

Investigating the Role of Psychogenic Shivers in Mental Health

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Abstract

The presence of shivering and psychogenic shivering in mental health was measured using a compiled database including the DSM-5 and a large body of existing assessment tools and technology. We found results for chills, tremors, and temperature. None of the other shiver-related terms (N=9) yielded any results, which suggests that the role of psychogenic shivering in mental health has been largely understudied by physicians and psychiatrists. Based on the results and the data extracted from a complete database of the literature devoted to psychogenic shivers in cognitive neuroscience, we outline the importance of psychogenic shivering in the assessment of mental health in a clinical setting. We discuss how the tools introduced in this article could be developed further to gather new clinical data about both shivers and health.

Keywords : mental health; chills; psychiatry; shivers; psychogenic; chills; database; DSM-5

1. Introduction

This article aims to investigate the extent to which psychogenic shivering has been used in psychiatry as either a symptom, a sign, a behavior or a question. The universal, conscious and measurable emotion of psychogenic shivers (shivers of psychological origins rather than thermoregulatory) has attracted significant scientific attention in recent years (figure 1). It is indeed puzzling that a basic survival mechanism such as shivering should be triggered by situations such as music listening (Blood & Zatorre, 2001), apparently unrelated to its primary vital function (i.e., maintaining the body's temperature stable), while still involving neural correlates such as the amigaloid complex and midbrain dopaminergic neurons (Blood & Zatorre, 2001). Several theoretical explanation have been proposed (Schoeller et al., 2018). Experimental studies in cognitive neuroscience suggest that the brain reward system

may be involved in psychogenic shivering (Blood & Zatorre, 2001; Zald & Pardo, 2002; Salimpoor, 2009; Schoeller, 2016). Current research in engineering and affective computing aims at developing clinical tools using psychogenic shivers (PS) and associated emotions to improve mental health (review in Schoeller et al., in press). Researchers have repeatedly suggested various medical uses for PS stimuli in clinical settings (e.g., Sachs, 2018; Benedek and Kaernbach, 2011, Konečni et al., 2007, Schoeller and Perlovsky, 2016, Sumpf et al., 2015). However, the PS literature contains no direct reference to psychiatry or mental health if one excludes psychogenic fevers (see relevant section) and a few technological devices, which claim to be built for mood disorders (review in Schoeller, in press). To investigate the role of PS in mental health

further, we chose to search for direct and indirect references to PS and associated activity and mechanisms (skin activity, thermoregulatory functions, etc.) in mental health questionnaires and assessment tools.

Number of publications x Year

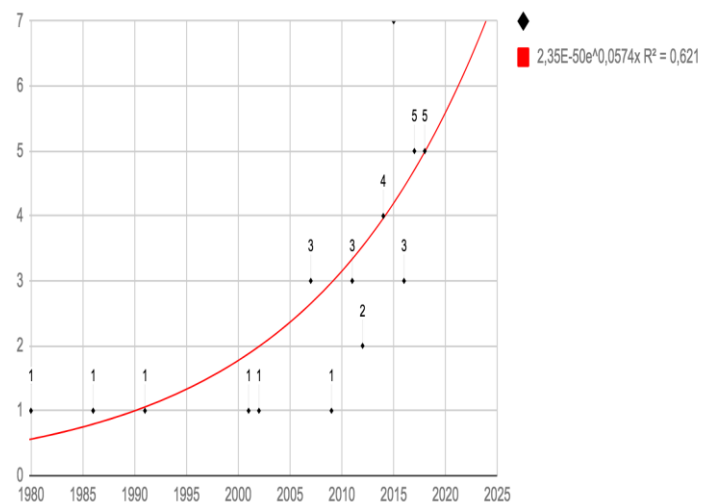


Figure 1 : Number of publications related to psychogenic shivers per year (N total = 38). List of publications accessible at “MindDB.org”.

To explore whether PS has ever been represented as a sign, symptom or in any other category related to disorders, we searched through the DSM-5 (A.P.A., 2013), as well as several mental health questionnaires (see full description in the methods section) used in mental health large scale studies.

2. Methods

Three major sources were used for this study: the DSM-5 (A.P.A., 2013), a rich set of questionnaires (N=94) used in two large scale studies aiming to collect clinical data, and a compiled database of all existing literature on PS (see appendix). This represents a total of 3944 questions from 94 questionnaires across 20 domains. These domains are Aggression and Oppositionality, Anxiety, Attention Problems and Hyperactivity, Cognitive and Executive Function, Depression and Mood, Personality Traits, Psychotic and Atypical Behavior, Risk Taking and Impulsive Behavior, Social Interaction, Somatic Complaints, Substance Use and Addictive Behavior, Trauma, Distress Tolerance, Autism Spectrum, General Impairment, Eating Behavior, Sleep, Social functioning, Tics.

2.1. Sources DSM-5

We used two main sources for this study : the DSM-5 and various Mental Health Questionnaires from two large scale studies. The Diagnostic and Statistical Manual of Mental Disorders (A.P.A., 2013) is used by psychiatrists in the diagnosis of mental health disorders in the United States, and elsewhere. It provides a taxonomy for mental health disorders, listing signs and symptoms, diagnostic categories, diagnostic criteria and specifiers, severity, and other information associated with each disorder. The Healthy Brain Network (HBN) and the Nathan Kline Institute Rockland Sample (NKI-RS) are two large scale studies aimed at collecting neuroimaging and clinical data (N=10000 children and adolescents in the case of HBN). The studies release a comprehensive dataset, containing de-identified anonymized data on brain imaging, genetics, psychiatric, behavioral and cognitive information for the scientific community. We selected the list of mental health and behavioural assessments used in the Healthy Brain Network Study and the NKI Rockland Sample Study, as this represents a rich set (N=94) of commonly used mental health assessments where 35 questionnaires were unique to the HBN, 40 questionnaires were unique to the NKI-RS, and 19 questionnaires that appeared in both.

General Information	Behavioral Measures
Demographics CMI Symptom Checker Edinburgh Handedness Inventory Intake Interview Physical Activity Questionnaire for Older Children (PAQ-C) (8-14) Physical Activity Questionnaire for Adolescents (PAQ-A) (14-19) Barratt Simplified Measure of Social Status Financial Support Questionnaire Medical History Questionnaire – Family Pregnancy and Birth Questionnaire	Child Behavior Checklist (CBCL) (5-17) Youth Self Report (YSR) (11-18) Adult Self Report (ASR) (18+) Screen for Child Anxiety Related Disorders (SCARED) – Parent Report & Self Report (8-17) State Trait Anxiety Inventory (STAI) (18+) – Self Report Mood & Feelings Questionnaire (MFQ) – Parent Report & Self Report (8+) Affective Reactivity Index – (ARI-S) Self Report Columbia Suicide Severity Rating Scale (C-SSRS) – Self Report (7+) Extended Strengths and Weaknesses Assessment of Normal Behavior (E-SWAN) (5-17) Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Scale (SWAN) (6+) Conners ADHD Rating Scales Self Report Short Form (Conners) (8+) Repetitive Behavior Scale (RBS) (5-21) Autism Spectrum Screening Questionnaire (ASSQ) (5+) Social Communication Questionnaire (SCQ) (5+) Social Responsiveness Scale-2 (SRS-2) (5+) Strengths and Difficulties Questionnaire (5+) The Columbia Impairment Scale (CIS) Parent and self report (5+) Social Aptitudes Scale (SAS) (5+) WHO Disability Assessment Schedule (WHODAS) Parent and Self-Report (5+) Food Frequency Questionnaire (FFQ) (5-17) Positive and Negative Affect Scale (PANAS) (5-21) Inventory of Callous-Unemotional Traits - Parent Report (5+)
Physical Measures	Family Structure, Stress and Trauma
FITNESSGRAM (Pushups, Curl-ups, Trunk-Lift, Sit and Reach, Grip Strength) Cardiovascular Fitness Test Vitals (Heart Rate, Blood pressure) Measurements (Height/weight, Waist circumference, Bio-impedance) Blood Draw Saliva and Hair Samples Baby Tooth Collection Urine Sample (Toxicology screen, Pregnancy test: 11+) Ishihara Color Vision Test Electroencephalography (EEG)/Eye Tracking Magnetic Resonance Imaging (MRI) Peterson Puberty Scale (6-17) Sleep Disturbance Scale for Children (SDSC) (6-15)	Family History-Research Diagnostic Criteria (FH-RDC) Parental Stress Index IV (PSI-IV) Alabama Parenting Questionnaire – Self Report (APQ) (6-18) Alabama Parenting Questionnaire – Parent Report (APQ) (6-18) Children’s Perception of Interparental Conflict (CPIC) (8-18) Distress Tolerance Index – Parental Self Report Children’s Coping Strategies Checklist – Revised (CCSC) (8-18) UCLA Trauma Reactivity Sale for DSM-V (UCLA) (5-18) Negative Life Events Scale (NLES) – Self Report (8-18) Negative Life Events Scale Parent Report (8-18) Adverse Childhood Experiences Scale (ACES) (18+)
Cognition and Language Tasks	Substance Use and Addiction Measures
NIH Toolbox Tasks: Flanker, Card Sort and Processing Speed Temporal Discounting Task Adaptive Cognitive Evaluation (ACE) (5-12) Rapid Automatic Naming & Rapid Alternating Stimulus Test (RAN/RAS) (5) Wechsler Intelligence Scale for Children-V (WISC-V) (6-17) Wechsler Adult Intelligence Scale-IV (WAIS-IV): (17+) Wechsler Abbreviated Scale of Intelligence-II (WASI): (17+) Wechsler Individual Achievement Test – III (WIAT) Differential Ability Scales – II (DAS) (5 or IQ below 70) Clinical Evaluation of Language Fundamentals – 5th Edition (CELF-5) Goldman Fristoe Test of Articulation – II (GFTA) Comprehensive Test of Phonological Processing – II (CTOPP) Test of Word Reading Efficiency (TOWRE) (6+) Expressive Vocabulary Test (EVT) (when indicated) Peabody Picture Vocabulary Test (PPVT) (when indicated)	Fagerstrom Test for Nicotine Dependence (FTND) (18+) Alcohol Use Disorders Identification Test (AUDIT) (11+) Modified Fagerstrom Tolerance Questionnaire- Adolescents (FTQA) (13-17) European School Survey Project on Alcohol & Other Drugs (ESPAD) (10+) Internet Addiction Test (IAT) Parent-Child Internet Addiction Test (PCIAT) Yale Food Addiction Scale (YFAS) and YFAS-Child
Diagnostic Assessments	Longitudinal Follow Up Measures
Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS) Child and Adolescent Psychiatric Assessment Schedule (Cha-PAS) (when indicated) Vineland Adaptive Behavior Scale – Parent/Caregiver Rating Form (when indicated) Yale Global Tic Severity Scale (YGTSS) (when indicated, 6+) Yale-Brown Obsessive Compulsive Scale (Y-BOCS) (when indicated, 18+) Children’s Yale-Brown Obsessive Compulsive Scale (when indicated, 6-18)	Youth Services Survey (YSS) & Services Assessment for Children and Adolescents Follow Up: CBCL Follow Up: Columbia Impairment Scale Parent and Self Report Follow Up: WHODAS Parent and Self Report

Figure 2 : List of assessments used in the HBN study. We excluded assessments that were classified under ‘General Information’, ‘Physical Measures’, ‘Cognitive tasks’, and ‘Diagnostic Interviews’.

2.2. Lexical analysis

Based on a lexical analysis of the existing literature (see appendix) and qualitative descriptions from three separate studies (Schoeller &

Perlovsky, 2016; Schoeller et al., 2018; Schoeller & Eskinazi, 2018), we queried the sources for psychogenic shivers as well as 12 related terms: chills, tremors, temperature, shivers, goosebumps, piloerection, frisson, feeling of cold, cutis anserina, gooseflesh, horripilation, and thrills.

General Information:	Behavioral Measures Continued:
<ul style="list-style-type: none"> · Demographic Questionnaire (DEMOS) · Edinburgh Handedness Questionnaire (EHQ) · Hollingshead Four-Factor Index of Socioeconomic Status: (SES-Adult, Child) · Medical History Questionnaire-Adult, Child · Medical Conditions · Medication Form · PhenX (13+) · Sex Role Identity Scale (13+) · Sexual History (13+) · Sexual Orientation Scale (13+) 	<ul style="list-style-type: none"> · The Child Behavior Checklist – Parent Report Form (CBCL), Youth Self-Report (YSR)(11-17), Adult Self Report (ASR)(18-59), Older Adult Self Report (OASR)(60+) · The Children’s Behavior Questionnaire (Very Short Form) – (CBQ-VSF), The Early Adolescent Temperament Questionnaire (Revised) Parent Report (EATQ-R)(9-15), Adult Temperament Questionnaire (ATQ)(16+) · The Children’s Depression Inventory 2 (CDI-2)(7-17), Beck Depression Inventory (BDI - II)(18-64), Geriatric Depression Scale (GDS)(65-85) · The Comprehensive Addiction Severity Index for Adolescents (CASI-A)(11+) · The Children’s Eating Behavior Questionnaire (CEBQ)(6-11), Tanner Three-Factor Eating (TFEQ)(12+) · The Cognitive Failures Questionnaire (CFQ) (6+) · The Cambridge-Hopkins Restless Legs Syndrome (Version 2) (CHRLS)(13+) · The Conners ADHD Rating Scale 3 - Parent Short Form (6+) · The Conners ADHD Rating Scale 3 - Youth Short Form (8-17) · The Domain-Specific Risk-Taking Scale (DOSPERT)(18+) · Dot Probe · Eating Disorder Examination Questionnaire (EDEQ)(13+) · Fagerstrom Test for Nicotine Dependence (FTND)(18+) · Modified Fagerstrom Tolerance Questionnaire – Adolescents (FTQA)(13-17) · Inventory of Callous-Unemotional Traits – Parent Version (ICUP); Youth Self-Report (ICUY)(13+) · International Physical Activity Questionnaire (IPAQ)(15+) · Interpersonal Reactivity Index (IRI)(13+) · Multidimensional Anxiety Scale for Children (MASC)(8-17) · MRI Mind Wandering Questionnaire (MRIQ)(13+) · NEO Five Factor Inventory (NEO-FFI-3)(12+) · NIDA Quick Screen V1.01(11+) · The 21-Item Peters et al. Delusions Inventory (PDI-21)(13+) · Pittsburgh Sleep Quality Index (PSQI)(13+) · Positive and Negative Affect Schedule-Short Form (PANAS-S) · Repetitive Behaviors Scale – Revised (RBS-R)(6-17) · Satisfaction Survey (Adult, Child)(12+) · Social Networking Questionnaire (22-85) · Social Responsiveness Scale (SRS) - Parent Report (6-17) · State Trait Anxiety Inventory (STAI)(18+) · Strengths and Weaknesses of Attention-Deficit/Hyperactivity Disorder Symptoms and Normal Behavior Scale (SWAN)(6-17) · Trauma Symptom Checklist for Adults (TSC-40)(18+), Trauma Symptom Checklist for Children (TSC-C)(8-17) · UCLA PTSD Reaction Index (UCLA-Parent) (UCLA-Youth)(8+) · UPPS-P Impulsive Behavior Scale (18+) · Yale Global Tic Severity Scale (YGTSS)(6+) · Youth Risk Behavior Surveillance System YRBSS-MS (11-13), YRBSS-HS (14-21)
Physical Measures:	
<ul style="list-style-type: none"> · Actigraphy · Bike Test · Blood Collection: chemistry profile, lipid profile, thyroid profile, CBC with differential, lead level, genetics, pregnancy test · Urine Sample (Drug Test)(11+) · Height/Weight · Hip/Waist Measurements · Ishihara’s Test for Color Deficiency · Grip Strength · The Grooved Pegboard Test · MRI Mock Scan · MRI Scan · MRI Incidental Finding Report · Tanner Staging (TANN)(6-17) · Vital Signs 	
Cognitive Tasks:	
<ul style="list-style-type: none"> · Attention Network Test (ANT) (Child, 6-12)(Adult, 12+) · Penn’s Computerized Neurocognitive Battery (CNB) · Delis-Kaplan Executive Functioning System (D-KEFS)(8+) · Wechsler Abbreviated Scale of Intelligence (WASHI) · Wechsler Individual Achievement Test – Second Edition Abbreviated (WIAT-IIA) · Digit Span (Forward and Backward)(Child, 6-17)(Adult, 18+) · Rey Auditory Verbal Learning Test (RAVLT)(8+) 	
Diagnostic Assessments:	
<ul style="list-style-type: none"> · Adult ADHD Clinical Diagnostic Scale (ACDS)(18+) · Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS-PL)(6-17) · Structured Clinical Interview for DSM-IV – Non Patient Edition (SCID-NP)(18+) 	
Behavioral Measures:	Behavioral Measures, Real-Time Neurofeedback Only
<ul style="list-style-type: none"> · The High-Functioning Autism Spectrum Screening Questionnaire (ASSQ)(6-17) · Behavior Assessment System for Children, 2nd Edition – Parent Rating Scale (BASC -2, 6-11), (BASC - 2, 12-17) · The Behavioral Indicator of Resiliency to Distress (BIRD) · Yale-Brown Obsessive Compulsive Scale (CY-BOCS, 6-17), (Y-BOCS, 18+) · Conners Adult ADHD Rating Scale – Self Report, Short Version (CAARS-S.S)(18+) 	<ul style="list-style-type: none"> · Affect Intensity Measure (AIM) · Ruminative Response Scale (RRS) · Rapid Visual Information Processing Assessment (RVIP) · Penn State Worry Questionnaire (PSWQ) · Perseverative Thinking Questionnaire (PTQ) · Emotional Regulation Questionnaire (ERQ) · Short Imaginal Process Inventory (SIPI) · Meditation Questionnaire

Figure 3: List of assessments used in the NKI study. We excluded assessments that were classified under ‘General Information’, ‘Physical Measures’, ‘Cognitive tasks’, and ‘Diagnostic Interviews’.

3. Results

3.1. Results from DSM-5 analysis

We first searched for PS-related terms in the DSM-5 (table 1). We found mentions of chills (N=3), temperature (N=4), and tremors (N=7), piloerection (N=1), and Opioid Disorders (N=1) as signs for a total of 16 disorders. No results (N=0) were found for the terms shivers, goosebumps, frisson, feeling of cold, cutis anserina, gooseflesh, horripilation, or thrills.

Chills was found as a for two disorders category: Panic Disorders and Substance Abuse Related Disorders, namely cannabis withdrawal and stimulus intoxication.

Concerning tremors, we found Medication-Induced Postural Tremor, a disorder under the categories “medication induced movement disorders and other adverse effects of medication”. Tremors also appeared as an associated feature supporting diagnosis for disorders like childhood fluency disorder (i.e., stuttering) and anxiety disorders. Tremors were also associated with neurological disorders such as conversion disorders, and as a diagnostic marker for substance abuse related disorders, as a sign for withdrawal. Finally, tremors are a sign of neurocognitive disorders like Parkinsons Disease.

Temperature was mentioned under sensory-related responses and activities in autism. The exact symptom is : Hyper- or hypo-reactivity to

sensory input or unusual interest in sensory aspects of the environment (e.g., apparent indifference to pain/temperature, adverse response to specific sounds or textures, excessive smelling or touching of objects, visual fascination with lights or movement). Temperature was also mentioned under sensory characteristics of qualities of food, in the context of eating-related disorders. Temperature was mentioned under sleep-wake related disorders as a factor that influences sleep. We omitted the above two search results since it related to the temperature of something external rather than internal.

Temperature was also related with withdrawal symptoms in substance related and addictive disorders, in that temperature regulation was observed for up to 6 months after opioid detoxification. Likewise, withdrawal symptoms were characterized by increases in body temperature along with other signs. Elevations in temperature reflected by breakdown of thermoregulation were associated with the diagnosis of neuroleptic malignant syndrome.

In the DSM-5, piloerection was found under diagnostic criteria of Opioid Withdrawal (292.0; (F11.23)) as one of the sign or symptoms that may be experienced. It was also mentioned that piloerection was more associated with severe forms of withdrawal. Thrill seeking is also mentioned as a consequence of reckless behaviour under post traumatic stress disorders. Thrill seeking is also mentioned as a personality feature associated with diagnostic specifiers of, or co-occurring with conduct disorders.

Terms	Disorder	Symptom/Sign
Chills	Panic disorders	“Chills or heat sensations.”
	Cannabis withdrawal	“At least one of the following physical symptoms causing significant discomfort: abdominal pain, shakiness/tremors, sweating, fever, chills, or headache.”
	Stimulus intoxication	Perspiration or chills
Temperature	Autism Spectrum Disorders	“Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment (e.g., apparent indifference to pain/temperature,...”
	Opioid use Disorder	“Subtle changes in cortisol secretion patterns and body temperature regulation have been observed for up to 6 months following opioid detoxification.”
	Sedative, Hypnotic, or Anxiolytic Withdrawal	“This withdrawal syndrome is characterized by two or more symptoms (similar to alcohol withdrawal) that include autonomic hyperactivity (e.g., increases in heart rate, respiratory rate, blood pressure, or body temperature, ”
	Neuroleptic Malignant Syndrome	“Extreme elevations in temperature, reflecting a breakdown in central thermoregulation, are more likely to support the diagnosis of neuroleptic malignant syndrome. ”
Tremors	Medication-Induced Postural Tremor	
	Childhood fluency disorder (stuttering)	associated feature supporting diagnosis
	Anxiety disorders	associated feature supporting diagnosis
	Parkinson’s disease	symptom/sign
	Conversion Disorder	“With abnormal movement (e.g., tremor, dystonic movement, myoclonus, gait disorder)”

	Alcohol use Disorder and Alcohol withdrawal	“Other physical signs of heavy drinking and alcohol withdrawal include tremor,”
	Substance abuse disorders related (eg., Sedative, Hypnotic, or Anxiolytic Withdrawal, inhalant intoxication)	
Piloerection	Opioid Withdrawal (292.0; (F11.23)) as one of the sign or	Piloerection is seen under diagnostic criteria of Opioid Withdrawal (292.0; (F11.23)) as one of the sign or symptoms that may be experienced. It was also mentioned that piloerection was more associated with severe forms of withdrawal
Thrill seeking	Post Traumatic Stress Disorders. Conduct Disorders	Thrill seeking is mentioned as a consequence of reckless behaviour under post traumatic stress disorders. Thrill seeking is also mentioned as a personality feature associated with diagnostic specifiers of, or co-occurring with conduct disorders

Table 1 : Disorders and signs mentioning PS-related terms in the DSM-5.

3.2. Results from MH questionnaires analysis

We search for PS-related queries in MH questionnaires (results in table 2). Out of 100 mental health questionnaires taken from the list of assessments in the Healthy Brain Network Study and the NKI Rockland Sample Study. We found results for the terms “chills” (N=2) and “tremors” (N=4). These were all the mentions of PS-related terms in the 100 questionnaires examined. Likewise, we found no results for the terms shivers, goosebumps, frisson, feeling of cold, cutis anserina, gooseflesh, horripilation, or thrills.

Two questions directly related to chills were found. One question in the NEO Five Factor Inventory - 3 and one from the E-SWAN study. The question from the NEO relates to aesthetics and poetry whereas the E-

SWAN study maps directly to the symptom “chills and heat sensations” from panic disorders.

We then searched for tremors. “Intensity of Tremors” was a question in the SNAP-4 Rating Scale With Side Effects - Parent questionnaire. Intensity of “Hands trembling” and “Shaky / unsteady” were questions in the Beck Anxiety Inventory. “My hands shake” was a question in the Multidimensional Anxiety Scale for Children 2nd Edition (MASC 2)-Self Report and the corresponding question (“My child gets shaky or jittery”) in the parent report. “He/she child gets shaky” and “I get shaky” were questions found in the Screen for Anxiety Related Disorders Parent and Self Reports respectively.

Terms	Questionnaire	Query
Chills	NEO Five Factor Inventory - 3	“Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement.”
	E-SWAN	Maintain feelings of a comfortable body temperature”
Tremors	SNAP-4 Rating Scale With Side Effects - Parent questionnaire	“Intensity of Tremors”
	Beck Anxiety Inventory	Hands trembling” and “Shaky / unsteady”
	Multidimensional Anxiety Scale for Children 2nd Edition (MASC 2)-Self Report	“My hands shake”
	“He/she child gets shaky” and “I get shaky”	Screen for Anxiety Related Disorders Parent and Self Reports respectively.

Table 2 : Questionnaires and queries involving PS-related questions in the questionnaires.

3.3. Signs indirectly related to shivers associated to mental disorders

While conducting the search, we identified several signs related to shivers, which are associated to mental disorders. For example, cutaneous reactions such as skin picking, hallucinations, ants crawling under skin (formication), are found in Depressive Disorder; skin picking is associated with Obsessive Compulsive Disorder, and skin sensations are absent in Conversion Disorder. Among the low-risk phenotypes are the acute alcohol-related skin flush (seen most prominently in Asians) This sign is found under Alcohol Use Disorder.

Dyskinesia Distortion of voluntary movements involves involuntary muscle activity in a similar fashion to the activity of skeletal muscles during psychogenic shivers.

There was an association between hallucination and psychogenic shivers, such as Tactile A Hallucination involving the perception of being touched or of something being under one's skin. The most common tactile hallucinations are the sensation of electric shocks and formication (the sensation of something creeping or crawling on pr under the skin).

A number of neurobiological markers related to psychogenic shivers (e.g., lower heart rate and skin conductance reactivity; reduced basal cortisol

reactivity; abnormalities in the pre-frontal cortex and amygdala) have been associated with oppositional defiant disorder.

3.4. Searching for psychiatry terms in chills papers

We searched for the terms “mental health”, “disorder” and “psychiatry” in all the articles related to psychogenic shivers (N=39) and found no mention of these terms in the majority of them (N=30). We excluded results where there was a mention of PS terms in the citations, or author information. Several researchers belonging to departments of psychiatry or mental health authored papers on psychogenic fevers, but did not address psychiatry or mental health in their articles specifically. We also note that in some articles (N=4), recruited participants were either excluded for, or did not have a mental health disorder.

Direct and relevant results were found in 3 articles. In (Sumpf et al., 2015), under the future perspectives section, it was suggested that the findings could help biofeedback therapies used to treat depression or schizoid personality disorder. In (Oka, 2015), psychogenic fevers were claimed to be observed in anxiety, mood and borderline personality disorders. The third article (Neidlinger et al., 2017) involved a wearable that was developed for mood and affective disorders.

Indirect references (mentions of the search terms that are not in the context of, or do not relate directly to psychogenic shivers) were found in 3 articles. For example, music was mentioned to benefit mental well-being.

4. Discussion

We searched for PS-related terms in mental health assessment tools to identify whether this emotion has ever been used in psychiatry as a diagnosis. We found chills, tremors and temperature, piloerection and thrill seeking used in the DSM-5 as a sign for a total of 14 disorders. These were represented over many psychiatric disorders, including PTSD, Panic Disorders, Autism Spectrum Disorder, and Substance Use Disorders. Chills and tremors were also found present in questions of 6 questionnaires commonly used in mental health and in two existing database collected as part of large scale studies on brain imaging, genetics, psychiatric, behavioral and cognitive information. In this section, we first discuss these results and their utility in? psychiatry and behavioral science generally. We then discuss how the existing database can be improved to allow participation from physicians, researchers, patients and the scientific community at large.

We found chills to be related to panic disorders. This is intriguing and should be examined further in relation to negative PS (Halpern et al., 1986 ; Zald & Pardo, 2002). It is known generally that the relation between temperature and stress is quite old and present even in reptiles (Oka, 2015), a phenomenon described as stress-induced hyperthermia or emotional fever. One plausible explanation for this phenomenon and which should be examined further through physiological studies is the role of the immune system as a general response for stressful situations. Panic disorder chills and negative psychogenic shivers would be instances of emotional fever (Briese, 1991).

Shivering is a muscle tremor, we therefore searched for questions related to tremors in mental health to identify plausible match. We found tremors to be used both as a sign and a symptom. The relation between muscle tremors, anxiety and stress remain to be elucidated. One interesting line of study concerns shivering related to epilepsy, which is a comorbidity for some mental health disorders.

DSM-5 queries related thermal irregularity to opioid detoxification. The anti-opioid Naloxone was found to inhibit positive PS (Goldstein, 1980). Although that latter study’s sample size is limited and this study has never been replicated, this is of interest when considering the fact that opioid antagonist such as naloxone often play a role in the formation of new

memories and learning (Schoeller, 2015). In general, this demands that the relation between opioid agonists and antagonists, thermal irregularity, stress and learning be clarified.

5. Conclusion

As expected, shivering, chills and other thermoregulatory functions sometimes appear in mental health questionnaires. This is true in particular for the NEO Five Factor Inventory. In fact, PS was suggested by the creator of this inventory (McCrae, 2007) to be a universal marker for one of the five personality traits (i.e., Openness to Experience). Given the current interest in the possible role of music for the cognitive system (Matasaka & Perlovsky, 2013 ; Zatorre, 2003), it is regretting that music is not included in this specific question and we strongly suggest improving this questionnaire to include broader forms of cultural artifacts.

At a broader level, the present study suggests a possibility to centralize all existing data in psychiatry using the questionnaires identified and involving the PS-related query, to perform a meta analysis on a very large amount of data to identify patterns of behavior related to PS (i.e., clinical populations who experience PS at a very high rate or conversely). Given the benefits of PS in neurotypical populations and their relevance for scientific research, this promising discovery holds great promises for the future development of psychiatry.

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7. Contributions

AK created and queried the mental health database. FS and AK created and queried the PS database. AK wrote the results section. AK and FS wrote the rest of the manuscript.

8. Conflict of interest

The authors declare no conflict of interest.

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