)			
Other	13 (4.2)			

Note: OCD – obsessive-compulsive disorder, SUD – substance use disorder, ADS – alcohol dependence syndrome, R-GPTS - Green Paranoid Thoughts Scale - Revised, DERS – Difficulties in Emotion Regulation Scale, AIHQ – The Ambiguous Intentions Hostility Questionnaire, GAD-7 – Generalized Anxiety Disorder 7.

Table 2
Correlational matrix (n = 312).

	R-GPTS	MisoQuest	DERS	AIHQ
R-GPTS	-			
MisoQuest	0.497***	-		
DERS	0.494***	0.330***	-	
AIHQ	0.450***	0.317***	0.445***	-
GAD-7	0.520***	0.413***	0.718***	0.433***

Note: R-GPTS - Green Paranoid Thoughts Scale - Revised, DERS – Difficulties in Emotion Regulation Scale, AIHQ – The Ambiguous Intentions Hostility Questionnaire, GAD-7 – Generalized Anxiety Disorder 7.
*** <0.001.

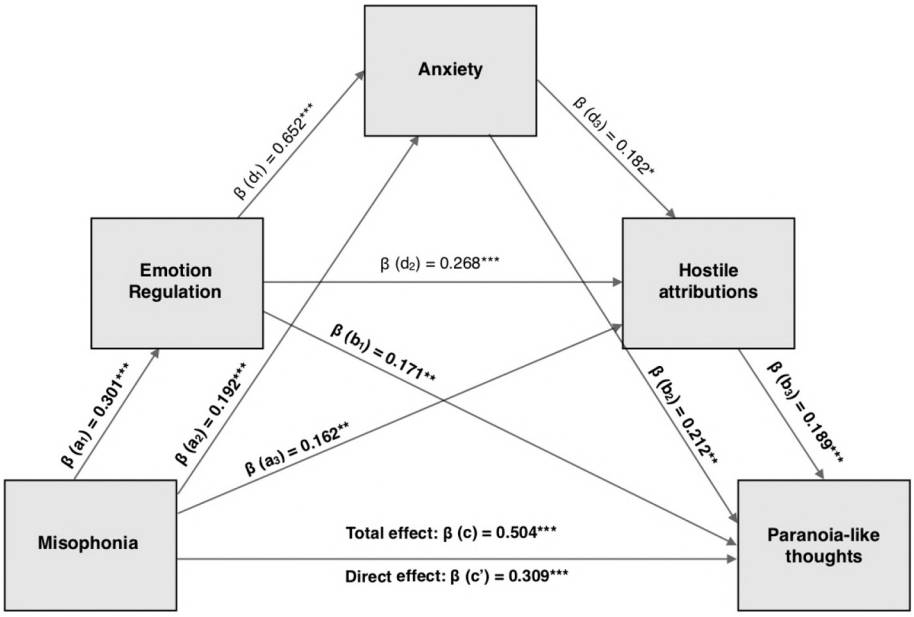

Fig. 1. Serial mediation analysis. The mediating role of difficulties in emotion regulation, anxiety and hostile attributions in the relationship between misophonia symptoms and paranoia-like thoughts.
Note: * < 0.05, ** < 0.01, *** < 0.001.

0.08), via emotion regulation and hostile attributions ($\beta = 0.016$, 95 % CI = 0.004 to 0.033) as well as via anxiety and hostile attributions ($\beta =$ 0.01, 95 % CI = 0.001 to 0.016). The total effect explained 26.81 % of the variance in paranoia-like thoughts, and the mediated model explained 44.27 % of the variance. Gender ($p < 0.05$) and lifetime diagnosis of psychiatric disorders ($p > 0.05$) were included as covariates in the model.

The independent samples *t*-tests revealed no significant difference in both the level of misophonia symptoms ($p = 0.312$) and in the level of paranoia-like thoughts ($p = 0.127$) between people who declared having a diagnosis of mental disorders at some point in their lifetime and people without a diagnosis. The one-way ANOVA showed no significant difference in the level of paranoia-like thoughts between the genders ($p =$ 0.112), but did show a significant difference in the level of misophonia symptoms ($p = 0.04$). Post-hoc analysis revealed a greater (at the trend level, $p = 0.06$) severity of misophonia in women ($M = 31.99$, $SD =$ 13.81) than in men ($M = 28.18$, $SD = 12.8$). The differences between women/men and people who stated their gender as "other" were not significant.

4. Discussion

Misophonia has appeared in the psychological and psychiatric literature only recently. Nevertheless, it has already gained enormous interest from researchers in various fields. While the subject is still being extensively studied, much has already been established. For instance, we already know that the symptoms of misophonia coexist with a number of other mental disorders, such as OCD, ADHD, depression or anxiety (Potgieter et al., 2019; Ferrer-Torres and Giménez-Llort, 2022; Siepsiak and Dragan, 2019). However, still little is known about different mental conditions that may be related to misophonia severity. In this study, we aimed to investigate whether there is an association between misophonia symptoms and paranoia-like thoughts in a non-clinical sample, and if so, what are the possible factors underlying this relationship.

First of all, in line with the results of previous studies, we show that the symptoms of misophonia positively correlate with difficulties in emotion regulation (e.g., Cassiello-Robbins et al., 2020; Guetta et al., 2022) and increased levels of anxiety (e.g., Siepsiak et al., 2020a, 2020b). Moreover, a significant positive correlation was found with hostile attributions measured with a validated scale (Combs et al., 2007), which is in congruence with the existing qualitative case study data (Reid et al., 2016; Natalini et al., 2020) on attributing hostile intentions to people making triggering sounds by the misophonia sufferers. Hence, these results highlight the important role of the cognitive-emotional aspects in the conceptualization of misophonia.

What is particularly important and what was the main research question of our study, the results revealed that misophonia is positively correlated with paranoia-like thoughts. Moreover, we found that difficulties in regulating emotions, anxiety, and hostile attributions are not only significant mediators of the relationship between misophonia and paranoia-like thoughts, but, most of all, form a coherent explanatory mechanism underlying this association. Namely, based on our findings we may hypothesize that people experiencing misophonia symptoms have difficulties in regulating their negative emotions caused by the presence of intolerable misophonic sounds. Further, due to the lack of effective emotion regulation strategies, these negative emotional states associated with hatred sounds may be exaggerated. Indeed, the inability to deal with unpleasant emotions can contribute to an increase in overall anxiety (Cisler et al., 2010). The consequence of this may be adopting defensive strategies in the form of hostile attitude towards people who may intentionally emit the triggering sounds. Attributing hostile intentions to other people in this particular situation, which is presumably associated with an elevated level of anxiety, can further develop into more intense and generalized thoughts that other people may intentionally want to hurt them, e.g. emitting the triggering sounds or in another threatening way. The negative emotional states associated with the presence of misophonic sounds makes the person more vulnerable to harm, as triggers, frequently being an inseparable part of everyday social functioning, are often inevitable. Vulnerability, in turn, is the basis upon which paranoia-like thoughts are built (Freeman et al., 2005), hence supporting our inference.

Nevertheless, although the directional model was tested, the data on which we built this theoretical hypothesis and our line of reasoning, is correlational, which means that no cause-and-effect conclusions can be drawn. Although this model turned out to be significant, it can be assumed that the relationships between these variables are bidirectional, and their order in the mediation model may change and take the form of a feedback loop mechanism. Moreover, the results of our study

showed that the mediation was complementary, which may indicate that misophonia symptoms directly (apart from the mediating role of emotion regulation, anxiety and hostile attributions) affect paranoia-like thoughts or that there are other mediators of this relationship, that were not included in our model. Our study was the very first step towards better understanding the relation between misophonia and paranoia-like thoughts and its mechanisms. The correlational nature of the study, however, can be considered as a limitation. Hence, further research, especially using experimental or longitudinal methods, which would allow establishing the causality of this association, as well as applying structured clinical interviews, is warranted.

Our findings also revealed significant (at the trend level) differences between the genders in the misophonia symptoms severity. In line with previous studies (Erfanian et al., 2019; Rouw and Erfanian, 2018), misophonia seemed to affect women more than men. However, the existing research regarding the role of gender in misophonia is inconsistent. A very recent study (Savard et al., 2022) revealed that misophonia did not differ between men and women, but additional analysis showed that one item on the misophonia questionnaire appeared to differentiate between the sexes and referred to the physiological component of emotions. However, it has not been proven to be specific to misophonia, as men and women typically differ in their self-reported responses to negative emotional stimuli, which is not necessarily reflected in their physiological responses (Poláčková Šolcová and Lačev, 2017). Future research aimed directly at gender differences in the context of misophonia is then needed.

We intended to conduct the study on a non-clinical sample, as it was found that both paranoia-like thoughts (Freeman et al., 2011) and misophonia symptoms (Wu et al., 2014; Kılıç et al., 2021) are, to some extent, prevalent in the general non-clinical population. However, a relatively large percentage (30.4 %) of the respondents participating in the study declared that they had some kind of psychiatric diagnosis in their lifetime, mainly depression (21.8 %) and anxiety (14.7 %). These numbers are also in line with a very recent meta-analysis (Chekole and Abate, 2021) which showed that the prevalence of anxiety and depression (mostly reported diagnoses in our study) is estimated at 33.59 % and 29.98 %, respectively. Nevertheless, the presence of the declared diagnosis was added as a covariate to the mediation analysis to limit the potential impact of the diagnosis on the results. However, the effects remained significant, suggesting that both paranoia-like thoughts and misophonia symptoms may appear and coexist in a healthy population, contributing to elevated stress levels and becoming a risk factor for more severe psychological symptoms if left untreated.

Even though our study was conducted primarily on a non-clinical sample, we can cautiously assume that our results may have potential clinical implications. If replicated in clinical samples, moderate relationships between paranoia-like thoughts and misophonia may suggest that hatred sounds emitted by other people are a source of significant distress and exaggerated safety behaviors (e.g., social withdrawal) complicating both symptoms of paranoia as well as misophonia. Furthermore, misophonia, as associated with interpersonal context, may be additional factor increasing emotional dysregulation associated with paranoia. To our best knowledge, the relationship between misophonia and paranoia or psychosis in general, was not considered in the existing therapy protocols. Although there are no proven psychological therapy protocols for treating misophonia symptoms as yet, cognitive behavioral therapy (CBT) is considered to be a promising and effective treatment for misophonia (Ferrer-Torres and Giménez-Llort, 2022). Further research on clinical samples is warranted to explore the potential role of misophonia in clinical paranoia or psychosis in general, as well as in relation to other psychotic-like experiences, e.g. auditory hallucinations. Another direction for future research may be to investigate sensory gating (brain processes engaged to selectively filter irrelevant sensory stimuli) as a potential common ground factor in the link between misophonia and psychosis, as it has been shown that sensory gating can be impaired in both syndromes (Brout et al., 2018; Shen et al., 2020).

To conclude, the results of our study enriched the existing literature with an additional factor playing a role in the conceptualization of misophonia, i.e. paranoia-like thoughts. Moreover, we proposed an exploratory model that describes a potential coherent mechanism underlying the relationship between misophonia symptoms and paranoia-like thoughts. Namely, we highlighted the role of difficulties in emotion regulation, anxiety, and hostile attributions as significant mediators, which collectively emphasize the key role of socio-cognitive factors in misophonia. Hence, our findings suggest that misophonia is significantly related to interpersonal trust and at least partially cognitive and emotional processes play a role in shaping this relation.

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CRediT authorship contribution statement

Paulina Bagrowska: Conceptualization, Methodology, Investigation, Formal analysis, Visualization, Project administration, Data curation, Writing – original draft. **Renata Pionke-Ubych:** Methodology, Formal analysis, Writing – review & editing. **Łukasz Gawęda:** Funding acquisition, Supervision, Writing – review & editing.

Declaration of competing interest

The authors have declared that there are no conflicts of interest in relation to the subject of this study.

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7.4 Publication 4

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Exacerbation of paranoia-like thoughts following exposure to common misophonia trigger sounds

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ABSTRACT

Paranoia-like thoughts refer to heightened suspicions and unfounded beliefs about being watched or persecuted by others. Recent research has found a significant correlation between misophonia symptoms, a form of decreased sound tolerance, and paranoia-like thoughts, both of which are linked to heightened negative emotions in clinical and non-clinical populations. Notably, it has been observed that misophonia may also be associated with the tendency to attribute hostile intent to those producing triggering sounds, a feature consistent with paranoid ideation (i.e., perceptions of intentional harm). However, existing research is based on correlational data, limiting causal inference. Therefore, an online study involving a non-clinical sample (N = 487) employed an experimental approach to examine the relationship between misophonia symptoms, negative emotional response, and paranoia-like thoughts. Participants were randomly assigned to one of four task conditions, each related to exposure to different stimulus types: orofacial human-produced sounds, non-human sounds, sounds without visual context, or visuals devoid of sound. The results of mixed model ANOVA and mediation analysis revealed that exposure to common misophonia trigger sounds with a human-related visual context slightly, but not significantly, raised the levels of paranoia-like thoughts. However, it did lead to a significant increase in negative emotions, which, in turn, proved to be a significant mediator of an increase in paranoia-like thoughts. Conversely, exposure to non-human sounds or to only audio/visual stimuli either decreased both negative emotions and paranoia-like thoughts or showed no significant change. This emphasized the role of context and the involvement of negative emotional response to human-made sounds in amplifying paranoia-like thoughts. Importantly, this effect was observed in individuals who do not meet the provisional diagnostic criteria for misophonia, suggesting that symptoms of misophonia may extend beyond clinical diagnoses, with milder manifestations potentially being present within the general population.

1. Introduction

Paranoid ideation, prevalent in both clinical and nonclinical samples, is characterized by unfounded beliefs about being watched or persecuted by others, as well as perceiving other people's intentions as malevolent, intended to purposely cause harm (Freeman et al., 2005, 2011). It is postulated that paranoia-like thoughts are influenced by heightened vulnerability, which, in accordance with the hierarchy of paranoid thoughts, forms the fundamental basis upon which such beliefs are constructed (Freeman et al., 2005). Vulnerability to harm is a maladaptive schema characterized by a strong belief in unavoidable harm, and a persistent perception of the world as dangerous (Young et al., 2003). This schema may influence the content of thoughts, emotions, and behaviors, leading to hypervigilance and a tendency to interpret ambiguous situations as threatening.

Perceiving certain objectively non-dangerous stimuli in social situations (i.e., sounds), as dangerous or harmful, increased hypervigilance and thoughts that the stimuli are intended to cause harm are also common features of a condition called misophonia (Ferrer-Torres and Giménez-Llort, 2022). It is a complex disorder (Swedo et al., 2022) with distinct neurological, physiological, behavioral and emotional components, with current prevalence estimates varying between 5 % and 20 % in various cohorts (Dixon et al., 2024; Jakubovski et al., 2022). Despite the fact that misophonia has not yet been officially recognized as a

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distinct disorder within major diagnostic manuals, such as the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Classification of Diseases (ICD), provisional diagnostic criteria have been proposed in an attempt to delineate its distinctive symptom profile (Schröder et al., 2013; Jager et al., 2020; Swedo et al., 2022). Misophonia involves experiencing intense negative emotional responses to specific auditory (or sometimes other) stimuli, particularly sounds produced by other people (e.g., chewing, breathing or pen clicking). These triggering sounds have the potential to elicit intense and overwhelming physiological responses along with a spectrum of negative emotional states (Brout et al., 2018). Given its profound effects on individuals' mental health, social functioning, and overall quality of life (Ferrer-Torres and Giménez-Llort, 2022), the clinical relevance of misophonia is increasingly acknowledged. The precise nature of the misophonic reaction and its intensity are, however, contingent upon a number of variables. For instance, the reactions elicited in response to common trigger sounds are thought to be context-specific rather than dependent solely on the sound itself, e.g., a stronger emotional response to sounds elicited by family or friends as compared to strangers or animals (Edelstein et al., 2013; Siepsiak et al., 2023). Moreover, a recent qualitative case study found that three individuals with misophonia reported the belief that other people may *intentionally* make triggering sounds (Natalini et al., 2020), thereby further intensifying their negative emotional response (Reid et al., 2016). This suggests that the severity of the misophonic reaction may not only depend on the context in which the sound occurs but also on the perceived intentionality or hostility behind the sound. The belief that other people are deliberately making triggering sounds to cause harm can develop a sense of threat and a perception of the close environment and world in general as a dangerous place, which in turn can exacerbate paranoia-like thoughts (i.e., other people as a source of harm). Frequent triggers, referred to as stimuli that elicit a misophonic reaction, encompass everyday human sounds such as eating or breathing. Thus, people suffering from misophonic symptoms may live in a constant state of stress and threat anticipation, which renders them more vulnerable to harm, which is suggested to form paranoid thoughts (Freeman et al., 2005).

One of the recent studies has revealed a link between paranoia-like thoughts and symptoms of misophonia. This relationship turned out to be mediated by anxiety, difficulties in emotion regulation, and hostile attributions (Bagrowska et al., 2022a). Namely, individuals experiencing misophonia symptoms may encounter challenges in effective emotion regulation in response to unpleasant triggering sounds. This difficulty can give rise to heightened negative emotional states, such as anxiety, which, in turn, may prompt the adoption of defensive strategies. As a result, people may attribute hostile intentions to others, perceiving them as directed to intentionally cause harm by making triggering sounds. However, this reasoning is based on cross-sectional data, and therefore it remains to be a hypothesis as alternative models may also be plausible. Moreover, in this study, a one-dimensional scale was used, which did not allow for the analysis of specific aspects of misophonia, that may be related to paranoia-like thoughts.

Recently, a new tool assessing five distinct dimensions of misophonia has been developed (Vitoratou et al., 2021). It places particular emphasis on understanding the *meaning* attributed to the overall misophonic experience. Hence, misophonia can be captured by 'Externalizing appraisals' (blaming others for the reaction), 'Internalizing appraisals' (self-blame for the reaction to specific sounds), 'Sense of threat' (fear of escalation of negative emotions in response to certain sounds, leading to anxiety when unable to avoid them), 'Outbursts' (fear of becoming verbally or physically aggressive towards others to stop the triggering sounds), and 'Impact' (perceived limitations caused by the reaction to certain sounds). Therefore, considering the previously described hypothesis linking misophonia and paranoia-like thoughts, one could speculate that the key factor underlying this association would be externalizing, which, in this context, may refer to the belief that people are responsible for causing harm and should refrain from making triggering sounds. This reasoning somehow aligns with the concept of 'poor-me' paranoia (Trower and Chadwick, 1995; Melo et al., 2006), where individuals hold the belief that others are guilty of causing harm and subject them to persecution despite being undeserving. Research has indeed shown that people experiencing paranoid thoughts tend to lean towards external attributions, being more prone to blame others when explaining the causes of negative events (Kinderman and Bentall, 1997). On the other hand, there is the 'bad-me' paranoia, often associated with low self-esteem, anxiety and depression (Chadwick et al., 2005), where individuals have a tendency to attribute negative events to their own actions and internalize the blame. Depending on the attributions made in response to one's own reactions, different dominant emotions may emerge, such as anger in the case of externalization and guilt and depression in the case of internalization (Freeman and Garety, 2003; Fornells-Ambrojo and Garety, 2009).

Yet, can misophonia be considered solely as an accompanying manifestation of paranoia-like thoughts, or does it also exhibit the potential to function as an autonomous predictor in its own right? Freeman and Garety (2014) highlighted six primary plausible causal factors involved in the occurrence of paranoia-like thoughts. Within this context, it is feasible to distinguish at least two factors that can elucidate the mechanistic link between misophonia symptoms and paranoia-like thoughts, i.e., interpersonal sensitivity (being extremely alert to potential threats or negative intentions of others) and negative thoughts about self (a sense of being different or inferior and therefore more vulnerable to harm). Therefore, in the event of activation of one or more of the above mechanisms, it could be cautiously assumed that misophonia is not only a simple correlate but also a potential predictor of paranoia-like thoughts. However, this requires empirical research.

Hence, the aim of this study is to further investigate the relationship between misophonia-like symptoms and paranoia-like thoughts in a non-clinical sample. Our goal is to determine the specific dimensions of misophonia that are most strongly associated with paranoia-like thoughts, as well as to examine the effect of exposure to common misophonia trigger sounds on the intensification of paranoia-like thoughts, both directly and through negative emotions. We hypothesize that exposure to audiovisual orofacial human-produced sounds that typically trigger misophonia (mainly eating or drinking) will have a stronger negative effect on state paranoia-like thoughts and negative emotions than exposure to other stimuli, such as non-human sounds, audio without visual context, or visuals without accompanying sound. Additionally, we hypothesize that negative emotional response will mediate the relationship between exposure to specific stimuli and the emergence of state paranoia-like thoughts, with a particularly strong effect when the stimuli involve human-produced sounds that commonly trigger misophonia.

2. Methods

2.1. Participants

A total of 889 individuals, recruited by a research panel took part in the online study, which was approved by the Ethics Committee of the Institute of Psychology of the Polish Academy of Sciences in Warsaw. Inclusion criteria included age over 18 and correct answers to all control questions that appeared throughout the survey to ensure data quality. Respondents who did not complete the entire survey or failed to respond to all control questions were excluded from the analysis ($n = 402$), resulting in a final total sample of 487 participants (50.7 % women). Informed consent was obtained from all participants prior to their involvement in the study.

2.2. Measures

At the beginning of the study, participants were asked to provide demographic information, along with details of any prior diagnoses of

neurological or intellectual disorders. Furthermore, they were asked to provide information regarding a history of psychiatric disorders, including anxiety disorder, depression, bipolar disorder, schizophrenia, obsessive-compulsive disorder, eating disorder, substance use disorder, alcohol use disorder, personality disorder, and other. Additionally, they were asked about their history of taking psychotropic medication during their lifetime, including antidepressants, anti-anxiety drugs, antipsychotics, sleeping pills, mood stabilizers, and other medication.

The revised Green et al*., Paranoid Thoughts Scale* (R-GPTS) (Freeman et al., 2021) is a comprehensive 18-item scale assessing two dimensions of trait paranoia-like thoughts – ideas of reference (e.g., "*People definitely laughed at me behind my back*") and ideas of persecution (e.g., "*People wanted me to feel threatened, so they stared at me*") (Cronbach's alpha = 0.96).

To assess state levels of paranoia-like thoughts before and after the experimental procedure, we employed a visual-analogue scale consisting of six items previously used by Freeman et al. (2015). The scale was translated by the authors into Polish using the back-translation method. Cronbach's alpha before and after the task in our sample was 0.96.

To evaluate negative emotional response elicited by the experimental procedure (misophonic-like reaction), we used a list of feelings derived from the S-Five scale (e.g., irritation, disgust). Participants were instructed to indicate the intensity of each emotion they experienced at a given moment (before and after the experiment) using a visual-analogue scale. Cronbach's alpha coefficient before the task was 0.85, and after the task was 0.90.

The Selective Sound Sensitivity Syndrome Scale (S-Five) (Vitoratou et al., 2021) is a multidimensional scale that assesses misophonia. It consists of five 5-item subscales, including Externalizing appraisals (e.g., "*I react strongly to certain sounds because I cannot stand how selfish, thoughtless, or bad-mannered people can be*"), Internalizing appraisals (e.g., "*The way I react to certain sounds makes me wonder whether deep inside I am just a bad person*"), Impact (e.g., "*The way I feel/react to certain sounds will eventually isolate me and prevent me from doing everyday things*"), Outburst (e.g., "*I can get so angry at certain noises that I get physically aggressive towards people to make them stop*") and Threat (e.g., "*I feel trapped if I cannot get away from certain noises*"). The scale also includes a checklist of potential triggers (e.g., sniffling) with associated feelings (e.g., irritation) and response intensity (from doesn't bother me at all to unbearable). The study used a Polish adaptation (Uglik-Marucha et al., 2024) with an excellent internal consistency (Cronbach's alpha = 0.96).

Sound-Swapped Video Database for Misophonia (Samermit et al., 2022) is a validated, audiovisual stimuli database created for use in misophonia research. It consists of 18 original video sources (OVS), such as a person chewing chips or sniffling, along with the original corresponding sounds, and 18 positive attributable video sources (PAVS), e.g., tearing a piece of paper synchronized to the sound of chewing chips or drawing with a pencil synchronized to the sound of sniffling. In this study, we utilized a total of 20 stimuli, comprising 10 OVS and 10 PAVS. These stimuli were then combined to create two continuous videos: one composed of the 10 OVS stimuli (for OVS condition) and the other of the 10 PAVS stimuli (for PAVS condition), with each video lasting approximately 2 min. For research purposes, we also developed a new variant of the OVS condition, featuring only visual stimuli (the same as original OVS) without sound (Video-only), as well as an Audio-only version presenting the same sound sequence as the OVS and PAVS but without any visual input. New task versions were created as control conditions to specifically assess the effects of human-made orofacial sounds (OVS), the most common triggers of misophonia. Participants were randomly assigned to one of the four task versions (1 - OVS, 2 - PAVS, 3 - Audio Only or 4 - OVS – Video Only). The authors of this study used stimuli from an available database designed for the study of misophonia. The entire task, comprising four experimental conditions, was developed specifically for and used for the first time in the current study. To ensure optimal quality, participants were provided with the appropriate version of the task based on their chosen device (smartphone or laptop), including the necessary resolution adjustments.

2.3. Procedures

The study was conducted using the Qualtrics® platform. First, participants completed a survey consisting of several questionnaires, i.e., concerning their demographic information, measures of trait paranoia (Freeman et al., 2021) and misophonia (Vitoratou et al., 2021) over the past four weeks. Following the completion of these initial measures, participants were randomly assigned to one of four experimental conditions. The first condition ("OVS" – Original Video Sources) involved watching a video featuring people, e.g., audibly swallowing water or eating chips. These actions were accompanied by the original sounds associated with them. In the second condition ("PAVS" - Positive Attributable Video Sources), participants heard the same sounds as in the first condition (human eating or drinking), but instead of videos depicting people eating or drinking, they viewed images of activities like a pencil drawing or flowing water. The third condition ("Audio Only") allowed participants to hear the same sounds as the previous conditions but did not present any visual stimuli. Lastly, in the fourth condition ("OVS - Video Only") participants watched the same video material as the first group but did not hear any sounds. A brief sample sound lasting approximately 3 s was included at the beginning of the survey to verify the proper functioning of the audio content on the respondent's device. If the sound was not audible, the respondent was prompted to either switch their audio source (headphones or the device's built-in audio) or switch to a different browser.

Prior to and following the presented material, the state levels of paranoia-like thoughts and negative emotions were measured. Subsequently, manipulation check questions were administered to assess participants' recollection of the sounds heard in the material. Upon completion of the survey, respondents received participation points credited to their survey panel accounts. Furthermore, a comprehensive debriefing was provided to all participants, which included information regarding the random allocation of participants to one of the four conditions, accompanied by a detailed description of each. Additionally, participants were given the opportunity to view the other conditions if they wished to do so.

2.4. Statistical analyses

Statistical analyses were carried out using SPSS 28. To investigate the relationships between trait paranoia-like thoughts (R-GPTS) and misophonia symptoms (S-Five), two-tailed Pearson's correlation analyses were performed. To investigate the significance of various aspects of misophonia in relation to paranoia-like thoughts, a multiple hierarchical regression analysis, with age and gender included as covariates, was conducted. A mixed-model ANOVA was employed to test the hypothesis that exposure to certain sounds, along with their associated visual context (OVS condition), would result in heightened levels of state paranoia-like thoughts and negative emotions. To investigate the role of negative emotions in the relationship between experimental condition and state paranoia-like thoughts, a mediation analysis with a multicategorical independent variable (i.e., condition) was conducted using the model 4 in the PROCESS macro (Preacher and Hayes, 2004), following the bootstrapping procedure with 5000 resample. The experimental condition served as a predictor, the post-experiment level of negative emotions (T1) acted as a mediator, and post-procedure paranoia-like thoughts (T1) served as the outcome variable. Baseline levels of negative emotions (T0) and paranoia-like thoughts (T0) were included as covariates in the model. To handle the categorical independent variable, following established practices (Hayes and Preacher, 2014), we employed dummy coding with OVS (condition 1) as the reference group. As a result, the relative indirect effects were assessed by comparing the indirect effect of each selected condition (conditions 2, 3, or 4, which all served as controls) to the OVS group. In order to provide

further clarification regarding the effect of exposure to OVS (1) on paranoia-like thoughts, an additional mediation analysis was conducted with the PAVS (2) condition serving as a reference group. The relative indirect effect measures the impact of a mediator (i.e., negative emotions) on a dependent variable (i.e., paranoia-like thoughts), by comparing one group (or task condition) with a designated reference group. This effect is termed "relative" because it is contingent upon the choice of the reference group, indicating that the outcome may vary if a different group is used as the basis for comparison.

3. Results

3.1. Demographic information

Table 1 displays demographic information of the total sample, and Table 2 describes characteristics of different groups within the sample. The groups did not differ from each other in terms of age, education, neurological, intellectual and psychiatric disorders, as well as in the levels of trait paranoia-like thoughts (R-GPTS), misophonia scores (S-Five) and baseline levels of state paranoia-like thoughts and negative emotions. The groups slightly differed in terms of gender - in the fourth condition (Video Only), there were fewer men than in the other groups. The most frequently reported psychiatric diagnoses were depressive and anxiety disorders, with a lifetime prevalence of 8.6 % and 9.9 %, respectively. Most respondents used the device's built-in sound (80.2 %).

3.2. Correlation analysis

The results of the correlation analysis are presented in Table 3, revealing positive correlations between trait paranoia-like thoughts (R-GPTS) and all misophonia subscales (S-Five). Notably, the strongest relationship was observed with the Internalizing subscale ($r = 0.573$, $p < 0.001$).

3.3. Multiple hierarchical regression analysis

Table 4 shows the multiple hierarchical regression model to predict trait paranoia-like thoughts (R-GPTS) using five distinct dimensions of misophonia (S-Five). In the first step, age and gender were included in the model as covariates, both of which were significant predictors of paranoia-like thoughts, explaining 7 % of the variance. Then, all five misophonia subscales (derived from S-Five) were introduced. In this model, incorporating gender and age as covariates, misophonia accounted for 40 % of the variance in paranoia-like thoughts. Internalizing emerged as the strongest predictor, showing a significant positive association ($\beta = 0.32$, $p < 0.001$). Additionally, significant relationships were observed with the Impact ($\beta = 0.18$, $p = 0.004$) and the Outburst subscales ($\beta = 0.17$, $p = 0.01$), while no significant associations were found with the Externalizing and Threat subscales. An increase in R^2 of 0.33 was observed in the second (and final) step.

Table 1
Total sample demographics ($N = 487$).

	N (%)		M (SD)	Range
Gender		Age	43.05 (16.16)	18–84
Female	247 (50.7)	R-GPTS (paranoia)	14.13 (15.31)	0–72
Male	240 (49.3)	Reference	7.55 (7.41)	0–32
Education		Persecution	6.58 (8.76)	0–40
Primary	7 (1.4)	S-Five (misophonia)	49.30 (45.59)	0–222
Vocational	39 (8.0)	Externalizing	19.18 (13.49)	0–50
Secondary	195 (40.0)	Internalizing	7.97 (10.64)	0–48
Higher	246 (50.5)	Impact	5.69 (9.40)	0–44
Professional situation		Outburst	7.13 (10.21)	0–46
Employed	329 (67.6)	Threat	9.33 (12.0)	0–50
Unemployed	32 (6.6)	Trigger Count	11.93 (8.7)	0–37
Retired	97 (19.9)			
Student	52 (10.7)			
Neurological disorders	22 (4.5)			
Intellectual disability	4 (0.8)			
Psychiatric disorders	74 (15.2)			
Symptoms currently	53 (10.9)			
Medication use	116 (23.8)			
Medication use currently	53 (10.9)			

Note: R-GPTS - Green et al., Paranoid Thoughts Scale – Revised; S-Five - The Selective Sound Sensitivity Syndrome Scale.

Table 2
Group characteristics.

	1. OVS ($n = 127$)	2. PAVS ($n = 124$)	3. Audio only ($n = 133$)	4. OVS – video only ($n = 103$)
Gender (female/male)	61/66	57/67	59/74	70/33
Age	43.43 ± 16.74	45.44 ± 15.81	42.69 ± 15.66	40.18 ± 16.22
Education	3.5 ± 0.64	3.35 ± 0.72	3.38 ± 0.73	3.34 ± 0.69
Neurological disorders	3	3	11	5
Intellectual disability	1	0	2	1
Psychiatric diagnosis (Y)	21	14	21	18
Symptoms currently (Y)	12	11	15	15
Medication use (Y)	32	25	36	23
Medication use currently (Y)	12	14	15	12
R-GPTS	15.97 ± 16.31	12.55 ± 14.35	13.15 ± 14.46	15.01 ± 16.15
S-Five	53.48 ± 50.19	49.02 ± 43.64	47.29 ± 44.34	47.10 ± 43.50
Paranoia T0	7.30 ± 12.03	5.24 ± 9.90	7.37 ± 12.79	6.10 ± 12.65
Paranoia T1	8.26 ± 13.35	3.06 ± 6.52	5.93 ± 12.49	6.00 ± 11.54
Negative emotions T0	9.91 ± 9.63	9.09 ± 9.74	10.12 ± 10.75	7.49 ± 8.68
Negative emotions T1	12.10 ± 15.02	5.38 ± 7.59	8.18 ± 11.98	9.18 ± 11.20

Note: R-GPTS - Green et al., Paranoid Thoughts Scale – Revised; S-Five - The Selective Sound Sensitivity Syndrome Scale.

Table 3
Correlational matrix (N = 487).

	1	2	3	4	5	6	7	8
1. R-GPTS Total score	–							
2. R-GPTS Reference	0.937***	–						
3. R-GPTS Persecution	0.956***	0.793***	–					
4. S-Five Total score	0.574***	0.518***	0.566***	–				
5. S-Five Externalizing	0.284***	0.295***	0.247***	0.699***	–			
6. S-Five Internalizing	0.573***	0.506***	0.574***	0.847***	0.475***	–		
7. S-Five Impact	0.545***	0.423***	0.594***	0.822***	0.323***	0.721***	–	
8. S-Five Outburst	0.532***	0.471***	0.532***	0.873***	0.412***	0.700***	0.775***	–
9. S-Five Threat	0.474***	0.455***	0.444***	0.875***	0.508***	0.638***	0.677***	0.773***

*** $p < 0.001$.

Table 4
Multiple hierarchical regression model (N = 487).

	t	*p*	Beta	*F*	adj R^2	ΔR^2
Step 1				18.79***	0.07	0.07***
Gender	−3.27	0.001	−0.15			
Age	−3.98	<0.001	−0.18			
Step 2				47.66***	0.40	0.34***
Gender	−4.32	<0.001	−0.16			
Age	−1.92	0.06	−0.07			
S-Five Externalizing	0.10	0.92	0.004			
S-Five Internalizing	5.63	<0.001	0.32			
S-Five Impact	2.88	0.004	0.18			
S-Five Outburst	2.49	0.01	0.17			
S-Five Threat	−0.29	0.77	−0.02			

*** <0.001.

3.4. Mixed model ANOVA

3.4.1. Paranoia-like thoughts

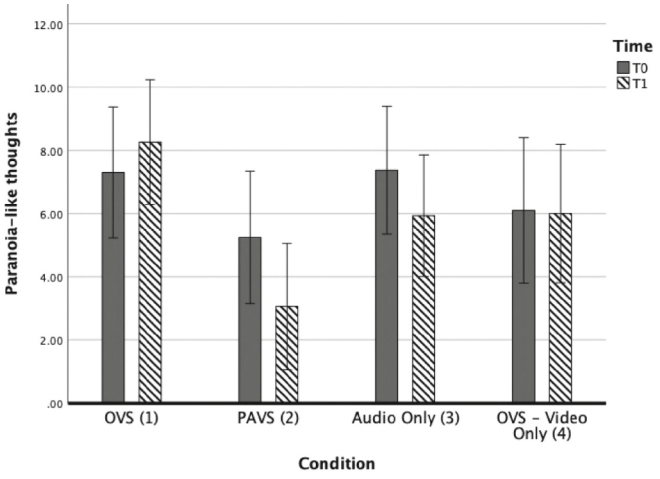
A mixed model ANOVA was conducted to examine whether exposure to certain sounds, accompanied by their corresponding visual context, influences state paranoia-like thoughts (Fig. 1a) and negative emotions (Fig. 1b).

The 4 (Condition: OVS, PAVS, OVS – Video Only or Audio Only) x 2 (Time: T0 – before and T1 – after experimental procedure) mixed model ANOVA on state paranoia-like thoughts revealed a significant Condition x Time interaction effect ($F(3,482) = 3.471$, $p = 0.02$ $\eta_p^2 = 0.02$). A pairwise comparisons (Bonferroni-corrected) showed a slight non-significant increase in the level of paranoia-like thoughts between T0 ($M = 7.30$, $SD = 12.03$) and T1 ($M = 8.26$, $SD = 13.35$) in the OVS (1) condition, a significant decrease in the level of paranoia-like thoughts between T0 ($M = 5.24$, $SD = 9.90$) and T1 ($M = 3.06$, $SD = 6.52$) in the PAVS (2) condition ($p = 0.004$), a significant decrease in T1 ($M = 5.93$, $SD = 12.49$) as compared to T0 ($M = 7.37$, $SD = 12.79$) in the Sound Only (3) condition ($p = 0.049$), and no significant difference between T0 ($M = 6.10$, $SD = 12.65$) and T1 ($M = 6.00$, $SD = 11.54$) in Video Only (4) version of the task. Moreover, a Bonferroni-adjusted pairwise comparison revealed that the level of paranoia-like thoughts at T1 (post-procedure) exhibited a statistically significant difference only between the OVS (1) and PAVS (2) conditions ($p = 0.002$).

3.4.2. Negative emotions

The 4 (Condition: OVS, PAVS, OVS – Video Only or Audio Only) × 2 (Time: T0 – before and T1 – after experimental procedure) mixed model ANOVA on state negative emotions revealed a significant Condition x Time interaction effect ($F(3,483) = 11.329$, $p < 0.001$, $\eta_p^2 = 0.07$). A pairwise comparisons (Bonferroni-corrected) showed significant increase in the level of negative emotions in T1 ($M = 12.10$, $SD = 15.02$) as compared to T0 ($M = 9.91$, $SD = 9.63$) in the OVS (1) condition ($p =$ 0.008), significant decrease following experimental procedures in both PAVS (2) (T0: $M = 9.09$, $SD = 9.74$; T1: $M = 5.38$, $SD = 7.59$, $p < 0.001$) and Sound Only (3) (T0: $M = 10.12$, $SD = 10.75$; T1: $M = 8.18$, $SD =$ 11.98, $p = 0.017$) conditions. No significant difference in the level of negative emotions between T0 ($M = 7.49$, $SD = 8.68$) and T1 ($M = 9.18$, $SD = 11.20$) was found in the Video Only (4) version of the task ($p >$ 0.05). Moreover, a Bonferroni-adjusted pairwise comparison revealed that the level of negative emotions at T1 (post-procedure) differed significantly only between the OVS (1) and PAVS (2) conditions ($p =$

a. Paranoia-like thoughts



b. Negative emotions

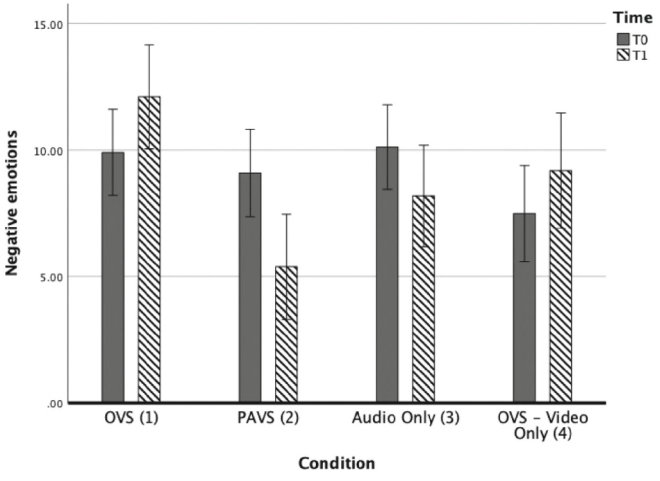


Fig. 1. Mixed model ANOVA of a) paranoia-like thoughts and b) negative emotions. Condition×Time interaction.

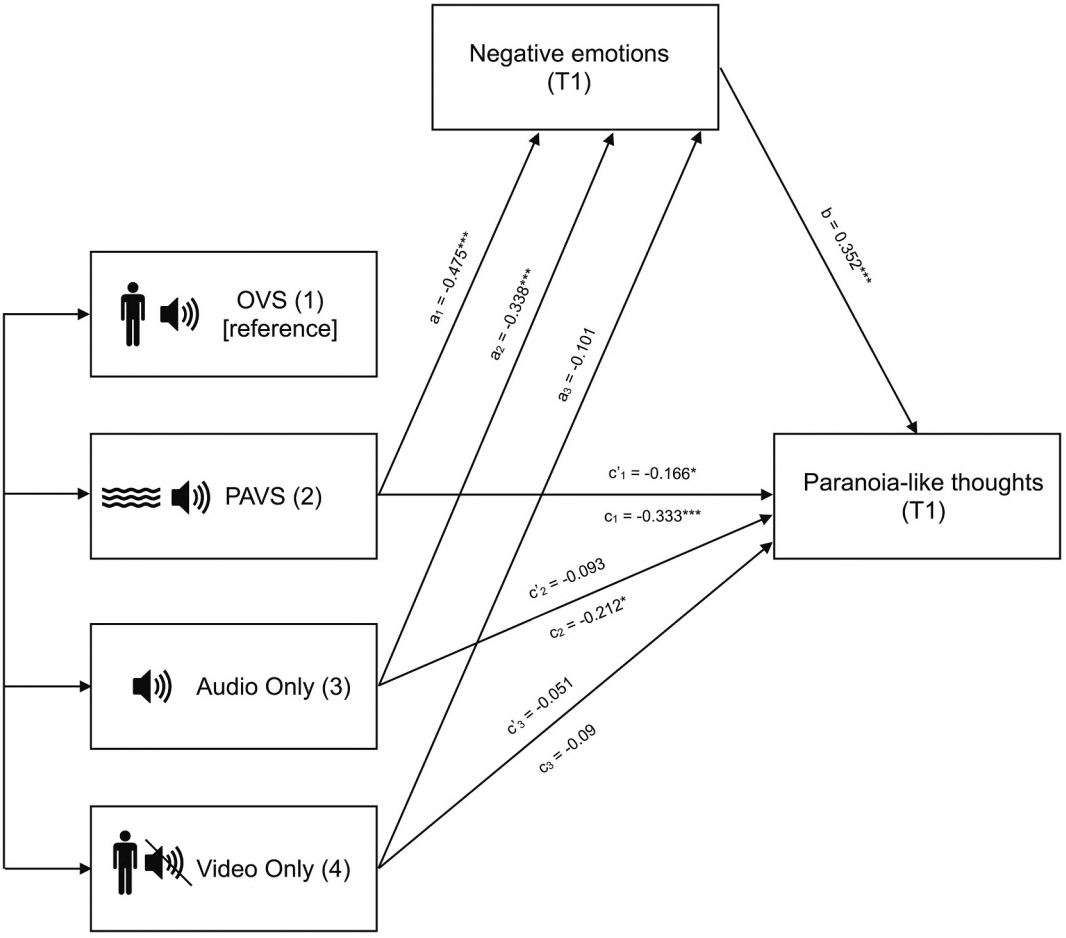


Fig. 2. Mediation analysis.

0.014).

3.5. Mediation analysis

To examine the mediating role of negative emotional response in the relationship between experimental condition and state paranoia-like thoughts, we conducted a mediation analysis (see Fig. 2).

The results revealed that the total effect ($F(5,481) = 134.74$, $p < 0.001$) explained 58.34 % of the variance in paranoia-like thoughts, and the mediated model ($F(6,480) = 147.42$, $p < 0.001$) explained 64.82 % of the variance. The OVS (1) condition was used as the reference group for the categorical independent variable. The direct effects of each condition on the dependent variable (paranoia-like thoughts) were tested. Compared to OVS (1), PAVS (2) ($b = -0.166$, $SE = 0.08$, $p < 0.05$) was the sole condition that demonstrated a significant *relative direct effect* on paranoia-like thoughts. In contrast, the Audio Only (3) and Video Only (4) conditions did not have a direct effect on the dependent variable. This model found a significant *relative indirect effect* of the experimental condition on paranoia-like thoughts mediated through negative emotions for the PAVS (2) ($\beta = -0.167$, $SE = 0.05$, 95 % $CI = -0.264$ to -0.087) and Audio Only (3) ($\beta = -0.119$, $SE = 0.04$, 95 % $CI = -0.210$ to -0.046) conditions. The *relative indirect effect* for the Video Only (4) condition was not significant. The results indicate that, in comparison to participants in the OVS (1) condition, subjects in the PAVS (2) and Audio Only (3) conditions reported significantly lower levels of negative emotions following exposure to the presented stimuli, which, in turn, decreased the intensity of paranoia-like thoughts.

To provide further clarification regarding the effect of exposure to OVS (1) condition on paranoia-like thoughts, an additional mediation analysis was performed with the PAVS (2) condition serving as a reference (see Supplementary material S1 for figure). Compared to PAVS (2), the OVS (1) was the only condition that demonstrated a significant *relative direct effect* on paranoia-like thoughts ($b = 0.166$, $SE = 0.08$, $p < 0.05$). In comparison to the PAVS (2), this model found a significant *relative indirect effect* of the experimental condition on paranoia-like thoughts mediated through negative emotions for the OVS (1) ($\beta = 0.167$, $SE = 0.05$, 95 % $CI = 0.083$ to 0.267) and Video Only (4) ($\beta = 0.131$, $SE = 0.04$, 95 % $CI = 0.066$ to 0.208) conditions. The *relative indirect effect* for the Audio Only (3) condition was not statistically significant. The results indicate that, compared to participants in the PAVS (2) condition, subjects in the OVS and Video Only groups reported higher levels of negative emotions following exposure to the presented stimuli. However, only in the case of participants in the OVS (1) condition an increase in the intensity of paranoia-like thoughts was observed, thereby highlighting the unique impact of the OVS (1) on these outcomes.

4. Discussion

The findings of this study align with previous research exploring the association between misophonia-like symptoms and paranoia-like thoughts (Bagrowska et al., 2022a), further confirming the positive relationship between these constructs in an independent sample. The primary aim of this study was to examine the extent to which exposure to common misophonia triggers, and, possibly, the resulting emotional response, contribute to the development of paranoia-like thoughts using an experimental approach. Although the aim of this study was not to suggest that misophonia symptoms are sufficient or necessary

explanatory factor for paranoia, the proposed mechanism, i.e., the mediating role of negative emotions, has been well established in previous research on paranoia (Bagrowska et al., 2022a, 2022b; Rehman et al., 2018). Intense negative emotional states, which are a characteristic response to certain sounds in individuals with misophonia, combined with internalised negative self-views (e.g., *"I am a bad person because of my reactions*"), may lead to an increased vulnerability to harm, a factor thought to underlie paranoid thinking. It is crucial to note that some notions, i.e., unfounded beliefs of being harmed in paranoia-like thoughts, express also common experiences in misophonia. Specifically, people suffering from misophonia often report a history of being misunderstood, laughed at, or abused by family and friends because of their symptoms (Ferrer-Torres and Giménez-Llort, 2022). Additionally, even if an individual has not experienced similar instances of abuse, the feeling of being harmed by specific sounds or people producing those sounds is at the core of misophonia. At present, it remains unclear whether the perceived harm from other people is related to fears and beliefs that others *intentionally* produce triggering sounds, or whether it stems from fears that others make these sounds *regardless of their intention*. Hence, various items related to paranoia-like thoughts (e.g. "*I was certain people did things in order to annoy me*" from the R-GPTS scale) could potentially be integrated into scales for measuring misophonia to more accurately capture the actual misophonic experience and its association with paranoid ideation.

The results revealed that the dimension of misophonia most strongly associated with paranoia-like thoughts is 'Internalizing'. Surprisingly, the weakest relationship, yet still significant, was observed with 'Externalizing' appraisals. Although one may assume that externalizing, and therefore blaming others, would strongly predict the emergence of paranoia-like thoughts characterized by attributing hostile intentions and deliberate actions to others, these results do not support such hypothesis. Externalizing bias refers to the tendency to blame others rather than oneself for adverse events (Langdon et al., 2006). In the context of misophonia, the externalizing dimension can be seen in the act of blaming others for producing triggering sounds based on the belief that they are selfish, unaware of the potential distress caused, or simply impolite (Vitoratou et al., 2021), e.g., "*I react strongly to certain sounds because I cannot stand how selfish, thoughtless, or bad-mannered people can be*" (a statement from the S-Five scale). These attributions pertain to the individuals' own inappropriate behavior. The externalizing dimension in the S-Five scale does not contain any items relating to hostile and intentional harm, which may partly explain the weakness of the correlation with paranoia-like thoughts. For further exploration, it would be worth considering an additional dimension – externalizing, which involves blaming others for emitting specific sounds not solely based on personal attributes such as selfishness or inappropriateness but instead implies hostile intentions on the part of certain individuals, such as "*I react strongly to certain sounds because I believe that others deliberately make them to hurt me or make me feel uncomfortable"*. While exploring such a hypothetical dimension, it would also be worth considering situations where hostile intentions are attributed due to the lack of responsiveness from close ones, such as, *'I've told my family/close ones multiple times about my misophonia/sound issue, but they don't consider it a real problem'*.

Although it was the occurrence of externalizing attributions in misophonia that has drawn attention to the potential link between misophonia and paranoia-like thoughts, the fact that internalizing appraisals emerged as a significant correlate and a robust predictor of paranoia-like thoughts demands more attention. In previous studies, it has also been found that internalizing appraisals are more strongly associated with symptoms of psychopathology (Remmert et al., 2022; Vitoratou et al., 2021; Uglik-Marucha et al., 2024). Within this dimension, two prominent facets can be discerned: self-directed appraisal, wherein individuals experience disrespect or dislike of themselves during their reactions to certain sounds, and other-directed appraisal, whereby the way they respond to the triggering sounds evokes a sense of being inherently unlikable. When combined with self-blame and a negative self-view, these reactions can potentially reinforce anxiety and instil a perceived sense of threat, including, e.g., the fear of rejection due to specific responses to particular sounds. In addition to internalizing, the current study identified two further dimensions of misophonia that demonstrated a moderate correlation and served as significant predictors of paranoia-like thoughts: Impact and Outburst. To illustrate, the statement "*I do not meet friends as often as I would like to because of the noises they make*" (Impact), and the statement "*I am afraid I will do something aggressive or violent because I cannot stand the noise someone is making*" (Outburst), reflect concerns about disruptions in social life and social interactions. These concerns can eventually lead to greater social isolation and greater fears of being rejected by others (because of misophonic reaction). Notably, rejection sensitivity has been found to be a significant factor in paranoia-like thoughts (Meisel et al., 2018). Therefore, exploring the role of rejection sensitivity, as well as examining both the perceived and actual experiences of social rejection and social isolation, could serve as fruitful avenues for further research on misophonia.

Considering that externalizing appraisals in misophonia were marginally related to paranoia-like thoughts, while the correlations between misophonia total scores and paranoia-like thoughts were moderate, it is worth noting that there may be yet other mechanisms contributing to these findings. The results may indicate a broader range of sound over-responsivity in individuals experiencing paranoia-like thoughts, extending beyond misophonia alone, and could encompass certain facets of general sensory sensitivity. Thus, the relationship between these two constructs may, at least partially, result from shared underlying mechanisms or the presence of transdiagnostic traits, such as negative affect, difficulties in emotional regulation, or more broadly, neuroticism as a personality trait. It is also worth noting that in the study by Natalini et al. (2020), in which hostile attributions were reported, all three patients were diagnosed with at least one comorbid personality disorder. Therefore, these individuals' cognitive appraisals of misophonic situations may also be more related to personality disorders rather than paranoia-like thoughts. This, however, requires further research, with a particular focus on examining sensitivity across various sensory modalities in individuals experiencing paranoid thoughts.

The findings also revealed that exposure to common misophonia triggering sounds accompanied by corresponding visual human-related stimuli slightly increased paranoia-like thoughts (although the increase was rather small and not statistically significant) and heightened negative emotions. Conversely, participants exposed to sounds paired with different visual stimuli, such as flowing water or pencil sketching, as well as those who solely heard the sounds without any visual stimuli, exhibited a significant decrease in paranoia-like thoughts and negative emotions. Interestingly, individuals in the group that did not hear any sounds but viewed videos portraying people eating or drinking experienced a slight, but non-significant, increase in negative emotions with no change in paranoia-like thoughts. This is in line with prior research that has indicated that auditory triggers are perceived as more aversive and capable of eliciting stronger physiological responses when compared to visual stimuli (Edelstein et al., 2013). These results suggest that visual stimuli alone, lacking the presence of auditory triggering sound (a prominent element of misophonia), fail to elicit a sufficiently strong negative emotional response, thereby providing insufficient grounds for the emergence of paranoia-like thoughts. Moreover, our findings support the notion that contextual factors play a crucial role in eliciting misophonic-like reactions, i.e., sounds emitted by people are perceived as more negative (Schröder et al., 2019; Edelstein et al., 2020; Siepsiak et al., 2023). Considering the intrinsic connection between negative emotions and paranoia-like thoughts, we hypothesized that the association between exposure to common misophonic triggers and the emergence of paranoia-like thoughts would primarily be mediated by the emotional misophonic-like reaction. In accordance with the hypothesis, exposure to auditory trigger sounds accompanied by

corresponding visual human-related stimuli, resulted in an elevation of negative emotions, serving as a significant mediator, potentially leading to an increase in paranoia-like thoughts as a consequence. Notably, this effect was observed exclusively in this condition. These findings highlight the vital role of emotional modulation, which bears potential clinical relevance.

While our study has yielded significant findings, it is important to acknowledge its limitations. First, to make inferences about the perceived hostility and intentionality of sounds emitted by others, it would be necessary to incorporate a suitable measurement tool specifically designed to assess this aspect. Moreover, it would be worthwhile to extend the study to clinical populations, including individuals who meet provisional diagnostic criteria for misophonia (Jager et al., 2020; Swedo et al., 2022) and patients diagnosed with psychotic disorders experiencing persecutory or referential delusions, which would provide a more comprehensive understanding of the relationship, whether correlational or causal, within clinical disorders. Furthermore, our experiment was conducted online, resulting in an artificial and predetermined exposure to triggering stimuli for a short, fixed duration. In our study, the stimuli led to a slight increase in paranoia-like thoughts, but this did not reach statistical significance. It is therefore plausible that a more natural setting and more ecologically valid methods might have produced statistically significant effects. As the study was conducted online, it was not possible to verify whether participants had turned off the audio at any point during stimuli exposure or adjusted the volume. Moreover, the study did not assess or control for the potential impact of pre-existing hearing impairments. Hence, while our hypotheses were partially confirmed, and the experimental procedures proved effective, considering more ecologically valid methods would be recommended.

This study brings forth new knowledge. Our study concentrated on a non-clinical sample consisting of individuals who do not predominantly exhibit clinically recognized symptoms. Yet, they still experienced a negative emotional misophonic-like response when exposed to common misophonic triggers, followed by increased paranoia-like thoughts. Hence, the results may suggest that misophonia could be understood as a continuum, from misophonia-like symptoms or reactions to severe clinical symptoms that impede daily functioning. We consider this approach to be innovative, but further research is needed to confirm or enrich our findings.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2024.10.005.

CRediT authorship contribution statement

Paulina Bagrowska: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Marta Siepsiak:** Writing – review & editing, Methodology. **Maria Nalberczak-Skóra:** Writing – review & editing, Methodology. **Łukasz Gawęda:** Writing – review & editing, Supervision, Methodology, Funding acquisition.

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Declaration of competing interest

The authors have declared that there are no conflicts of interest in relation to the subject of this study.

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Data availability

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

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7.5 Publication 5

Bagrowska, P., & Gawęda, Ł. (2025). ‘Rejection makes me suspicious’: Complex temporal network approach to the dynamics of real-time paranoid thoughts and psychological vulnerability. https://doi.org/10.31219/osf.io/mkqf3_v1

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‘Rejection makes me suspicious’: Complex temporal network approach to the dynamics of real-time paranoid thoughts and psychological vulnerability

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Abstract

Background and Hypothesis
Theoretical models and empirical evidence suggest that paranoid thoughts stem from a heightened sense of vulnerability, including the perception of the world as dangerous, and fears of rejection and social evaluation. However, the factors contributing to this sense of vulnerability and the complex interplay between these elements remain underexplored.

Study Design
A total of 175 individuals recruited from a non-clinical community sample, including 103 participants with low levels of paranoid thoughts (LP) and 72 with high levels (HP), took part in a 7-day ESM study assessing momentary levels of paranoia, social functioning, social rejection, negative affect, body image and misophonia symptoms. Temporal, contemporaneous and between-subject network models were estimated for the total sample and its subgroups separately.

Study Results
The temporal network identified paranoid thoughts as a predictor of negative affect, feelings of rejection, and negative body image, while in turn being predicted by feelings of rejection and reduced social safety. A bidirectional relationship between paranoia and social rejection emerged. These findings were supported by contemporaneous and between-subject networks, which showed that paranoid thoughts co-occurred with and were, on average, linked to feelings of rejection, negative affect, and reduced social safety.

Conclusions
These findings suggest that social rejection plays a central role in paranoia. While group differences in network structure were modest, the HP group exhibited more numerous and stronger connections between variables, suggesting that paranoia may develop through the gradual reinforcement of connections between symptoms rather than structural shifts, highlighting the importance of early intervention.

Keywords

Paranoia; Paranoid thoughts; Vulnerability; ESM

Introduction

Paranoid thoughts, observed in clinical and general populations (Freeman et al., 2005), refer to excessive mistrust and unfounded beliefs in hostile intentions from others (Freeman, 2007; Freeman & Garety, 2000). While these thoughts typically resolve naturally over time, the interaction of various factors can lead to their progression into full-blown disorders (Kelleher & Cannon, 2011; Os et al., 2009; Zavos et al., 2014). Research suggests that paranoia builds on feelings of vulnerability - concerns about social evaluation, fears of rejection, and the perception of the world as a dangerous place. These fears are conceptualized as interpersonal sensitivity (Boyce & Parker, 1989) – "feeling vulnerable in the presence of others due to expectation of criticism or rejection" (Bell & Freeman, 2014). A recent study (Freeman & Loe, 2023) suggested that reducing the sense of vulnerability may be one of the key pathways to lowering paranoia. Therefore, exploring the foundational element of the paranoia hierarchy (Freeman et al., 2005) – interpersonal sensitivity – and identifying its potential predictors and interactions between them could be crucial for designing effective interventions.

Feelings of vulnerability include fears of social rejection (Freeman et al., 2005; Freeman & Loe, 2023). Numerous studies have shown that social rejection can trigger paranoia, often through an increase in negative emotions (Bagrowska et al., 2022b; Stewart et al., 2017; Westermann et al., 2012; Lincoln et al., 2018). Past adverse experiences, such as actual or perceived social rejection, can significantly influence how individuals perceive social cues and engage in human interactions (London et al., 2007). These experiences may increase rejection sensitivity - an anxious anticipation and defensive overreaction to stimuli or situations that may involve rejection (Downey & Feldman, 1996), which may further result in hypervigilance in social contexts, causing individuals to misinterpret others' intentions as hostile despite insufficient evidence (Romero-Canyas et al., 2010). On the other hand, there are negative self-beliefs and fears of social evaluation (Freeman et al., 2005; Freeman & Loe, 2023). Previous research has extensively examined the relationship between self-esteem and paranoid thoughts (Humphrey et al., 2021; Kesting & Lincoln, 2013; Monsonet et al., 2020; Thewissen et al., 2008, 2011), indicating that low and unstable self-esteem significantly predicts both trait and state paranoia. Additionally, emerging research links paranoid thoughts to negative body image – one aspect of self-esteem (Waite & Freeman, 2017; Marshall et al., 2020; Bagrowska et al., 2022a, 2023; Waite et al., 2023). While the association between self-esteem and paranoia is well established, body image remains a newer research focus, with its causal role largely unexplored. Importantly, interpersonal (or rejection) sensitivity has been suggested to mediate the relationship between negative self-views and paranoia (Bagrowska et al., 2022a; Meisel et al., 2018), but the interplay between these factors is yet to be examined, especially in the light of another aspect of vulnerability – the perception of the world as dangerous and the sense of loss of control over events (Freeman et al., 2005; Freeman & Loe, 2023). For instance, recent studies have linked paranoid thoughts to misophonia symptoms (Bagrowska et al., 2022c), a form of decreased sound tolerance, particularly to sounds made by other people, which places it strongly within an interpersonal context (Swedo et al., 2022). Exposure to misophonia trigger sounds has been shown to induce negative emotions, further leading to the intensification of paranoid thoughts (Bagrowska et al., 2024). Since triggers like chewing, swallowing, and breathing are often unavoidable - making the world feel unpredictable, uncontrollable, and thus dangerous - individuals with misophonia may experience constant stress, anxiety, and feelings of inferiority (e.g., "I am a bad person because of my reactions"), further heightening their sense of vulnerability to harm, and serve as the foundation for paranoia development. Although these factors have been studied individually in the past, there is a lack of research that examines multiple 'vulnerability factors' in the context of paranoia together. A recent network approach

helps to address this gap by enabling the simultaneous study of multiple factors and the development of sophisticated models that capture their dynamics.

The network approach to psychopathology (Robinaugh et al., 2020) posits that mental disorders develop from causal interactions between multiple symptoms in a network (Borsboom, 2017). Recent studies have employed this approach to paranoia research (Bell & O'Driscoll, 2018; Contreras et al., 2022; Hajdúk et al., 2019; Januška et al., 2021), but the findings are based on cross-sectional data, employing rather static approach. Thus, directional relationships between factors and their temporal dynamics cannot be established. To the best of our knowledge, only one study to date has applied a temporal network approach (Epskamp, van Borkulo, et al., 2018) to investigate paranoia (Contreras et al., 2020). However, this was a pilot study conducted on a relatively small sample, indicating a need for further research.

Hence, this study employs a temporal network approach and ecologically valid, intensive longitudinal Experience Sampling Method (ESM) to identify key predictors and outcomes that reflect broader psychological mechanisms, such as social evaluative concerns, fears of social rejection, and perceived interpersonal threat, within a network of vulnerability-related factors in the context of paranoid thoughts and to explore their dynamic temporal interplay.

Material and Methods

This study forms part of a larger project on the experimental testing of the role of interpersonal sensitivity and fear conditioning in the context of paranoia.

Participants

One hundred and seventy-five individuals (58.3% of females) were recruited from the non-clinical community sample in two ways - via a survey link shared on social media and via a survey panel using the CAWI (Computer-Assisted Web Interview) method. The study comprised a pilot, initial screening cohort of over 800 individuals to establish cut-off scores for the level of paranoid thoughts, using the Revised Green et al., Paranoid Thoughts Scale (R-GPTS) (Freeman et al., 2021), based on which participants were subsequently being recruited and assigned to one of two groups. Namely, the control group (with low levels of paranoid thoughts; LP) consisted of participants scoring within the lowest 10% on the R-GPTS scale, as determined during the initial screening phase and corresponding to a score of ≤ 1 point. In contrast, the experimental group (with high levels of paranoid thoughts; HP) consisted of individuals scoring within the highest 10% (Aleksandrowicz et al., 2025; Pionke-Ubych et al., 2021; Reed & Randell, 2014) on the R-GPTS scale, corresponding to a score of ≥ 35 points. The study included a total of 103 participants in the LP group (52.4% of females) and 72 participants in the HP group (66.7% of females).

The study focused on adults aged 18 to 40. Subjects assigned to the LP group and included in the study were required to score ≤ 1 point on the R-GPTS scale, have no active symptoms of any psychiatric disorders in the past month, and have not used any psychotropic medication in the past month. HP participants were included in the study if they scored ≥ 35 points on the R-GPTS scale. Individuals from both groups were excluded from the study if they were outside the age range of 18-40, had a history of neurological disorders or intellectual disability, had been diagnosed with autism spectrum disorders, had a lifetime history of psychotic disorders or bipolar disorders (as the study aimed to examine non-clinical paranoid thoughts in the general population), reported a history of psychotic disorders or bipolar disorders in their first-degree

relatives, had ever used antipsychotic medication, or had declared alcohol or substance abuse or dependence in the past six months. Given the co-occurrence of elevated paranoid thoughts with other symptoms, including anxiety and depression, the presence of concomitant mental disorders was not an exclusion criterion in the HP group. The study was approved by the Ethics Committee of the Institute of Psychology of the Polish Academy of Sciences (no. 03/III/2021), and conducted in accordance with the latest version of the Declaration of Helsinki. All participants were required to provide written consent at each stage of the recruitment process and the main study.

Measures

The specific measurements and items used in the ESM assessment are detailed in Table 1. The factors measured in the ESM include paranoid thoughts, social functioning (social isolation, social stress, social safety), feeling of social rejection, important / stressful events, negative affect, body image and misophonia symptoms.

The Revised Green et al. Paranoid Thoughts Scale (R-GPTS) (Freeman et al., 2021) was employed to measure the baseline level of paranoid thoughts experienced over the past month. It consists of 18 items forming two subscales: one to assess ideas of reference (8 items) and another to assess ideas of persecution (10 items). The responses ranged from 0 to 4, resulting in a total score between 0 and 72 points. Cronbach's alpha (α) for this scale in this study was 0.98.

The Comprehensive Assessment of At-Risk Mental States (CAARMS) (Yung et al., 2005) is a semi-structured clinical interview designed to assess attenuated psychotic symptoms and to identify individuals at risk for developing psychotic disorders. The CAARMS is structured into seven domains, including the assessment of positive symptoms, cognitive change, emotional disturbance, negative symptoms, behavioral change, motor changes and general psychopathology. In the present study, a shortened version of the interview was employed, with only positive and negative symptoms being assessed. Each of the four subscales of positive symptoms (unusual thought content, non-bizarre ideas, perceptual abnormalities, disorganized speech) and three subscales of negative symptoms (alogia, avolition/apathy, anhedonia) were rated in terms of the intensity of symptoms (Global Rating Scale) and frequency and duration of the symptoms. Both scales rate symptom severity and frequency on a scale from 0 to 6 for each of the individual positive and negative symptoms subscales. This yields a total score for positive symptom intensity ranging from 0 to 24 points, a total score for positive symptom frequency and duration ranging from 0 to 24, a total score for negative symptom intensity ranging from 0 to 18, and a total score for negative symptom frequency and duration ranging from 0 to 18. All participants were asked to respond to questions pertaining to the experiences occurring in *the past year* and *the past month*.

The Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998) is a structured diagnostic interview aimed to assess a range of psychiatric disorders using the established Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) and International Classification of Diseases (ICD-10) criteria. Each module corresponds to a distinct disorder and receives a score of 1 if the participant fulfills the diagnostic criteria for that particular disorder or a score of 0 if the diagnostic criteria are not met. In the present study, only a subset of disorders was evaluated, including major depressive disorder, suicidality, manic episode, hypomanic episode, bipolar disorder, social anxiety disorders (social phobia), alcohol use

disorder, substance use disorder, anorexia nervosa, bulimia nervosa and body dysmorphic disorder.

Polish Adult Reading Test (PART) (Karakuła-Juchnowicz & Stecka, 2017) was employed to assess the level of premorbid intelligence. PART is a validation of the National Adult Reading Test (NART) by Hazel Nelson (Nelson, 1982), which is one of the most widely used methods of measuring premorbid intelligence in psychiatric patients. The PART is comprised of 50 words. Participants are given 1 point for each correctly pronounced word, while incorrectly pronounced words yield 0 points.

Procedure

To participate in the study, all individuals were required to complete a preliminary screening questionnaire. This survey was distributed by an external company to research panel participants and shared by the researchers across various social media platforms throughout the study. This questionnaire covered the R-GPTS scale, demographic data, personal and family psychiatric history (including lifetime diagnoses and current symptoms), neurological disorders or intellectual disabilities, history of psychotropic medication use (ever and currently), and psychoactive substance use, including alcohol. Those not meeting the inclusion criteria were thanked for their participation and not invited to take part in further recruitment stages. Individuals who passed the preliminary screening were subsequently contacted for a telephone verification to reconfirm their eligibility, with particular focus on the level of paranoid thoughts within the predetermined cut-off points and revisiting the inclusion and exclusion criteria. If a participant did not qualify at this stage, they were thanked and excluded from further participation. Those who successfully passed both the online screening and telephone verification were invited to the main study phase conducted on-site at the Institute of Psychology of the Polish Academy of Sciences in Warsaw.

The procedure began with the MINI interview to identify the presence of any current and lifetime psychiatric disorders. In the event that a participant met the diagnostic criteria for bipolar disorder or was currently experiencing substance abuse or dependence, the study was terminated for that individual, with no progression to the ESM assessment. Subsequently, participants proceeded with the PART test, which required them to read aloud the words provided to them on a paper sheet. Following this, participants were asked to complete a series of self-report questionnaires, including the R-GPTS. The CAARMS interviews were scheduled in a separate meeting after the ESM phase to avoid overburdening participants with an extensive assessment in a single session and to comply with the demands of subsequent experimental procedures not covered in this study.

The ESM assessment, conducted using the ©movisensXS GmbH software, began the following day. Participants were asked to complete surveys eight times a day for seven consecutive days, resulting in a total of 56 assessments. The surveys were distributed at random times between 9 am and 10 pm, with at least a 45-minute break between each prompt. Participants were allowed to delay completing the survey by up to 11 minutes. If a survey was not answered immediately or within the specified period, it was recorded as not responded. Participants were required to respond to at least six out of the eight daily surveys. To ensure compatibility with the ©movisensXS app, all participants were provided with the same model of smartphone. Finally, participants who completed this stage of the study, as well as the subsequent experimental phase (not reported here), received financial compensation in the form of a prepaid card with an approximate value of 115 EUR.

Statistical Analysis

Statistical analyses were performed using SPSS 29 and the R software (R version 4.3.0, RStudio version 2023.03.1+446) (R Core Team, 2023).

All analyses were conducted on the total sample, as well as on the LP and HP groups separately for group comparisons. Independent samples t-tests were employed to examine the statistical differences between the groups in terms of their demographic characteristics and all studied variables. The effect sizes were calculated using Cohen's d.

Network estimation

Temporal network analysis, aimed at investigating the dynamic interrelationships between paranoia-like thoughts and their correlates, was conducted using the R package *multivariate vector autoregression* (mlVAR) (Epskamp et al., 2024). The standard vector autoregression (VAR) model (Brandt & Williams, 2007) estimates the extent to which one variable at a specific time point (*t*) can be predicted by other variables at a previous time point (*t-1*). In this study, time-series (ESM) data with a multilevel structure derived from multiple subjects was analyzed. Therefore, the VAR model within a multilevel modelling framework (mlVAR) has been implemented, as it allows the temporal dynamics to be studied not only within a single individual, but also at the group level, estimating both average and individual effects. Network models were estimated for the total sample, as well as for the LP and HP groups separately.

To address the issue of missing data and to avoid the unnecessary exclusion of valid data, the Kalman filter (Harvey, 1990) for data imputation has been employed, using the R package *imputeTS* (Moritz et al., 2022). The multivariate vector autoregressive (mlVAR) analysis assumes stationarity of all variables, which means that the statistical properties of the time series, such as means, variances and autocorrelations, should be stable over time (Bringmann et al., 2016; Hamaker & Dolan, 2009). To test this assumption, the Augmented Dickey-Fuller (ADF) test was employed (Holmes et al., 2021), using the *adf.test* function within the R package *tseries* (Trapletti et al., 2024). The ADF tests revealed that all variables met the assumption of stationarity (all p-values < 0.01).

The mlVAR analysis on time-series data allows for estimation of three networks: temporal, contemporaneous, and between-subject network. All three network models were visualized using the R package *qgraph* (Epskamp et al., 2012). In all cases, each node (depicted as a circle) represents a variable. The variables in the networks include paranoid thoughts (‘Paranoia’), negative affect (‘NegAffect’), feeling of social rejection (‘FeelReject’), important event (‘Event’), social stress (‘SStres’), social safety (‘SSafety’), body image (‘BodyImage’) and misophonia symptoms (‘Misophonia’). The *temporal network* represents: 1) cross-lagged effects, i.e., how one variable (measured at *t*-1) influences another variable (measured at *t*) over time, controlling for the autoregressive effects; 2) autoregressive effects, i.e., how one variable (*t*-1) is predictive of itself over time (*t*), controlling for the cross-lagged relations (Bringmann et al., 2018). When one variable (*t*-1) significantly predicts another variable in the next measurement window (*t*), the nodes are linked with a directed arrowhead line pointing from one node to another (cross-lagged effects). An arrow of a node pointing at itself represents an autoregressive effect. The *contemporaneous network* represents partial correlations between nodes measured at the same time point, after controlling for both temporal effects and all other variables in the network in the same window of measurement (Epskamp, van Borkulo, et al.,

2018). Significant partial correlations between nodes are depicted as lines without arrowheads. The *between-subject network* represents the average relationships between variables across individuals (Epskamp, Waldorp, et al., 2018). It demonstrates how, on average, the level of one variable is related to the level of another variable across multiple participants over time (i.e., the entire ESM testing period), while accounting for the influence of other variables in the network. In all cases, thicker lines indicate stronger effects, green lines indicate positive effects, and red lines indicate negative effects. The absence of a line between two nodes indicates no statistically significant associations.

In temporal networks, two commonly calculated centrality indices are in-strength and out-strength (Bringmann et al., 2016). Out-strength indicates the summed absolute strengths of all outgoing edges, representing the extent to which a specific node predicts other nodes. In-strength, on the other hand, indicates the summed absolute strengths of all incoming edges, representing the extent to which the node is predicted by other nodes in the network. Given that our network contains negative edges, we calculated the in- and out-expected influence indices, rather than using the in- and out-strengths. Expected influence operate in a manner analogous to strength, but it takes into account the directional nature of the edges between nodes, i.e., it is not dependent on the absolute values of the edge weights. Nevertheless, despite the calculation of centrality indices, it has been advised that the centrality measures in temporal networks should be interpreted with particular caution (Bringmann et al., 2019).

Comparison of group networks

In order to estimate group differences in all three types of networks (LP vs. HP), permutation tests with 1000 permutations were performed, using the R-package *mnet* (Haslbeck, 2023; Haslbeck et al., 2023).

Results

General sample characteristics

The total sample characteristics are presented in Table 2, while Table 3 provides a breakdown of the demographic characteristics for the two subgroups (LP and HP). No significant differences were found between the groups in terms of gender, educational background, or premorbid IQ. Nevertheless, significant differences were observed in age, with LP participants being slightly older. The HP group reported a higher prevalence of psychiatric diagnoses and psychotropic medication use, as well as a greater number of diagnostic criteria met for various psychiatric disorders based on the MINI interview. Those in the HP group displayed heightened levels of baseline paranoia-like thoughts, as well as both positive and negative attenuated psychotic symptoms, as assessed by the CAARMS interview. Moreover, the groups differed significantly across nearly all ESM variables, with the exception of 'social isolation'. In the LP group, men reported higher levels of feelings of rejection, social stress, and lower social safety compared to women. Within the HP group, men exhibited significantly higher levels of paranoid thoughts than women. The mean completion rate for all ESM surveys was 95% (SD = 0.06; range 70-100%).

Temporal network estimation

The temporal network models consist of 8 nodes (variables) and a total of 64 edges, including 8 autocorrelation edges.

Figure 1a presents the estimated temporal network model for the total sample (n = 175). All 8 nodes showed a positive autocorrelation over time, with the strongest effects being observed for social safety, negative affect, and paranoid thoughts. A total of 14 non-zero edges were found (25% of the possible 56 edges, excluding autocorrelation edges), consisting of 7 positive and 7 negative edges. Paranoid thoughts significantly predicted negative affect, feelings of rejection, and negative body image over time, and were significantly predicted only by feelings of rejection and social safety. A feedback loop mechanism was observed, with feelings of rejection being a significant predictor of paranoid thoughts, which in turn predicted further feelings of rejection. Among all the edges in the network, the strongest were paranoid thoughts predicting feeling of being rejected and negative affect predicting important/stressful events. The nodes with the highest in-expected influence (i.e., those most strongly predicted by other nodes) were feeling rejected and negative affect. The nodes with the highest out-expected influence (i.e., those most strongly predicting other nodes) were paranoid thoughts and negative affect.

Figure 3a presents the estimated temporal network model for the LP group (n = 103). Similarly, all 8 nodes showed a positive autocorrelation over time, with the strongest effects being observed for social safety, negative affect and social stress. A total of 9 non-zero edges were found (16% of the possible 56 edges), consisting of 5 positive and 4 negative edges. Paranoid thoughts were significantly predicted by negative affect and misophonia symptoms, but paranoid thoughts themselves have not been found to significantly predict other variables. Among all the edges in the network, the strongest were negative body image predicting important/stressful events and negative affect predicting important/stressful events. The nodes with the highest in-expected influence were feeling rejected and body image. The nodes with the highest out-expected influence were body image and negative affect.

Finally, Figure 3b presents the estimated temporal network model for the HP group (n = 72). All 8 nodes showed a positive autocorrelation over time, with the strongest effects being observed for paranoid thoughts, social safety and negative affect. A total of 13 non-zero edges were found (23% of the possible 56 edges), consisting of 9 positive and 4 negative edges. Paranoid thoughts significantly predicted negative affect, feelings of rejection and social stress. In turn, paranoid thoughts were significantly predicted by feelings of rejection and social safety. Again, a feedback loop mechanism was observed, suggesting a bidirectional relationship between feelings of rejection and paranoid thoughts. Among all the edges in the network, the strongest were paranoid thoughts predicting feelings of being rejected and negative affect predicting social safety. The nodes with the highest in-expected influence were feelings of rejection and social stress. The nodes with the highest out-expected influence were paranoid thoughts and feelings of rejection.

The permutation tests revealed a significant difference between the LP and HP groups in 7 edges, including 2 autocorrelation and 5 temporal edges (see Figure 3c). The HP group showed a stronger autocorrelation effect for paranoid thoughts, and stronger temporal effects for feelings of rejection predicting negative affect, feelings of rejection predicting social stress, and negative affect predicting social safety. Conversely, the LP group demonstrated a stronger autocorrelation effect for social stress, and stronger temporal effect for important/stressful events predicting body image. The visual inspection indicated that the network model estimated for the HP group exhibited a greater number and stronger non-zero edges compared to the LP group. Additionally, the HP group temporal network model had no isolated nodes, in contrast to the LP group model, which showed an isolated node representing social safety.

Supplementary Table 2 (see Supplementary materials) shows the edge values estimated for the temporal network models for the total sample, as well as for the LP and HP groups separately. In- and out-expected influence values for all nodes within the temporal network models are presented in Supplementary Table 1 (see Supplementary materials), as well as on Figures 2a and 2b for the total sample, Figures 2c and 2d for the LP group, and Figures 2e and 2f for the HP group.

Contemporaneous network estimation

The contemporaneous network models consist of 8 nodes (variables) and a total of 28 edges.

Figure 1b presents the estimated contemporaneous network model for the total sample (n = 175). A total of 20 (71%) non-zero edges were identified, consisting of 10 positive and 10 negative edges. Paranoid thoughts turned out to be significantly and directly associated with 4 nodes – feelings of rejection, negative affect, social safety and misophonia symptoms. Among those, the strongest edges represented links between paranoid thoughts and feelings of rejection and negative affect.

Figure 4a presents the estimated contemporaneous network model for the LP group (n = 103). A total of 17 (61%) non-zero edges were identified, consisting of 9 positive and 8 negative edges. Paranoid thoughts were significantly and directly associated with 4 nodes – feelings of rejection, negative affect, social stress and social safety. Among those, the strongest edges represented links between paranoid thoughts and feelings of rejection and negative affect.

Figure 4c presents the estimated contemporaneous network model for the HP group (n = 72). A total of 18 (64%) non-zero edges were identified, consisting of 11 positive and 7 negative edges. Paranoid thoughts were significantly and directly associated with 4 nodes – feelings of rejection, negative affect, social safety and misophonia symptoms. Among those, the strongest edges represented links between paranoid thoughts and feelings of rejection and negative affect.

The permutation tests revealed a significant difference between the LP and HP groups in 4 edges. HP group showed a stronger association between negative affect and body image, and between social safety and misophonia symptoms, as compared to LP group. Conversely, LP group demonstrated a stronger association between feelings of rejection and misophonia symptoms. Negative affect and feeling rejected seemed to act as mediators in the relationships between paranoid thoughts and the remaining variables in both groups.

Supplementary Table 3 (see Supplementary materials) shows the edge values estimated for the contemporaneous network models for the total sample, as well as for the LP and HP groups separately.

Between-subject network estimation

The between-subject network models consist of 8 nodes (variables) and a total of 28 edges.

Figure 1c presents the estimated between-subject network model for the total sample (n = 175). A total of 14 (50%) non-zero edges were identified, consisting of 7 positive and 7 negative edges. Paranoid thoughts found to be significantly and directly associated with 3 nodes –

negative affect, feelings of rejection and social safety. Among those, the strongest edges represented links between paranoid thoughts and negative affect and feelings of rejection.

Figure 4b presents the estimated between-subject network model for the LP group (n = 103). A total of 12 (43%) non-zero edges were identified, consisting of 7 positive and 5 negative edges. Paranoid thoughts found to be significantly and directly associated with 4 nodes – negative affect, feelings of rejection, social safety and misophonia symptoms. Among those, the strongest edge represented a link between paranoid thoughts and misophonia symptoms.

Figure 4d presents the estimated between-subject network model for the HP group (n = 72). A total of 11 (39%) non-zero edges were identified, consisting of 7 positive and 4 negative edges. Paranoid thoughts found to be significantly and directly associated with 2 nodes – feelings of rejection and negative affect.

The permutation tests revealed a significant difference between the LP and HP groups in 3 edges. HP group showed a stronger association between feelings of rejection and body image, and between important/stressful event and social safety, as compared to LP group. Conversely, LP group demonstrated a stronger association between important/stressful event and social stress.

Supplementary Table 4 (see Supplementary materials) shows the edge values estimated for the between-subject network models for the total sample, as well as for the LP and HP groups separately.

Discussion

This study employed ESM data and temporal network analysis to examine the dynamic interactions among factors potentially contributing to a sense of vulnerability and their role in the development of paranoid thoughts.

The findings consistently indicate that social rejection, negative affect, and a perceived lack of social safety are central to paranoid thoughts. Among all the variables included in the network models, social rejection was the only one to exhibit a bidirectional relationship with paranoia. This suggests a two-way dynamic in which social rejection predicts an increase in paranoid thoughts, and conversely, paranoia predicts feelings of rejection. Whereas previous research has primarily focused on the unidirectional nature of this relationship (Lincoln et al., 2018; Stewart et al., 2017), our findings highlight the importance of recognizing social rejection not only as a predictor but also as a consequence of paranoia. This self-perpetuating cycle can exacerbate both experiences, increasing emotional distress and potentially contributing to the onset of more severe symptoms. It has been observed that individuals with heightened rejection sensitivity tend to respond to rejection with withdrawal and isolation, thus further reinforcing the vicious cycle (Weittenhiller & Kring, 2025). Furthermore, feelings of social rejection and negative affect were not only the key components of temporal network models, but their associations with paranoid thoughts were also among the strongest relationships in both contemporaneous and between-subject networks, indicating both their simultaneous co-occurrence and a broader correlation, independent of individual differences. It is important to consider when interpreting these results that fears of social rejection and associated negative emotions constitute a fundamental component of paranoid thought content (Freeman & Garety, 2006), which may contribute to a certain degree of overlap between these constructs.

Nevertheless, it remains evident that social rejection and negative affect play a central role in paranoid thinking.

The primary goal of this study was to examine the interplay between various predictors of paranoid thoughts, hypothesized to contribute to their development through a shared effect on vulnerability. Somewhat unexpectedly, the estimated network models revealed that, although paranoia was predicted by some variables, it was not the most strongly *predicted* variable among those included in the model. Instead, it emerged as the strongest *predictor* of other variables, both in the total sample and the high-paranoia subgroup. Specifically, paranoid thoughts significantly predicted negative affect, social rejection, and social stress, while they were themselves directly predicted by social rejection and a lack of social safety. The bidirectional relationship between paranoid thoughts and their psychosocial correlates has been demonstrated in previous studies (Bagrowska et al., 2023; Hajdúk et al., 2024; Moritz et al., 2017; Saarinen et al., 2022). Indeed, paranoid thoughts have been shown to arise from the interaction of multiple risk factors, including, among others, worry, sleep disturbances, stress, and depressive symptoms. However, they can also further intensify stress, worry, negative body image, and impair social functioning. Notably, alongside negative affect and a reduced sense of social safety, paranoid thoughts demonstrated the strongest autocorrelation over time, suggesting a degree of persistence - individuals experiencing high levels of paranoia at one point are likely to continue experiencing it in the future, potentially exacerbating other symptoms. On the other hand, the fact that paranoid thoughts were not directly predicted by many proposed variables in the estimated network models does not necessarily imply an absence of causal relationships. Instead, these associations may be mediated by other factors, such as social rejection or negative emotions, which exhibited the highest in-expected influence, meaning they were the most strongly predicted by other variables in the network. Social rejection emerged as a direct predictor of paranoid thoughts. Aligning with the approach adopted in this study, it may be suggested that stressful events, a negative self-view, or negative emotional states (e.g., misophonic reactions) may first impact rejection sensitivity and feelings of inferiority, which in turn foster paranoid thoughts. In contrast, in the control group, paranoia did not significantly predict any other variable in the network. Instead, negative emotions and negative body image had the strongest predictive effect. Since paranoia was not central to this group's psychological dynamics, other vulnerability-related factors, such as body image concerns, played a more prominent role. Over time, consistent with the network approach to psychopathology (Borsboom, 2017; Robinaugh et al., 2020), these factors may contribute to worsening symptoms and activate interconnected psychological processes, potentially leading to more severe consequences, such as the development of paranoid thoughts. However, it is important to acknowledge, that the LP group was characterized by a very low baseline level of paranoid thoughts, which was also reflected in the ESM measures. Consequently, these findings are likely attributable, in large part, to floor effects and the minimal variance in paranoia over time.

Although the results revealed several significant differences between the groups, they were relatively few and did not predominantly involve paranoid thoughts. However, a visual inspection of the estimated models indicated a greater number of significant and stronger associations between variables in the high-paranoia group. This suggests that as paranoid thoughts increase, it is not necessarily the structure of the network that changes, but rather the strength of the relationships between factors (i.e., network connectivity). These findings may be cautiously interpreted in the context of the complex dynamic systems theory (Wichers et al., 2016), which suggests that gradual changes within a system may eventually reach a critical threshold, triggering a sudden shift to more severe psychological states. On the other hand,

symptom deactivation – such as through psychological interventions - may have a cascading beneficial effect. For instance, previous research revealed that targeting worry (Freeman et al., 2015) and insomnia (Myers et al., 2011) significantly reduced paranoid thoughts. Therefore, recognizing early warning signals that destabilize the system could facilitate timely interventions that specifically address the most central symptoms, potentially preventing them from developing into full-blown disorders.

When interpreting the results of this study, it is important to consider its limitations. First, although the factors selected as predictors of a sense of vulnerability in the context of paranoid thoughts were based on mechanisms described in existing literature (Freeman & Garety, 2014), it remains unclear whether they fully capture the underlying processes. For instance, the model did not account for global self-esteem, which often represents the concerns about social evaluation. Importantly, the variables included in the model were intended to represent broader psychological constructs contributing to interpersonal vulnerability - such as fear of rejection, negative self-views, and perceptions of others and the world as threatening - rather than isolated factors. It is plausible that alternative variables could similarly capture the mechanisms described. For instance, misophonia was introduced as a novel element to reflect the perception of social threat. However, given the early stage of research on the link between misophonia and paranoia, further studies are needed to fully understand its role and implications. Additionally, while this study focused specifically on factors that may increase a sense of vulnerability, incorporating other potential triggers of paranoid thoughts, such as sleep disturbances or substance use, could provide further insights as the inclusion of additional factors might alter the network's dynamics. Future research should therefore examine vulnerability-related factors alongside a broader range of correlates of paranoid thoughts (Freeman & Loe, 2023) to determine whether the same variables remain central. Moreover, future studies could include additional groups along the paranoia continuum, such as individuals at ultra-high risk or patients with schizophrenia experiencing persecutory delusions. This would allow for the investigation of whether the structure of paranoid thoughts remains consistent while the strength of relationships between variables further intensifies in clinical populations. It is also possible that the absence of structural differences observed in this study resulted from the groups being too similar to detect meaningful distinctions. Notably, relative to the LP group, a significantly higher proportion of HP participants had a diagnosis of, or met MINI criteria for, comorbid disorders (e.g., depression). Therefore, the observed between-group differences should be interpreted with caution, as they may also be attributable to the effects of comorbidity, including its consequences, such as stigma, rather than paranoid thoughts per se. Another limitation is that some variables were measured using only a single item. In particular, the measures of misophonia symptoms and body image were employed for the first time in the ESM study protocols, underscoring the need for their validation in other samples. Furthermore, social isolation (and thus social stress and social safety) was assessed solely on the basis of the physical presence of others, without taking into account any remote or virtual social interactions, limiting our understanding of the full spectrum of participants' social experiences. Lastly, fluctuations in variables over time does not necessarily imply causality. Thus, integrating intensive longitudinal studies with experimental research is essential for examining causal relationships.

To conclude, this study is the first to use intensive longitudinal data to build a complex temporal network model of the mechanisms behind paranoia. The results identify social rejection and negative affect as the most central symptoms, each strongly influencing and being influenced by other variables, and underscore the bidirectional relationship between paranoia and social

rejection. Although the overall network structure remains stable, higher levels of paranoia intensify symptom interconnectedness, highlighting the need for early intervention.

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Author contributions

Paulina Bagrowska: Conceptualization; Methodology; Project administration; Investigation; Formal analysis; Visualization; Data curation; Writing - original draft. **Łukasz Gawęda:** Conceptualization; Methodology; Supervision; Funding acquisition; Writing - review & editing.

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Declaration of interests

The authors have declared that there are no conflicts of interest in relation to the subject of this study.

Data availability

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

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Table 1. ESM measures.

Domain / Factor		ESM measures / Items
Paranoia		The total ‘paranoia’ score was calculated as a mean of six items. The Likert scale was employed, with responses ranging from "1 – Definitely not" to "7 – Definitely yes". The items included: ‘Right now, I am distrustful’, ‘Right now, I think that others may want to intentionally hurt me’, ‘Right now, I think others are conspiring against me’, ‘Right now, I think bad things are being said about me behind my back’, ‘Right now, I think I might be being watched or followed’, ‘Right now, I think that people are deliberately being hostile towards me’. Higher scores indicated a higher level of paranoia-like thoughts (Between-subject Cronbach’s $\alpha = 0.93$).
Social functioning	Social isolation	The ‘social isolation’ score was calculated based on a question "Who are you with right now?". The respondents were asked to select one or more of the following options: 'alone', 'with family', 'with a partner', 'with friends', 'with strangers', or 'with coworkers'. Those who indicated that they were 'alone' were assigned a value of “1”, while all other responses were assigned a value of “2”, indicating that the participants were in the company of someone else.
	Social stress	The 'social stress' score was calculated based on ‘social isolation’ score. In the event that a participant indicated that they were currently alone, they were requested to indicate on a 1-7 Likert scale, with responses ranging from "1 – Definitely not" to "7 – Definitely yes", whether they ‘... would prefer to have a company right now’. In the event that a participant indicated that they were currently in the company of others, they were asked to indicate whether they '... would prefer to be alone right now'. Higher scores indicated a higher level of social stress.
	Social safety	The ‘social safety’ score was calculated based on ‘social isolation’ score. In the event that participants indicated that they were with other people right now, they were prompted to provide responses to two statements: 'Right now, I feel accepted by the people I am currently with', and 'Right now, I feel threatened by the people I am currently with'. The responses ranged from “1 – Definitely not” to “7 – Definitely yes”. Higher scores indicated a higher level of social safety [feeling threatened was reverse coded].
Social rejection		The feeling of being rejected by others was assessed with one item, i.e., ‘To what extent do you feel rejected or overlooked by other people right now?’. The Likert scale was employed, with responses ranging from “1 – Definitely not” to “7 – Definitely yes”. Higher scores indicated a higher level of feeling rejected by others.
Event		The ‘important event’ (assessing minor daily stress) score was calculated based on one question: ‘Think of the most important event that has happened since the last 'beep'. Rate how pleasant or unpleasant the event was.’ The Likert scale was employed, with responses ranging from “1 – Very unpleasant” to “7 – Very pleasant”. Higher scores indicated more pleasant event.
Negative affect		The total ‘negative affect’ score was calculated as the mean of five items. The Likert scale was employed, with responses ranging from “1 – Definitely not” to “7 – Definitely yes”. Participants were asked to report to what extent they felt given emotion at that moment. The items covered being ‘sad’, ‘worried’, ‘angry’, ‘ashamed’ and ‘irritated’. Higher scores indicated a higher level of negative affect (Between-subject Cronbach’s $\alpha = 0.9$).
Body image		Perceived body image was assessed with one item, i.e., ‘What feelings do you have about the appearance of your body right now?’. The Likert scale was employed, with responses ranging from “1 – Very unpleasant” to “7 – Very pleasant”. Higher scores indicated more positive body image.
Misophonia		Misophonia symptoms were assessed with one item, i.e., ‘Do you feel unpleasant emotions because of sounds made by other people (e.g. smacking, chewing, sniffling, breathing, or others) right now?’. The Likert scale was employed, with responses ranging from “1 – Definitely not” to “7 – Definitely yes”. Higher scores indicated more misophonia symptoms.

Table 2. Descriptive characteristics of the total sample (N = 175).

	N (%)		M (SD)	Range
Gender		Age	29.16 (6.79)	18-40
Female	102 (58.3)	PART (premorbid IQ)	48.04 (2.73)	29-50
Male	73 (41.7)	R-GPTS	14.27 (18.97)	0-70
Education		Reference	7.75 (9.68)	0-32
Primary	0 (0)	Persecution	6.51 (9.69)	0-40
Vocational	2 (1.1)	CAARMS positive (past year)		
Secondary	81 (46.3)	Score	2.66 (3.28)	0-15
Higher	92 (52.6)	Frequency	2.93 (3.18)	0-19
Professional Situation		CAARMS positive (past month)		
Employed	135 (77.1)	Score	2.25 (3.05)	0-14
Unemployed	5 (2.9)	Frequency	2.63 (3.58)	0-19
Retired	2 (1.1)	CAARMS negative (past year)		
Student	59 (33.7)	Score	1.56 (2.02)	0-10
Psychiatric disorders (lifetime)	35 (20.0)	Frequency	2.21 (2.99)	0-14
Medication use (lifetime)	52 (29.7)	CAARMS negative (past month)		
Medication use currently	18 (10.3)	Score	1.33 (2.04)	0-10
MINI		Frequency	1.93 (2.92)	0-13
MDD	54 (30.9)	ESM		
Suicidality	20 (11.4)	Paranoia	1.56 (1.1)	1-7
Social anxiety	9 (5.1)	Social isolation	1.60 (0.5)	1-2
AUD	8 (4.6)	% time alone	38.8	
SUD	3 (1.7)	% time with others	57.1	
Bulimia nervosa	6 (3.4)	Social stress	2.64 (1.9)	1-7
BDD	11 (6.3)	Social safety	6.19 (1.1)	1-7
		Social rejection	1.74 (1.4)	1-7
		Event	4.70 (1.6)	1-7
		Negative affect	2.01 (1.4)	1-7
		Body image	4.70 (1.6)	1-7
		Misophonia symptoms	1.53 (1.2)	1-7

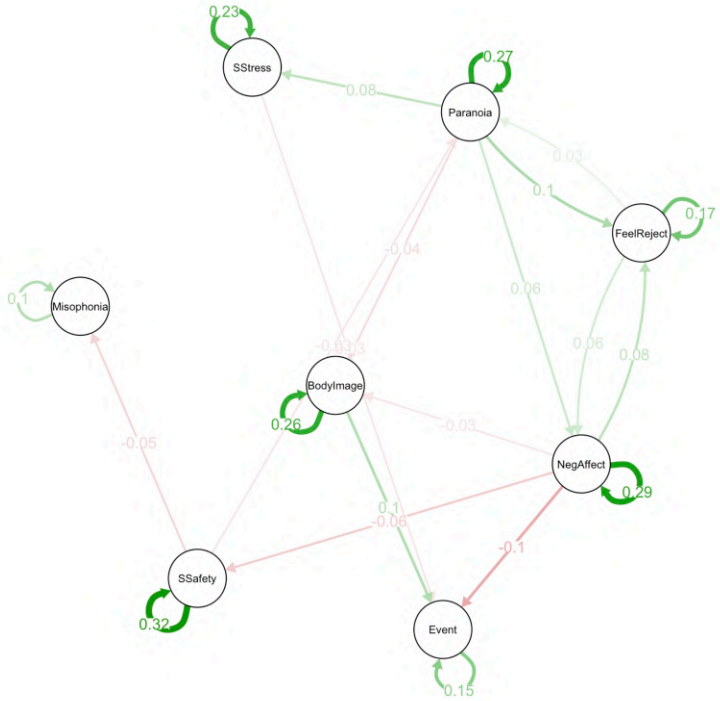
Note: MINI - The Mini International Neuropsychiatric Interview (criteria met for a given diagnosis at any point throughout the participant's lifetime)*; MDD – Major Depressive Disorder; AUD – Alcohol Use Disorder; SUD – Substance Use Disorder; BDD – Body Dysmorphic Disorder; PART - Polish Adult Reading Test (premorbid IQ); R-GPTS - The Revised Green et al. Paranoid Thoughts Scale; CAARMS - The Comprehensive Assessment of At-Risk Mental States; ESM – Experience Sampling Method*

Table 3. Descriptive characteristics of the subgroups.

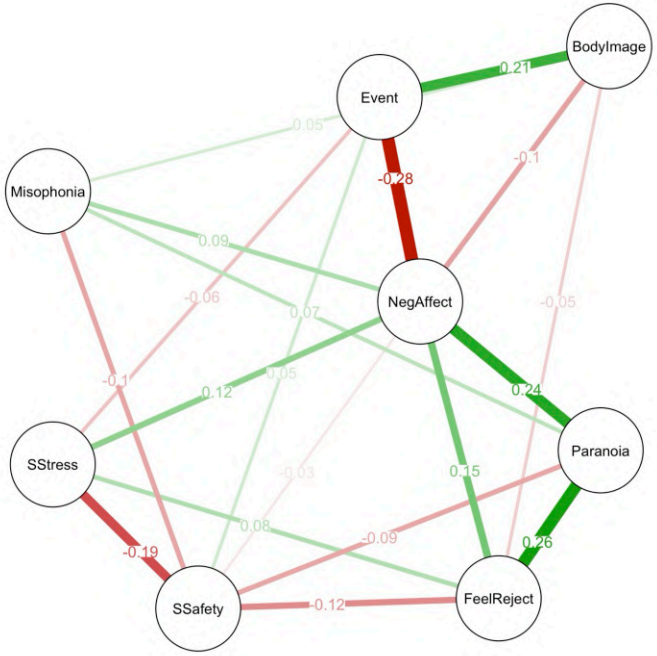
Measures	HP (N = 72)	LP (N = 103)	Group comparison
		N (%)	
Gender (females)	48 (66.7%)	54 (52.4%)	n.s.
Education (higher)	33 (45.8%)	59 (57.3%)	n.s.
Professional situtation (employed)	49 (68.1%)	86 (83.5%)	$p < 0.05$; $\chi 2 = 4.3$
Psychiatric disorders (lifetime diagnosis)	25 (34.7%)	10 (9.7%)	$p < 0.001$, $d = 0.7$
Medication use (lifetime use)	37 (51.4%)	15 (14.6%)	$p < 0.001$, $d = 0.9$
Medication use currently (current use)	18 (25.0%)	0	$p < 0.001$, $d = 1.1$
MINI (diagnostic criteria met)			
MDD	42 (58.3%)	12 (11.7%)	$p < 0.01$, $d = -0.4$
Suicidality	18 (25.0%)	2 (1.9%)	$p < 0.001$, $d = -0.8$
Social anxiety	9 (12.5%)	0	$p < 0.001$, $d = -0.6$
AUD	5 (6.9%)	3 (2.9%)	n.s.
SUD	12 (16.7%)	17 (16.5%)	n.s.
Bulimia nervosa	6 (8.3%)	0	$p < 0.01$, $d = -0.5$
BDD	10 (13.9%)	1 (1.0%)	$p < 0.01$, $d = -0.5$
		M (SD)	
Age	27.4 (6.8)	30.4 (6.5)	$p < 0.01$, $d = 0.5$
PART (premorbid IQ)	48.2 (2.1)	47.9 (3.1)	n.s.
R-GPTS	33.0 (16.4)	1.2 (2.4)	$p < 0.001$, $d = -3.0$
Reference	17.6 (7.6)	0.9 (1.6)	$p < 0.001$, $d = -3.3$
Persecution	15.4 (9.6)	0.3 (1.1)	$p < 0.001$, $d = -2.4$
CAARMS positive (past year)			
Score	5.5 (3.1)	0.8 (1.3)	$p < 0.001$, $d = -2.1$
Frequency	5.8 (3.6)	0.9 (1.7)	$p < 0.001$, $d = -1.5$
CAARMS positive (past month)			
Score	4.8 (3.2)	0.5 (1.0)	$p < 0.001$, $d = -2.0$
Frequency	5.6 (3.8)	0.6 (1.4)	$p < 0.001$, $d = -1.9$
CAARMS negative (past year)			
Score	3.1 (2.3)	0.5 (0.8)	$p < 0.001$, $d = -1.6$
Frequency	4.2 (3.3)	0.8 (1.8)	$p < 0.001$, $d = -1.4$
CAARMS negative (past month)			
Score	3.0 (2.3)	0.2 (0.5)	$p < 0.001$, $d = -1.8$
Frequency	4.2 (3.3)	0.4 (0.9)	$p < 0.001$, $d = -1.7$
ESM			
Paranoia	2.26 (1.4)	1.08 (0.3)	$p < 0.05$, $d = -1.2$
Social isolation	1.60 (0.5)	1.61 (0.5)	n.s.
% time alone	39.1	38.6	n.s.
% time with others	57.0	57.1	n.s.
Social stress	3.04 (2.0)	2.37 (1.7)	$p < 0.05$, $d = -0.4$
Social safety	5.70 (1.2)	6.54 (0.7)	$p < 0.05$, $d = 0.8$
Social rejection	2.44 (1.7)	1.24 (0.8)	$p < 0.05$, $d = -0.9$
Event	4.30 (1.7)	4.98 (1.4)	$p < 0.05$, $d = 0.4$
Negative affect	2.86 (1.6)	1.41 (0.8)	$p < 0.05$, $d = -1.2$
Body image	3.93 (1.5)	5.24 (1.4)	$p < 0.05$, $d = 0.9$
Misophonia symptoms	1.97 (1.5)	1.22 (0.8)	$p < 0.05$, $d = -0.6$

Note: MINI - The Mini International Neuropsychiatric Interview (criteria met for a given diagnosis at any point throughout the participant's lifetime)*; MDD – Major Depressive Disorder; AUD – Alcohol Use Disorder; SUD – Substance Use Disorder; BDD – Body Dysmorphic Disorder; PART - Polish Adult Reading Test (premorbid IQ); R-GPTS - The Revised Green et al. Paranoid Thoughts Scale; CAARMS - The Comprehensive Assessment of At-Risk Mental States; ESM – Experience Sampling Method*

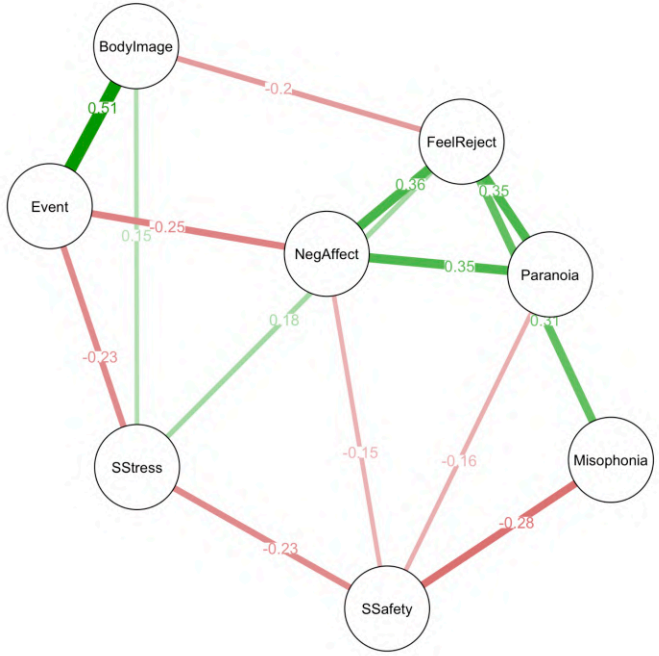
a) Temporal network



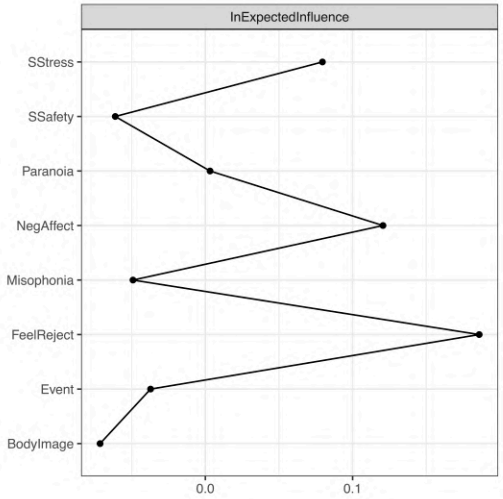
b) Contemporaneous network



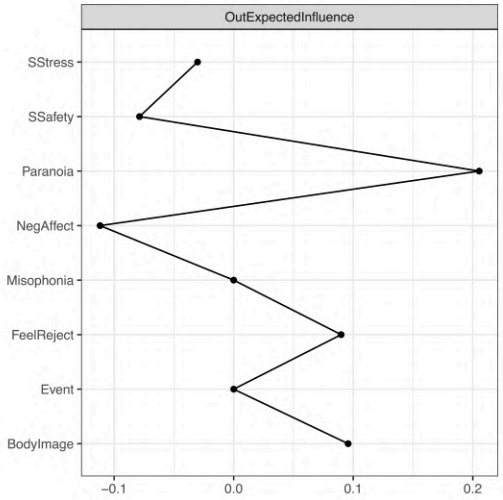
c) Between-subject network



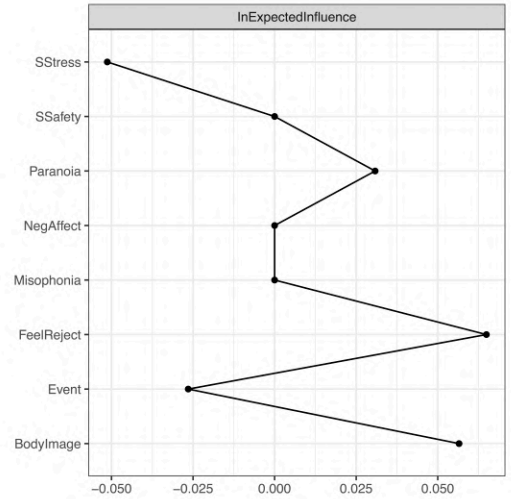
a) Total sample – In Expected Influence



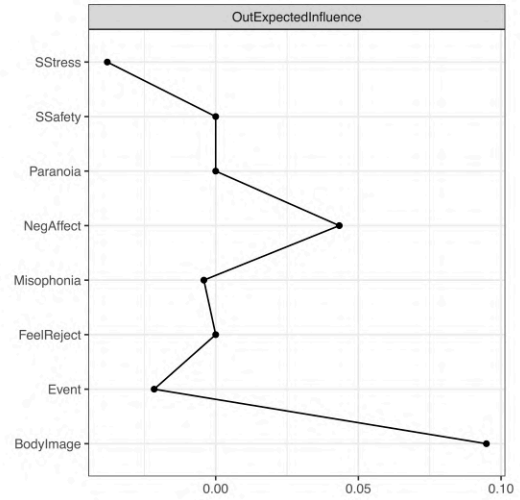
b) Total sample – Out Expected Influence



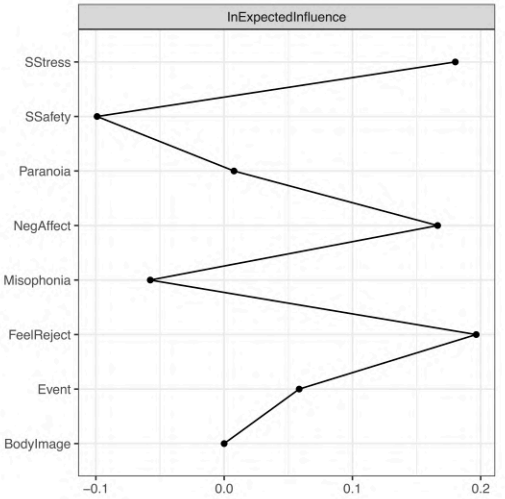
c) LP group – In Expected Influence



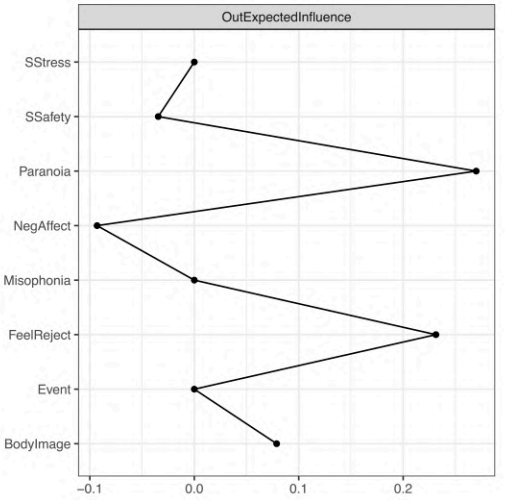
d) LP group – Out Expected Influence



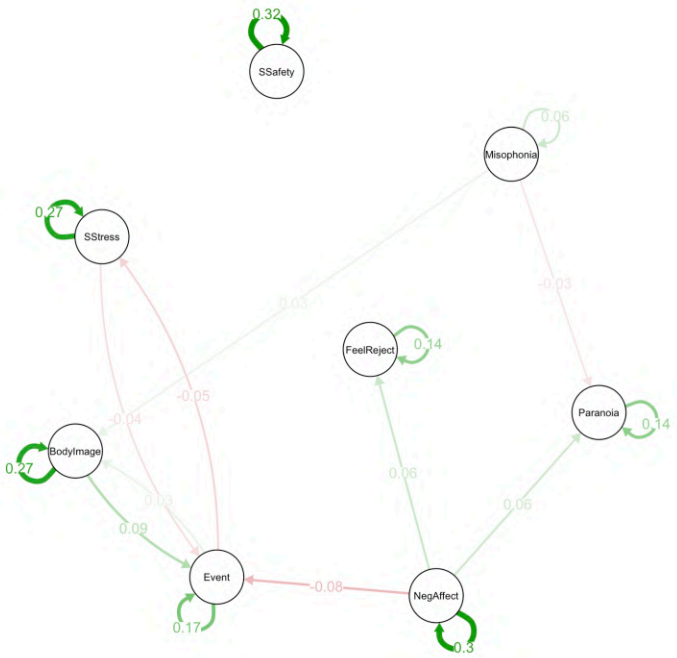
e) HP group – In Expected Influence



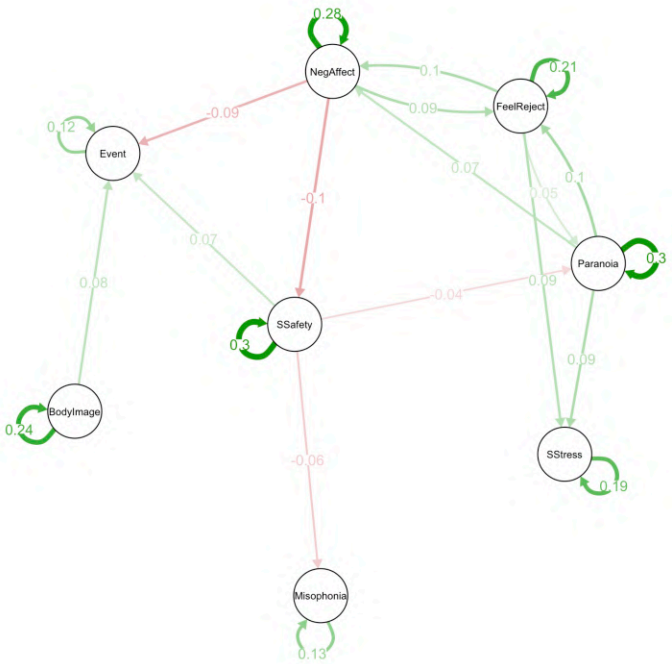
f) HP group – Out Expected Influence



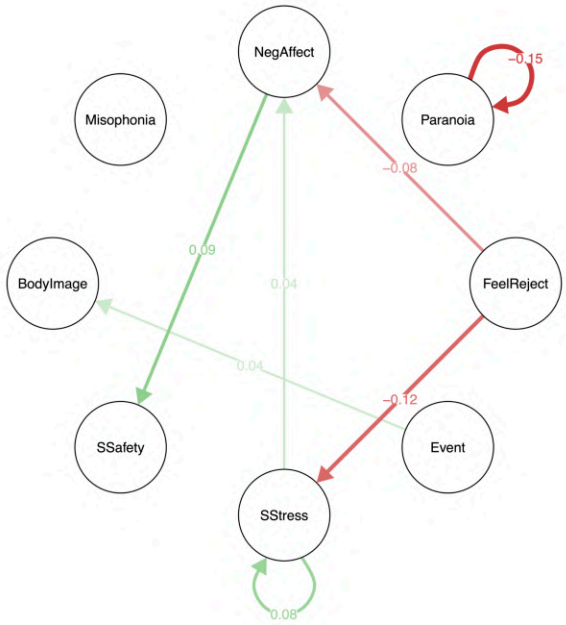
a) LP group – Temporal network



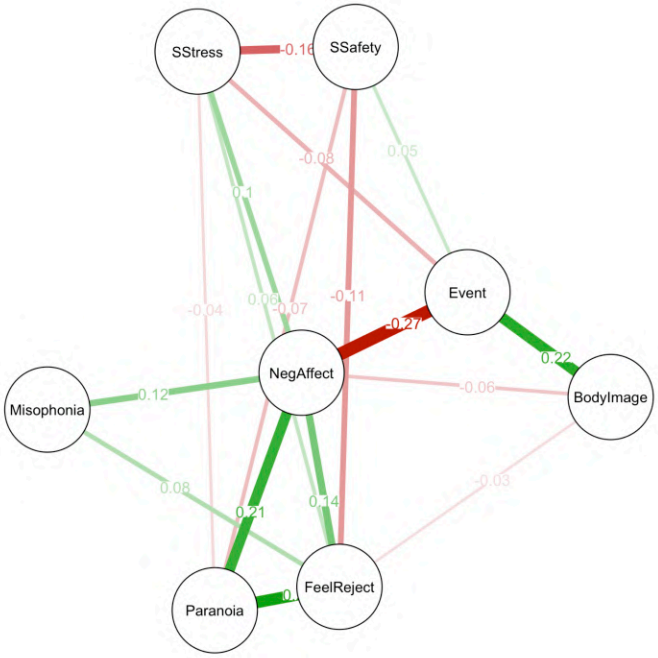
b) HP group – Temporal network



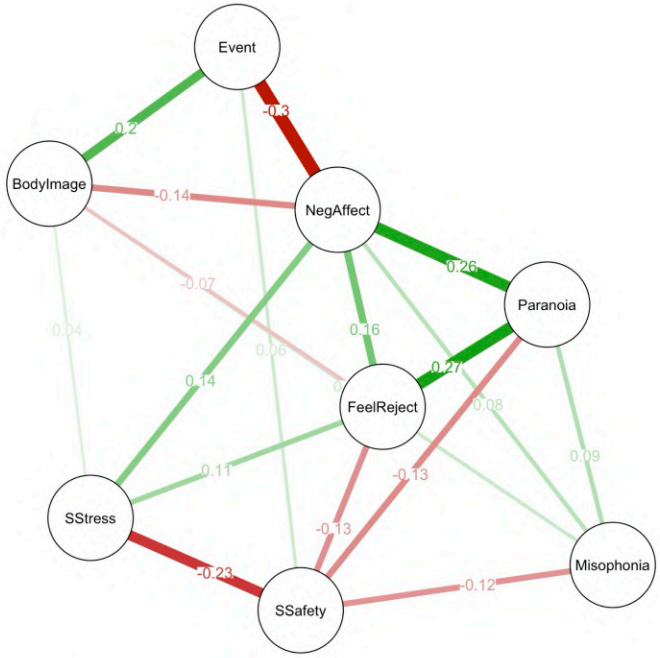
c) Significant differences between groups



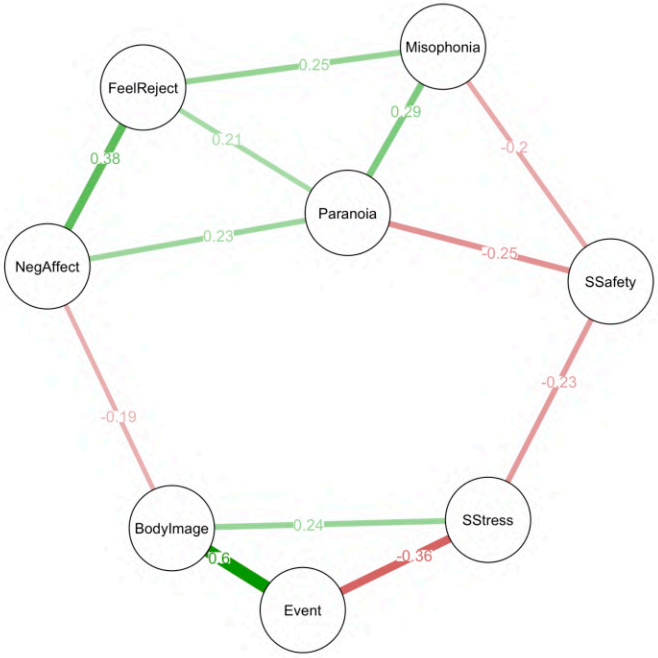
a) LP group – Contemporaneous network



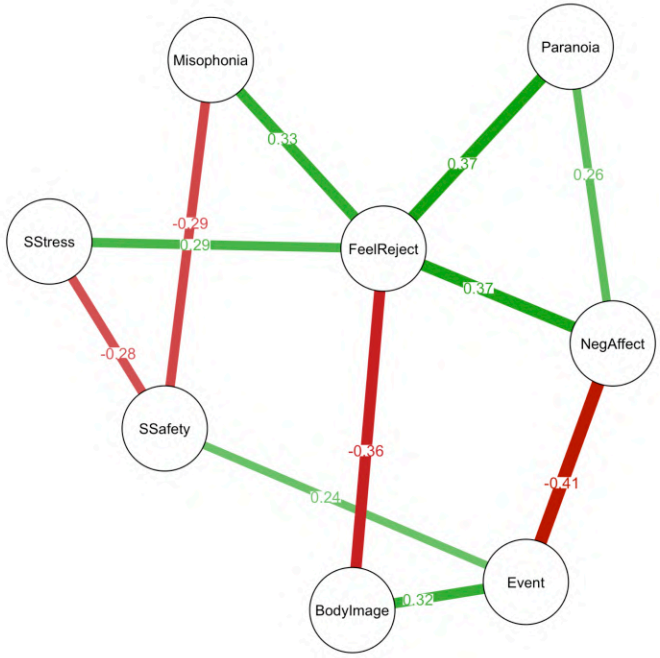
c) HP group – Contemporaneous network



b) LP group – Between-subject network



d) HP group – Between-subject network



Supplementary Materials

'Rejection makes me suspicious': Complex temporal network approach to the dynamics of real-time paranoid thoughts and psychological vulnerability

Supplementary Table 1. In- and out-expected influence values.

Node	Total sample		LP		HP	
	In-expected influence	*Out-expected influence*	*In-expected influence*	*Out-expected influence*	*In-expected influence*	*Out-expected influence*
Negative affect	0.121	-0.112	0.00	0.043	0.166	-0.093
Paranoia	0.003	0.205	0.031	0.00	0.008	0.270
Social rejection	0.186	0.09	0.065	0.00	0.196	0.231
Event	-0.037	0.00	-0.026	-0.022	0.058	0.00
Social stress	0.079	-0.03	-0.051	-0.038	0.180	0.00
Social safety	-0.061	-0.079	0.00	0.00	-0.10	-0.035
Body image	-0.071	0.096	0.057	0.095	0.00	0.079
Misophonia	-0.049	0.00	0.00	-0.004	-0.058	0.00

Supplementary Table 2. Edge weights in the temporal network models and path differences between groups.

Path		Total sample	LP	HP	Difference *(LP-HP)*	*p*
From $_{(t-1)}$	**To** $_{(t)}$					
NegAffect	NegAffect	**0.29**	**0.30**	**0.28**	0.02	0.633
NegAffect	Paranoia	0.02	**0.06**	0.01	0.05	0.261
NegAffect	FeelReject	**0.08**	**0.07**	**0.09**	-0.03	0.513
NegAffect	Event	**-0.10**	**-0.08**	**-0.09**	0.01	0.909
NegAffect	SStress	0.04	0.02	0.04	-0.02	0.673
NegAffect	SSafety	**-0.06**	-0.01	**-0.10**	**0.09**	**0.045**
NegAffect	BodyImage	**-0.03**	-0.02	-0.04	0.03	0.385
NegAffect	Misophonia	-0.01	-0.01	-0.01	0.00	0.988
Paranoia	NegAffect	**0.06**	0.04	**0.07**	-0.04	0.4
Paranoia	Paranoia	**0.27**	**0.14**	**0.30**	**-0.15**	**0.021**
Paranoia	FeelReject	**0.10**	0.03	**0.10**	-0.08	0.225
Paranoia	Event	-0.02	0.01	-0.04	0.06	0.401
Paranoia	SStress	**0.08**	0.03	**0.10**	-0.07	0.248
Paranoia	SSafety	-0.03	-0.02	-0.04	0.01	0.784
Paranoia	BodyImage	**-0.04**	-0.01	-0.06	0.05	0.336
Paranoia	Misophonia	0.06	0.03	0.06	-0.03	0.65
FeelReject	NegAffect	**0.06**	0.01	**0.10**	**-0.08**	**0.025**
FeelReject	Paranoia	**0.03**	0.02	**0.05**	-0.03	0.357
FeelReject	FeelReject	**0.17**	**0.14**	**0.21**	-0.07	0.166
FeelReject	Event	-0.01	0.02	-0.04	0.05	0.283
FeelReject	SStress	0.03	-0.03	**0.09**	**-0.12**	**0.003**
FeelReject	SSafety	0.01	0.02	-0.01	0.02	0.557
FeelReject	BodyImage	-0.01	-0.02	0.01	-0.03	0.294
FeelReject	Misophonia	0.03	0.00	0.05	-0.05	0.303
Event	NegAffect	-0.01	0.00	-0.01	0.01	0.689
Event	Paranoia	0.00	0.02	0.00	0.02	0.279
Event	FeelReject	0.01	0.00	0.01	-0.01	0.658
Event	Event	**0.15**	**0.17**	**0.12**	0.05	0.172
Event	SStress	**-0.03**	**-0.05**	0.00	-0.05	0.111
Event	SSafety	-0.01	0.01	-0.02	0.03	0.148
Event	BodyImage	0.01	**0.03**	-0.01	**0.04**	**0.033**
Event	Misophonia	0.01	-0.01	0.02	-0.04	0.315
SStress	NegAffect	0.00	0.02	-0.02	**0.04**	**0.026**
SStress	Paranoia	0.00	-0.01	0.00	-0.01	0.535
SStress	FeelReject	0.00	0.01	-0.01	0.01	0.563
SStress	Event	**-0.03**	**-0.04**	-0.01	-0.02	0.337

SStress	SStress	**0.23**	**0.27**	**0.19**	**0.08**	**0.035**
SStress	SSafety	0.01	0.01	0.01	0.00	0.923
SStress	BodyImage	0.00	-0.01	0.01	-0.02	0.26
SStress	Misophonia	-0.01	0.00	-0.02	0.02	0.449
SSafety	NegAffect	-0.01	0.01	-0.02	0.03	0.224
SSafety	Paranoia	**-0.03**	-0.02	**-0.04**	0.02	0.416
SSafety	FeelReject	-0.02	-0.01	-0.03	0.02	0.551
SSafety	Event	0.03	0.00	**0.07**	-0.07	0.078
SSafety	SStress	-0.01	0.00	-0.03	0.02	0.621
SSafety	SSafety	**0.32**	**0.32**	**0.30**	0.03	0.501
SSafety	BodyImage	0.01	-0.01	0.03	-0.05	0.055
SSafety	Misophonia	**-0.05**	-0.04	**-0.06**	0.02	0.598
BodyImage	NegAffect	**-0.03**	-0.03	-0.03	0.01	0.849
BodyImage	Paranoia	-0.02	-0.03	-0.03	-0.01	0.802
BodyImage	FeelReject	-0.01	-0.02	0.00	-0.02	0.507
BodyImage	Event	**0.10**	**0.10**	**0.08**	0.01	0.793
BodyImage	SStress	0.00	0.01	0.01	0.00	0.996
BodyImage	SSafety	0.03	-0.01	0.04	-0.05	0.125
BodyImage	BodyImage	**0.26**	**0.27**	**0.24**	0.03	0.47
BodyImage	Misophonia	-0.02	-0.03	0.00	-0.03	0.407
Misophonia	NegAffect	0.00	-0.01	0.01	-0.02	0.513
Misophonia	Paranoia	-0.01	**-0.03**	0.00	-0.03	0.324
Misophonia	FeelReject	-0.01	-0.02	0.00	-0.02	0.525
Misophonia	Event	0.01	-0.01	0.03	-0.04	0.304
Misophonia	SStress	0.01	0.02	0.00	0.02	0.55
Misophonia	SSafety	0.00	-0.03	0.01	-0.04	0.268
Misophonia	BodyImage	0.02	**0.03**	0.02	0.00	0.883
Misophonia	Misophonia	**0.10**	**0.06**	**0.13**	-0.06	0.122

Supplementary Table 3. Edge weights in the contemporaneous network models and path differences between groups.

Path		Total sample	LP	HP	Difference *(LP-HP)*	*p*
NegAffect	Paranoia	**0.24**	**0.21**	**0.26**	0.05	0.21
NegAffect	FeelReject	**0.15**	**0.14**	**0.16**	-0.03	0.537
NegAffect	Event	**-0.28**	**-0.27**	**-0.30**	0.05	0.238
NegAffect	SStress	**0.12**	**0.10**	**0.14**	-0.05	0.161
NegAffect	SSafety	**-0.03**	-0.02	-0.04	0.01	0.8
NegAffect	BodyImage	**-0.1**	**-0.06**	**-0.14**	**0.07**	**0.046**
NegAffect	Misophonia	**0.09**	**0.12**	**0.08**	0.04	0.325
Paranoia	FeelReject	**0.26**	**0.25**	**0.27**	-0.01	0.826
Paranoia	Event	-0.01	-0.01	-0.02	0.01	0.868
Paranoia	SStress	-0.01	-0.04	0.01	-0.05	0.157
Paranoia	SSafety	**-0.09**	**-0.07**	**-0.13**	0.08	0.066
Paranoia	BodyImage	0.02	0.01	0.02	-0.01	0.751
Paranoia	Misophonia	**0.07**	0.02	**0.09**	-0.07	0.108
FeelReject	Event	-0.01	0.00	0.00	0.00	0.943
FeelReject	SStress	**0.09**	**0.06**	**0.11**	-0.06	0.145
FeelReject	SSafety	**-0.12**	**-0.11**	**-0.13**	0.03	0.48
FeelReject	BodyImage	**-0.05**	**-0.03**	**-0.07**	0.03	0.365
FeelReject	Misophonia	0.02	**0.08**	0.00	**0.09**	**0.033**
Event	SStress	**-0.06**	**-0.08**	-0.04	-0.04	0.222
Event	SSafety	**0.05**	**0.06**	**0.06**	0.00	0.958
Event	BodyImage	**0.21**	**0.22**	**0.20**	0.03	0.47
Event	Misophonia	-0.01	-0.02	-0.01	-0.01	0.849
SStress	SSafety	**-0.20**	**-0.16**	**-0.23**	0.07	0.08
SStress	BodyImage	0.01	-0.03	**0.04**	**-0.07**	**0.022**
SStress	Misophonia	0.03	0.03	0.02	0.01	0.821
SSafety	BodyImage	0.02	0.01	0.03	-0.03	0.446
SSafety	Misophonia	**-0.10**	-0.05	**-0.12**	**0.08**	**0.026**
BodyImage	Misophonia	**0.05**	0.02	**0.06**	-0.04	0.286

Supplementary Table 4. Edge weights in the between-subject network models and path differences between groups.

Path		Total sample	LP	HP	Difference *(LP-HP)*	*p*
NegAffect	Paranoia	**0.35**	**0.23**	**0.26**	-0.04	0.867
NegAffect	FeelReject	**0.36**	**0.38**	**0.37**	0.01	0.966
NegAffect	Event	**-0.25**	-0.06	**-0.41**	0.37	0.149
NegAffect	SStress	0.08	0.15	0.10	0.06	0.766
NegAffect	SSafety	**-0.15**	0.00	-0.12	0.12	0.565
NegAffect	BodyImage	0.02	**-0.19**	0.20	-0.39	0.052
NegAffect	Misophonia	0.06	-0.01	0.03	-0.05	0.798
Paranoia	FeelReject	**0.35**	**0.21**	**0.37**	-0.19	0.429
Paranoia	Event	-0.03	0.08	-0.13	0.23	0.105
Paranoia	SStress	-0.12	0.05	-0.19	0.25	0.15
Paranoia	SSafety	**-0.16**	**-0.25**	-0.09	-0.18	0.357
Paranoia	BodyImage	0.03	0.10	0.07	0.04	0.8
Paranoia	Misophonia	-0.02	**0.30**	-0.06	0.34	0.141
FeelReject	Event	0.09	-0.17	0.14	-0.30	0.084
FeelReject	SStress	**0.18**	-0.01	**0.29**	-0.29	0.082
FeelReject	SSafety	-0.03	-0.03	0.04	-0.06	0.819
FeelReject	BodyImage	**-0.20**	0.08	**-0.36**	**0.47**	**0.016**
FeelReject	Misophonia	**0.31**	**0.25**	**0.33**	-0.08	0.753
Event	SStress	**-0.23**	**-0.36**	0.00	**-0.36**	**0.03**
Event	SSafety	0.03	-0.07	**0.24**	**-0.32**	**0.043**
Event	BodyImage	**0.51**	**0.60**	**0.32**	0.26	0.082
Event	Misophonia	0.06	-0.01	0.13	-0.16	0.362
SStress	SSafety	**-0.23**	**-0.23**	**-0.28**	0.03	0.837
SStress	BodyImage	**0.15**	**0.24**	0.10	0.16	0.384
SStress	Misophonia	-0.03	-0.07	-0.07	-0.01	0.971
SSafety	BodyImage	0.10	0.05	0.21	-0.16	0.323
SSafety	Misophonia	**-0.28**	**-0.20**	**-0.30**	0.10	0.595
BodyImage	Misophonia	-0.01	-0.12	0.12	-0.25	0.155