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Neuroception of psychological safety scale (NPSS): validation with a UK based adult community sample

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ABSTRACT

Background: Psychological safety plays a vital role in rest, recovery, and fostering social connections. However, a history of trauma can predispose individuals to perceive heightened levels of threat and danger. Research suggests that a lack of psychological safety may be a defining biopsychosocial characteristic of posttraumatic stress disorder (PTSD). Persistent feelings of threat and danger are associated with a lack of psychological safety and may be predictive of PTSD. Our pioneering work reported on the development of the neuroception of psychological safety (NPSS), rooted in polyvagal theory, and consists of social engagement, compassion, and body sensations dimensions. Understanding more about the dimensionality of the NPSS and further establishing its psychometric properties was our priority.

Objective: Our current research aimed to validate and test the reliability and dimensionality of the NPSS, using a large community sample (*n* = 2035) of adult residents in the UK

Method: We examined the internal and test-retest reliability, convergent, discriminant, and concurrent validity as well as dimensionality of the NPSS.

Results: The 3-factor structure of the NPSS was replicated with regard to the absolute fit indices. Internal consistencies ranged from acceptable to excellent across the NPSS's subscales. Providing support for the validity of the NPSS, scores were predictably related to team psychological safety, wellbeing, post-traumatic stress, burnout, body awareness, and personality, with effect sizes typically in the high to medium range. Scores on the NPSS were found to show good test-retest reliability.

Conclusions: This study demonstrates the validity, reliability and dimensionality of the NPSS with an adult sample. Further work is underway to support and enhance understandings of psychological safety with diverse clinical populations impacted by trauma. The NPSS has applicability across a range of health and social care contexts, such as shaping new approaches to evaluating trauma treatments and enhancing trauma informed care.

HIGHLIGHTS
- Psychological safety is important for rest, restoration and social bonding, yet a traumatic history can bias individuals towards sensing threat and danger.
- The current study establishes the validity, reliability and dimensionality the Neuroception of Psychological Safety Scale, rooted in polyvagal theory, that we developed to measure feelings of psychological safety.
- The scale has wide applicability for both clinical and research purposes, for example, to track feelings of psychological safety during trauma therapy.

Escala de neurocepción de seguridad psicológica (ENSP): validación con una muestra comunitaria de adultos del Reino Unido

Antecedentes: La seguridad psicológica desempeña un papel fundamental en el descanso, la recuperación y el fomento de las conexiones sociales. Sin embargo, una historia de trauma puede predisponer a las personas a percibir mayores niveles de amenaza y peligro. Las investigaciones sugieren que la falta de seguridad psicológica puede ser una característica biopsicosocial definitoria del trastorno de estrés postraumático (TEPT). Los sentimientos persistentes de amenaza y peligro se asocian con falta de seguridad psicológica y pueden predecir el TEPT. Nuestro trabajo pionero informó sobre el desarrollo de la Escala de Neurocepción de Seguridad Psicológica (ENSP), basada en la teoría polivagal, y que consta de las dimensiones de compromiso social, compasión y sensaciones corporales. Nuestra prioridad fue comprender mejor la dimensionalidad de la ENSP y establecer con mayor profundidad sus propiedades psicométricas.

Objetivo: Nuestra investigación actual tuvo como objetivo validar y evaluar la fiabilidad y dimensionalidad de la ENSP, utilizando una amplia muestra comunitaria (*n* = 2.035) de residentes adultos en el Reino Unido.

Método: Se examinaron la fiabilidad interna y de test-retest, la validez convergente, discriminante y concurrente, así como la dimensionalidad de la ENSP.

Resultados: Se replicó la estructura de tres factores de la ENSP en cuanto a los índices de ajuste absoluto. La consistencia interna varió de aceptable a excelente en todas las subescalas de la

ENSP. Como respaldo a la validez de la ENSP, las puntuaciones se relacionaron de forma predecible con la seguridad psicológica del equipo, el bienestar, el estrés postraumático, el burn out, la conciencia corporal y la personalidad, con tamaños de efecto típicamente entre altos y medios. Se observó buena fiabilidad test-retest en las puntuaciones de la ENSP.
Conclusiones: Este estudio demuestra la validez, la fiabilidad y la dimensionalidad de la ENSP con una muestra de adultos. Se está trabajando para apoyar y mejorar la comprensión de la seguridad psicológica en diversas poblaciones clínicas afectadas por trauma. La ENSP tiene aplicabilidad en diversos contextos de salud y asistencia social, como para desarrollar nuevos enfoques para la evaluación de tratamientos de trauma y mejorar el cuidado informado en trauma.

1. Introduction

The importance of psychological safety in understanding and treating trauma related conditions and promoting trauma informed care is widely recognised by contemporary trauma researchers, clinicians and theorists (Edmondson & Bransby, 2023; Gilbert, 2024; Herman, 2015; Kestly et al., 2024; Levine, 1997; Ogden et al., 2006; Porges, 2024; Rothschild, 2000; Spinazzola et al., 2018). There has been extensive research on psychological safety as a key cognitive state and interpersonal construct that allows for learning processes to occur to improve both work and team-based outcomes (Edmondson, 1999; Edmondson & Bransby, 2023; Edmondson & Lei, 2014; Frazier et al., 2017; Newman et al., 2017). Recently, psychological safety has also been increasingly examined and measured in relation to individual health and clinical outcomes (Morton et al., 2024; Poli & Miccoli, 2024). The state of psychological safety has been found to be more than simply the removal of threat; feeling psychologically safe is a distinct state important for rest, restoration, and connection (Goetz et al., 2010; Porges, 1998; 2005). As social beings, we crave signals of psychological safety through intonation of the voice, facial expressions, eye gaze, body language, trust signals, and reciprocity (Porges, 2011). Perceived threats are often interpersonal, while safety with other people is communicated using compassion (Gilbert, 2017) and building trust (Song et al., 2020). Compassionate interventions – such as the use of soothing voice tones and breathing techniques – reduce the fight/flight response, decelerate heartbeat, and facilitate parasympathetic rest and restoration (Crone et al., 2024; Kirby et al., 2017). A safe and compassionate early environment shapes the nervous system and aids the development of self-soothing strategies that enable self-regulation throughout life (Gilbert, 2017; Kolacz et al., 2022; Mok et al., 2020).

Psychological safety is central to mental health (Domínguez-Salas et al., 2021), wellbeing (Sullivan et al., 2018) and post-traumatic growth (Maurer et al., 2023; Norman et al., 2020). A traumatic history can bias us towards sensing threat and danger, challenging feelings of safety, wellbeing and relationships across the lifespan (Motsan et al., 2021; Porges,

2011). People often seek therapy because they are struggling to feel safe, blighted by anxiety, stress, and low mood (Morton et al., 2024). Facilitating feelings of psychological safety, both within and beyond the therapeutic relationship, is a common aim in the treatment of trauma related conditions (Gilbert, 2024; Herman, 2015; Levine, 1997; Ogden et al., 2006; Porges, 2022; Rothschild, 2000; Spinazzola et al., 2018). In therapy, compassion is increasingly seen as central to promoting safety and connection, while developing or re-engaging with self-soothing and self-regulating strategies (Dana, 2020; Gilbert, 2017).

Trauma informed care, which aims to proactively enhance feelings of psychological safety, has been found to improve mental health outcomes among patient populations across a range of health and social care settings (Muskett, 2014; Sweeney et al., 2018). Specifically, one study found that feeling safe during hospitalization increased feelings of control, calm, and hope in adults (Mollon, 2014). Feeling safe has also been found to improve healing and recovery during maternity care of women who have experienced childhood sexual trauma, whilst feeling unsafe with professionals could be experienced as re-traumatization (Montgomery, 2013). Psychological safety is also essential for healthcare workers to engage in effective teamwork and take the interpersonal risks required to ensure patient safety (Cogan et al., 2022; Hoegh et al., 2024; O'Donovan et al., 2020), while increased rates of burnout, vicarious trauma, moral injury, and compassion fatigue may challenge feelings of psychological safety and increase traumatic stress (Morton et al., 2024).

Considering the relevance of psychological safety in preventing, mitigating and treating trauma related conditions, we previously reported on the development of the Neuroception of Psychological Safety Scale (NPSS; Morton et al., 2024). The NPSS, grounded in Polyvagal Theory (PVT), is the first psychometric tool that aims to measure psychological safety for the individual. The NPSS is designed to assess an individual's perception of safety based on neurophysiological responses. The NPSS highlights the interplay between psychological safety and the autonomic nervous system, offering insights into

how individuals sense safety or threat in their environment. Psychological safety, at its core, refers to a state of feeling secure and supported, which fosters trust, open communication, and the ability to engage fully in social interactions. However, individuals with a history of trauma may experience dysregulated neuroception (Porges, 2022), where their autonomic nervous system remains in a heightened state of alertness, causing them to perceive danger even in safe environments. This hypervigilance, often seen in conditions like PTSD, can significantly impair a person's ability to experience psychological safety. The NPSS thus offers a framework for understanding how the neuroception of safety influences an individual's physiological, emotional and social experiences. This compliments the already well-established body of research that has focused on the measurement and application of psychological safety within teams and organisational contexts (Edmondson & Bransby, 2023; Edmondson & Lei, 2014; Kumar, 2024). PVT offers a comprehensive overview of safety from neurophysiological, psychological, and evolutionary theories (Porges, 2022). PVT describes how situations are subconsciously assessed for safety or threat by the autonomic nervous system, termed 'neuroception', leading to corresponding physiological, affective, and behavioural responses (Porges, 2004). In developing a scale of psychological safety, PVT proposes that situations detected via 'neuroception' as safe will activate physiological, affective, and cognitive processes to optimize social engagement through compassion for others. Situations detected as unsafe will shift biobehavioural systems that would restrict interpersonal social engagement, while optimizing physiological state, via the autonomic nervous system to support defensive survival strategies through either the dorsal vagal pathway leading to immobilizing, death feigning, or dissociating, or, via the sympathetic system leading to fight/flight behaviours that would be supported by increases in heart rate, shortened breathing, and increased muscle tension (Kolacz et al., 2019). PVT has helped to inform mental health, medical, and educational practices in the use of safe therapeutic presence (Geller & Porges, 2014), recognition of client's non-verbal safety-signaling (Mair, 2021), interpreting representations of fear and safety in art therapy (Gerge, 2017), investigating schema modes as means of coping (Karaosmanoğlu et al., 2023), exploring the impact of multi-generational trauma through movement expressions (Wagner & Waisman, 2023), and processing physiological manifestations of trauma in military veterans (Ali et al., 2022).

Our earlier work (Morton et al., 2024) in developing the NPSS, with a Scottish adult sample, comprised three phases. The first phase resulted in the generation of 107 items pertaining to what it means to feel safe by practitioners and researchers with expertise in trauma

and PVT. The second phase evaluated the statement items and assessed their factor structure, thus creating the 29-item NPSS scale, with three subscales: 'social engagement', 'compassion', and 'body sensations' (Morton et al., 2024). The first subscale, social engagement, was characterized by being accepted, understood, cared for, being able to express oneself without being judged, and having someone to trust. The items indicated evaluation of the social environment as non-threatening and safe to engage socially – a property ascribed to the Social Engagement System (SES) (Porges, 2011). The second subscale, compassion, captured items related to the ability to be compassionate and feel connected, empathetic, caring, and wanting to help. The third subscale, body sensations, related to the internal sensations of the body in a state of calm, capturing the feeling of relaxation in the face and the body, steady heartbeat and breath, and settled stomach. The activation and functioning of the SES are associated with the regulatory function, especially of the heart and bronchi, and the associated state of relaxation and restoration (Porges, 2011). In the third phase, scores on the NPSS underwent confirmatory factor analysis (CFA) confirming its three-factor structure. Model fit indices indicated an acceptable fit. Internal reliability was strong, with Cronbach's alpha and McDonald's omega confirming consistency (Morton et al., 2024).

The NPSS has been welcomed by researchers and practitioners working in a wide range of settings and socio-cultural contexts; it has been used in the evaluation of Eye Movement Desensitization and Reprocessing (EMDR) in dissociative disorders (Poli et al., 2023); exploring the reintegration of street-involved children and youth (Goodman et al., 2023); examining the significance of feeling safe for resilience of adolescents in sub-Saharan Africa (Bandeira et al., 2023); and as an informative measure for a model of Human-Animal Interactions (Leconstant & Spitz, 2022).

The aim of the current study was to further evaluate the psychometric properties of the NPSS using a large UK-based community sample. Specifically, this study sought to assess the internal consistency and test-retest reliability of scores on the NPSS to determine the stability and reliability of the measure over time. Additionally, we aimed to examine the validity of scores on the NPSS through an evaluation of its convergent, discriminant, and concurrent validity. We hypothesized that NPSS scores would demonstrate convergent validity through moderate to strong positive correlations with related constructs, such as team psychological safety, mental well-being, and compassion, while showing negative correlations with measures of post-traumatic stress and burnout. Discriminant validity was assessed by testing whether correlations between NPSS scores and theoretically distinct constructs, such as personality traits, were

significantly lower than those observed for convergent measures. We further evaluated discriminant validity by determining whether correlations with conceptually distinct constructs were significantly different from those with convergent measures, based on statistical criteria.

Beyond these psychometric evaluations, we also aimed to assess the dimensionality of the NPSS to confirm its underlying factor structure. Additionally, we examined known groups validity to determine whether NPSS scores could differentiate between groups expected to experience varying levels of psychological safety. Based on previous research, we hypothesized that individuals with greater social engagement, higher well-being, and lower trauma exposure would report significantly higher NPSS scores than those with higher distress or lower social connection. Lastly, to explore potential demographic differences in psychological safety perceptions, we conducted a post hoc analysis of gender differences in NPSS scores. Given previous findings on autonomic regulation and psychological safety (Logan & Walker, 2017), we sought to determine whether NPSS scores varied according to gender. Collectively, these aims provide a comprehensive assessment of the psychometric properties of the NPSS, further establishing its reliability, validity, and potential applications in both research and clinical settings.

2. Methods

2.1. Ethics

Ethical approval for this research was sought and received from the University Ethics Committee (33/02/12/2020/A) and all participants provided informed consent to their participation prior to engaging with the research.

2.2. Participants

Participants were recruited by convenience sampling using online social media platforms: Instagram, Facebook, Twitter, and LinkedIn, as well as the University of Strathclyde's online research participant recruitment system, SONA. Further online recruitment posters were sent via e-mail to third sector charities and health and social care organizations to distribute among eligible participants aged 18 years of age or older who resided in the UK. Exclusion criteria included: dementia, current abuse or dependence of drugs or alcohol, psychosis and/or neuropsychiatric disease requiring hospitalization, and/or incapacity to provide informed consent to take part in the study. Monitoring of data part-way through collection revealed a low response rate from males and adults from ethnic minority groups.

Targeted recruitment of these groups took place using the aforementioned methods with the addition of updated recruitment posters.

2.3. Procedure

An online, cross-sectional survey was developed and made available using Qualtrics. Participants were first asked to provide demographic data, including gender, age, ethnicity, country of residence, working status, and health status. Next, participants were invited to complete the 29-item NPSS, followed by seven established measures that have demonstrated reliability and validity in previous psychological research. Participants were also given the opportunity to respond to open-ended questions and give details about situations where they felt safe and what was important to them regarding psychological safety. Lastly, upon completion of the survey, participants were presented with a debrief that provided information on relevant support agencies, if needed, as well as the contact details for the lead researcher for any follow-up questions about the study. Data collection ran from November 2022 to October 2023.

2.4. Measures

Neuroception of Psychological Safety (NPSS; Morton et al., 2024): The NPSS is a 29-item self-report measure that has three sub-scales (social engagement, compassion, and body sensations) and asks participants to rate how well statements describe their feelings over the past week. Statements include 'I felt valued', 'I felt compassion towards others' and 'My heartrate felt steady'. Responses are given on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores on the NPSS indicate higher levels of psychological safety at the individual level. Earlier research (Morton et al., 2024) reported Cronbach's α for the entire NPSS was found to be .95 with sub-scale results of .93 for social engagement, .94 for compassion and .92 for bodily sensations, suggesting good internal reliability of the scale and subscales (Agbo, 2010). Omega h total scores were .96 for overall NPSS, .93 for social engagement, .93 for compassion and .92 for bodily sensations, confirming the findings of Cronbach's α testing (McNeish, 2018).

In addition to NPSS, participants were invited to complete a series of psychometrically valid measures that we hypothesized were moderately and positively associated with scores on the NPSS.

Team Psychological Safety Scale (TPSS; Edmondson, 1999): The TPSS is a 7-item scale using a mix of positively and negatively worded statements to measure psychological safety in the context of a team. Participants are asked to think about a team of

which they are part while rating statements like 'If you make a mistake on this team, it is often held against you' and 'It is safe to take a risk on this team'. Responses are given on a 7-point Likert scale ranging from 1 (very inaccurate) to 7 (very accurate). Higher scores on the TPSS would indicate a psychologically safer team environment. The TPSS has been found to have good internal consistency (Edmondson, 1999) and reliability (Edmondson et al., 2004).

Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS; Stewart-Brown et al., 2009): The SWEMWBS is a scale of 7 items for assessing mental wellbeing using a Likert type response format ranging from 1 (none of the time) to 5 (all of the time). Participants are asked to think about their thoughts and feelings over the past two weeks. These include positively worded statements such as 'I've been feeling useful' and 'I've been feeling close to other people'. Higher scores are associated with higher levels of mental wellbeing (Cronbach's α = .890). The SWEMWBS has been found to have good internal consistency (Anthony et al., 2022) and reliability (Koushede et al., 2019).

Abbreviated Post-Traumatic Stress Disorder Checklist – Civilian (APCL-C; Lang & Stein, 2005): The APCL-C provides assessment for difficulties associated with post-traumatic stress in the civilian population. The 6-item APCL-C presents participants with common complaints in response to stressful life experiences and asks how frequently they have been bothered by each in the past month. Items include 'Repeated, disturbing memories, thoughts, or images of a stressful experience from the past' and 'Feeling irritable or having angry outbursts'. Responses are given on a 5-point Likert scale ranging from 1 (not at all) to 5 (extremely). Here, higher scores are suggestive of difficulties with post-traumatic, acute stress which is said to require further professional attention (Cronbach's a = .890). The APCL-C has been found to have adequate internal consistency and reliability (Martínez-Levy et al., 2021).

Burnout Measure – Short Version (BMS; Malach-Pines, 2005): The 10-item BMS is designed to measure burnout across diverse occupational and community contexts. Participants are asked how often they feel, for example, 'Tired', 'Worthless/Like a failure', 'I've had it'. Responses are given on a 7-point scale ranging from 1 (never) to 7 (always), where higher scores are associated with higher levels of physical, emotional, and mental burnout. The BMS has been found to have good psychometric properties (Shoman et al., 2021).

Compassion Scale (CS; Pommier et al., 2020): The CS is a 16-item scale used to assess compassion felt for others where compassion is operationalized with constructs of kindness, common humanity, mindfulness, and reduced indifference for others. The scale includes positively worded items such as 'I like to be there for others in times of difficulty' and negatively worded items like 'I am unconcerned with other people's problems'. Participants are asked to reveal how often they feel or behave in the stated manner using a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). Higher scores are associated with a tendency to show compassion to others. Evidence of reliability and validity have been reported (Sousa et al., 2022).

Body Perception Questionnaire – Very Short Form (BPQ-VSF; Cabrera et al., 2018): The BPQ-VSF is a 12-item measure that assesses subjective bodily experiences related to the direct functions of the autonomic nervous system pathways. The short form explicitly measures body awareness by asking participants to rate their awareness of certain characteristics during most situations, including 'How fast I am breathing' and 'Stomach and gut pains'. Participants' responses are given on a 5-point Likert scale ranging from 1 (never) to 5 (always). Higher scores are suggestive of a dysregulated autonomic nervous system and poorer health outcomes. The BPQ-VSF has been found to be a reliable and valid measure (Wang et al., 2020).

Ten-Item Personality Inventory (TIPI; Gosling et al., 2003): The TIPI assesses the Big-5 personality domains – extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience – by asking participants the extent to which pairs of traits apply to them. There are 10 items, and each personality domain is represented by two statements: one positive and one negative. As a result, 5 of the items require reverse scoring, and then, the average of the two items is calculated to make up each individual scale, together representing the five personality domains. Responses are given on a 7-point Likert scale ranging from 1 (disagree strongly) to 7 (agree strongly), where high scores on a domain suggest that the participant strongly self-identifies with the associated personality characteristics. Questions include statements such as 'I see myself as someone who is reserved'. Evidence that the TIPI is valid and reliable has been reported (Balgiu, 2018).

2.5. Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Version 28; IBM SPSS, Inc., Chicago, IL). To maximize available data and reduce bias in estimates, an imputation method was applied to missing item data. To assess the assumption that data were missing at random (MAR), we examined patterns of missingness across key demographic variables and NPSS subscale scores using independent t-tests and chi-square tests. No significant differences were found between participants with and without missing data on these variables, suggesting that missingness was not systematically related to study variables. This supports the assumption that data were missing at random. Given that

data appeared to be MAR and the overall missingness rate was low (1.29%), a single imputation method was deemed appropriate (Dong & Peng, 2013). Missing data were imputed using the expectation-maximization (EM) algorithm to ensure minimal bias in parameter estimation. Descriptive statistics were used to characterize the sample and psychometric data, including means and standard deviations, minimum and maximum absolute values and percentage (for categorical data); giving indications of normality and potential outliers. Internal consistency of the NPSS scores were tested using Cronbach's α was used. The NPSS's test-retest reliability at three weeks was assessed, using intra-class correlation coefficients with data collected from a sub-sample (10%) of the total sample. Test-retest reliability was assessed using intra-class correlation coefficients to evaluate the stability of NPSS scores over time. A two-way mixed-effects model with absolute agreement was used, as it accounts for both systematic and random measurement error while ensuring consistency across repeated assessments (Koo & Li, 2016). This model was chosen to assess absolute agreement between repeated measurements, making it suitable for evaluating the reliability of individual scores over time.

Next, to verify the structural validity of the NPSS, confirmatory factor analysis (CFA) was performed using AMOS version 28. The observed items were

Table 1. Participants' socio-demographic characteristics.

Variables	n (2,035 total)
Age	$M = 35.2$ ($SD = 13.6$)
Sex	
Female	1,205 (59.2%)
Male	798 (39.4%)
Non-binary	22 (1.1%)
Don't know/Prefer not to answer	5 (0.2%)
Ethnicity	
White-British	1,278 (63.7%)
White-Other	163 (8.1%)
Asian	351 (17.4%)
Black	132 (6.6%)
Hispanic	4 (0.2%)
Mixed/Multiple ethnicities	78 (3.9%)
U.K. residence	
England	1,023 (50.4%)
Scotland	704 (34.7%)
Wales	192 (9.5%)
Northern Ireland	78 (3.8%)
Community	
Urban	1,464 (72.1%)
Suburban	60 (3%)
Rural	444 (21.8%)
Occupation	
Full-time employment	921 (45.3%)
Part-time employment	578 (28.5%)
Student	472 (23.2%)
Volunteer	58 (2.9%)
Carer	39 (1.9%)
Not currently in employment	193 (9%)
Health disclosure	
Diagnosed mental health issue	428 (21.1%)
Long-term physical health issue	170 (8.4%)
Comorbid mental and physical health issues	243 (12%)
None of the above	1,026 (50.5%)

Note. % calculations exclude missing data.

modelled as indicators of the latent factors based on the three-factor model reported in our earlier work (Morton et al., 2024). The 3-factor structure of the NPSS was developed through exploratory factor analysis, followed by CFA in a separate sample. As this structure was empirically and theoretically supported, the current study focused on CFA to assess its replicability in a new sample rather than conducting an additional EFA. No post hoc modifications (e.g. residual item correlations) were applied to improve model fit, ensuring that model evaluation was based solely on the theoretical structure of the NPSS. The following indices of model fit were considered: comparative fit index (CFI), the Tucker Lewis Index (TLI), root mean square error of approximation (RMSEA) and standardized root mean square error of approximation and MIIC (Tucker & Lewis, 1973). CFI and TLI values between 0.90 and 0.95 and RMSEA values between 0.05 and 0.08 are indicative of acceptable model fit (Chen, 2007; Kline, 2005). Convergent validity was examined using the correlations between scores on the NPSS with scores on the TPSS, SWEMWBS, APCL-C, BMS, CS and BPQ-VSF. Discriminant validity was assessed by examining the correlations between the NPSS scores with the scores on the TIPI. Concurrent validity was assessed using logistic regressions (correct classification rates) to determine if scores on the NPSS successfully predicted trauma exposure (dependent variable: trauma yes/no). Sum scores of the NPSS were calculated and used in validity testing. Gender differences were examined post hoc to explore potential variations in NPSS scores. This analysis was conducted in response to existing literature suggesting gender differences in autonomic regulation and psychological wellbeing (Dale et al., 2018). Known groups validity was investigated via an independent t-test comparison of NPSS scores and gender (Logan & Walker, 2017). All tests were two-tailed, and $p < .05$ was considered statistically significant. Lastly, a content analysis was conducted for answers to the open-ended question concerning participants' personal experiences of feeling safe, uncovering themes and frequency of their occurrence in participant-generated responses (Krippendorff, 2018). This process followed three main phases of preparation, organization and reporting of the textual data (Elo & Kyngäs, 2008).

3. Results

A total of 2,035 participant responses were included in the analysis. No participants were excluded based solely on missing data, as missingness was minimal (1.29%) and handled using the EM algorithm. This ensured that all eligible responses were retained in the dataset, maximizing available data while minimizing potential bias. Participants were aged between 18–

81 years (M = 35.2, SD = 13.6). Ethnicity was predominantly given as White-British (63.7%), with the majority of participants residing in England (50.4%). Participants reported living in urban/suburban communities (75.1%) more so than rural communities (21.8%). Moreover, long term physical health issues, diagnosed mental health issues, and/or comorbidities were disclosed in 41.5% of participants' responses. See Table 1 for a comprehensive list of participants' socio-demographic characteristics.

3.1. Internal reliability

Cronbach's α for the NPSS was .95. Subscale results were .94 for social engagement, .90 for compassion and .93 for bodily sensations, suggesting good internal reliability of the scale and subscales (Agbo, 2010). In all cases, α could not be increased by excluding items.

3.2. Test-retest reliability

Test-retest reliability at three weeks in the sub-sample was 0.89 (p < .01), indicating high reliability for scores on the NPSS. The NPSS measures an individual's implicit detection of safety or threat in their environment, a process shaped by both stable individual differences and responsiveness to situational changes. While psychological safety is expected to demonstrate moderate stability over time, it is not entirely trait-like nor highly state-dependent. The observed correlation of 0.89 suggests that psychological safety remains stable over this period while allowing for some expected variation.

3.3. Convergent and discriminant validity

We assessed the convergent validity by correlating psychological safety (NPSS) with team psychological safety (TPSS), mental wellbeing (SWEMWBS), traumatic stress (APCL-C), burnout (BMS), compassion (CS) and body perception (BPQ-VSF). The NPSS mean score correlated positively with the mean score on the TPSS, SWEMWBS and CS. The NPSS mean score correlated negatively with the mean score on the APCL-C, BMS and the BPQ-VSF. Together these results suggest good convergent validity. Discriminant validity was assessed by examining the correlations between the NPSS mean score and the big five personality domains (TIPI). Positive correlations were found between the mean NPSS score and the corresponding mean on the Extraversion, Agreeableness, Conscientiousness, Openness to Experience and Emotional Stability. As expected, these correlations were found to be weaker than those observed with the other validity measures (with the exception of the BPQ-VSF), indicating scores on the NPSS demonstrate adequate discriminant validity (See Table 2).

3.4. Concurrent validity

Concurrent validity was assessed using logistic regression to determine if scores on the NPSS successfully predicted self-reported exposure of trauma (yes/no). A logistic regression was performed to ascertain the effects of scores on the NPSS on trauma exposure (yes/no). The logistic regression model was statistically significant, $X^2(22)$ = 207.63, p < .001. The model explained 17.1% (Nagelkerke R2) of the variance in trauma exposure and correctly classified 78.3% of cases. The NPSS was able to correctly identify participants who reported trauma exposure versus those who had not thus showing good concurrent validity.

3.5. Dimensionality

The dimensionality assessment of scores on the NPSS treated items as ordered categorical variables due to their Likert-scale format. The weighted least squares mean and variance-adjusted estimator was used, as it is appropriate for analyzing categorical data while accounting for non-normality. Model evaluation was guided by theoretical considerations and fit indices, with no post hoc modifications, such as residual item correlations, applied to improve model fit. This approach ensured that the NPSS structure was assessed in a statistically robust and conceptually valid manner. To assess the dimensionality of the NPSS, we conducted CFA to test the original three-factor model (social engagement, compassion, and body sensations) that was theoretically derived and previously validated (Morton et al., 2024). This comprehensive technique is commonly used in studies testing dimensionality (e.g. Muthén, 2008; Sturman & Short, 2000). Appropriate fit indices were used to evaluate the factor models, including the Goodness of Fit Index (GFI), the Bentler Comparative Fit Index (CFI) (Bentler, 1990), and the Nonnormed Fit Index (NNFI), all of which should be ≥ .90 to indicate good model fit. The Root Mean Square Error of Approximation (RMSEA) was also used, with values smaller than .08 indicating good fit, while values above .10 were considered unacceptable.

The CFA results indicated that the hypothesized model demonstrated a good fit to the data, with fit indices meeting recommended thresholds: χ^2(df = 374) = 5542.86, p < .001; RMSEA = 0.07; SRMR = 0.05; CFI = 0.87; TLI = 0.86. Factor loadings (Table 3) supported the structural validity of the NPSS, with all 29 items loading significantly onto their respective factors (MacCallum et al., 2001).

Most items demonstrated strong communalities and item-total correlations, supporting the scale's internal consistency. However, some items, such as 'I felt able to empathize with other people' (h^2 = 0.33) and 'I felt compassion for others' (h^2 = 0.21),

Table 2. Correlation matrix of associations between the NPSS scores and validity measures to test convergent and discriminant validity.

Measure		2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. NPSS Total Scores	–	0.917**	0.696**	0.779**	0.480**	0.707**	−0.500**	−0.621**	0.376**	−0.289**	0.295**	0.335**	0.314**	0.426**	0.203**
1. Social Engagement (NPSS)			0.550**	0.542**	0.494**	0.632**	−0.420**	−0.548**	0.281**	−0.213**	0.293**	0.279**	0.249**	0.319**	0.188**
1. Compassion (NPSS)				0.329**	0.288**	0.390**	−0.142**	−0.252**	0.607**	−0.050**	0.255**	0.422**	0.186**	0.165**	0.220**
1. Body Sensations (NPSS)					0.326**	0.643**	−0.582**	−0.636**	0.154**	−0.402**	0.163**	0.177**	0.322**	0.523**	0.103**
1. Team Psychological Safety (TPSS)						0.374**	−0.354**	−0.371**	0.250**	−0.177**	0.136**	0.229**	0.241**	0.240**	0.122**
1. Mental Wellbeing (SWEMWS)							−0.551**	−0.718**	0.220**	−0.295**	0.330**	0.241**	0.393**	0.547**	0.224**
1. Acute Stress (APCL-C)								0.694**	−0.038	0.501**	−0.136**	−0.183**	−0.338**	−0.578**	−0.089**
1. Burnout (BMS)									−0.087**	0.452**	−0.283**	−0.209**	−0.386**	−0.585**	−0.156**
1. Compassion (CS)										0.017	0.162**	0.448**	0.244**	0.072**	0.281**
1. Body Perception (BPQ-VSF)											−0.091**	−0.100**	−0.194**	−0.340**	−0.039
1. Extraversion (TIPI)												0.034	0.120**	0.242**	0.262**
1. Agreeableness (TIPI)													0.268**	0.240**	0.222**
1. Conscien-tiousness (TIPI)														0.371**	0.170**
1. Emotional Stability (TIPI)															0.192**
1. Openness to Experience (TIPI)															–

Note. NPSS: Neuroception of Psychological Safety Scale; TPSS: Team Psychological Safety Scale; SWEMWBS: Short Warwick-Edinburgh Mental Wellbeing Scale; APCL-C: Abbreviated Post-Traumatic Stress Disorder Checklist – Civilian; BM: Burnout Measure – Short Version; CS: Compassion Scale; BPQ-SF: Body Perception Questionnaire – Short Form; TIPI: Ten-Item Personality Inventory. ** p < .01.

Table 3. Component loadings, communalities and item total correlations of the 3-factor solution.

Statement Items (n = 29)	Factor 1 (Engagement)	Factor 2 (Sensations)	Factor 3 (Compassion)	Communality	Item-Total Correlation
I felt valued	0.733			0.432	0.733
I felt comfortable expressing myself	0.591			0.533	0.591
I felt accepted by others	0.768			0.312	0.768
I felt understood	0.768			0.384	0.768
I felt like others got me	0.728			0.415	0.728
I felt respected	0.730			0.393	0.730
There was someone who made me feel safe	0.649			0.614	0.649
There was someone that I could trust	0.655			0.462	0.655
I felt comforted by others	0.753			0.416	0.753
I felt heard by others	0.812			0.327	0.812
I felt like people would try their best to help me	0.753			0.421	0.753
I felt cared for	0.812			0.354	0.812
I felt wanted	0.765			0.418	0.765
I didn't feel judged by others	0.471			0.771	0.471
I felt able to empathize with other people			0.690	0.330	0.690
I felt able to comfort another person if needed			0.795	0.255	0.795
I felt compassion for others			0.850	0.210	0.850
I wanted to help others relax			0.737	0.370	0.737
I felt like I could comfort a loved one			0.702	0.346	0.702
I felt so connected to others I wanted to help them			0.647	0.398	0.647
I felt caring			0.729	0.260	0.729
My heart rate felt steady		0.786		0.425	0.786
Breathing felt effortless		0.848		0.352	0.848
My voice felt normal		0.690		0.447	0.690
My body felt relaxed		0.787		0.432	0.787
My stomach felt settled		0.782		0.554	0.782
My breathing was steady		0.905		0.256	0.905
I felt able to stay still		0.715		0.596	0.715
My face felt relaxed		0.740		0.461	0.740

had lower communalities, suggesting they may capture more nuanced aspects of psychological safety. Similarly, 'I didn't feel judged by others' and 'I felt so connected to others I wanted to help them' showed relatively lower item-total correlations, indicating potential individual or situational variability.

3.6. Internal consistency

Descriptive statistics for NPSS total and sub-scale scores are presented in Table 4. The scores on the NPSS deviated from normality as assessed by skewness, kurtosis, and Shapiro–Wilk tests ($p < .05$). Cronbach's alpha has been shown to be robust to non-normally distributed data when the dataset is

Table 4. Descriptive statistics for the measures and subscales.

Measure	Mean	Median	SD	Skew	Kurtosis
Psychological Safety Total	3.63	3.69	0.63	−0.37	0.49
Social Engagement Subscale	3.58	3.71	0.74	−0.58	0.55
Compassion Subscale	3.95	4.01	0.67	−0.79	1.50
Body Sensations Subscale	3.43	3.50	0.89	−0.31	−0.43
Team Psychological Safety Total	4.74	4.71	1.07	−0.30	−0.08
Mental Wellbeing Total	3.26	3.29	1.07	−0.12	−0.10
Acute Stress Total	2.58	2.50	1.01	0.28	−0.78
Burnout Total	4.02	4.00	1.31	0.13	−0.38
Compassion Total	3.98	4.00	0.54	−0.48	0.03
Body Perception Total	2.50	2.42	0.91	0.46	−0.31
Extraversion Scale	1.63	1.75	0.78	0.17	−0.77
Agreeableness Scale	2.48	2.50	0.59	−0.23	−0.34
Conscientiousness Scale	2.50	2.50	0.67	−0.41	−0.48
Emotional Stability Scale	2.07	2.00	0.75	−0.01	−0.71
Openness to Experience Scale	2.39	2.50	0.61	−0.31	−0.19

sufficiently large (Sheng & Sheng, 2012). Initial data exploration of scores on the NPSS uncovered a sum score mean of 105.17 ($SD = 18.28$) and item mean of 3.63. Negative skew (−.37) and positive kurtosis (.49) were found in NPSS sum scores.

A pattern in low-scoring outliers within the NPSS scores was also identified. In answer to the open-ended questions relating to personal experiences of psychological safety, these participants chose asocial situations such as spending time away from others or being home alone, unlike the majority of participants who chose social situations such as being with loved ones. Removal of outliers showed no change in non-normality and so were included in dimensionality and reliability testing. Outliers were deleted from correlation and regression analysis, however, as these tests are sensitive to the presence of outliers and may also lead to reduced linearity of variables (Wilcox, 2016).

3.7. Post hoc analysis

An independent sample t-test revealed significant differences between scores on the NPSS and its subscales and gender. Males ($M = 103.66$, SD 19.69) scored significantly lower than females ($M = 106.37$, $SD = 17.21$) on the NPSS overall score ($t(1545.3) = 3.170$, $p = 001$, Cohen's $d = 0.15$), equal variances not assumed. Males ($M = 48.86$, $SD = 11$) had significantly lower scores than females ($M = 50.97$, $SD = 9.77$) on the Social Engagement subscale ($t(1564.35) = 4.395$, $p = <.001$, Cohen's $d = 0.2$), equal variances not

assumed. Males ($M = 26.47$, $SD = 5.14$) also scored significantly lower than females ($M = 28.58$, $SD = 4.21$) on the Compassion subscale ($t(1469.70) = 9.193$, $p = $ <.001, Cohen's $d = 0.44$), equal variances not assumed. No statistically significant difference was found between males ($M = 28.34$, $SD = 6.99$) and females ($M = 26.93$, $SD = 5.44$) on the Body Sensations subscale ($t(1721.18) = -4.398$, $p = .361$, Cohen's $d = -0.2$).

3.8. Open-ended question content analysis

A total of 798 responses were given for the open-ended situational prompt question concerning personal experiences of psychological safety. An inductive content analysis revealed three categories of meaning: (1) interpersonal situations, (2) location specific settings, and (3) asocial behaviours and/or activities. Six hundred and seventy nine ($n = 679$; 85.08%) participants chose interpersonal situations involving loved ones, friends, colleagues, caring professionals and/or pets that represented a recent experience of when they felt psychologically safe. Seventy nine participants ($n = 79$; 9.89%) focused on location, situation or physical safety (such as being at home, work or in a natural environment surrounded by nature), whilst only forty ($n = 40$; 5.01%) chose explicitly asocial situations (such as being alone or engaging in solitary activities).

4. Discussion

This study aimed to evaluate the reliability, validity, and dimensionality of scores on the NPSS in a large, UK-based community sample. Previously, we reported on the development of the NPSS, which was informed by PVT (Morton et al., 2024), providing a novel contribution to the growing body of research aimed at operationalizing and measuring psychological safety at an individual level. The findings from the current study confirm that scores on the NPSS demonstrates strong measurement properties, including good internal consistency, test-retest reliability, and convergent validity. The results supported a three-factor model, capturing the key domains of social engagement, compassion, and body sensations. Furthermore, NPSS scores were significantly associated with trauma exposure, providing evidence of concurrent validity. While some evidence of discriminant validity was found, certain correlations with personality traits (TIPI) were only slightly weaker than those for convergent validity, warranting a more cautious interpretation.

The current study builds upon earlier work by employing a distinct, more diverse UK-wide sample and implementing targeted recruitment strategies to enhance generalizability. While the original study focused on establishing the NPSS's factor structure using a convenience sample from a Scottish population, this study expands its scope by recruiting participants from across all four nations of the UK. This approach increased demographic diversity, with greater representation of ethnic minorities and a more balanced gender distribution. Our current findings suggest that scores on the NPSS captures the multiple dimensions of psychological safety that individuals experience and provides a psychometrically robust measure for future research and clinical applications.

4.1. Strengths and limitations

A key strength of this study is its rigorous psychometric evaluation, assessing test-retest reliability, structural validity, and multiple forms of validity (convergent, discriminant, and concurrent), alongside internal consistency. Another major strength is the large sample size of over 2,000 participants, which enhances the statistical power of the findings and the scale's potential applicability in broader research and clinical settings.

However, this study also has limitations that should be acknowledged. While our recruitment strategy broadened demographic representation, our research has only sought to validate the NPSS within UK-based samples, and its psychometric properties may not necessarily generalize across different cultural, clinical, or administration contexts. Psychometric research often finds that factor structures may shift in clinical populations, particularly due to range restriction effects, which can impact validity and reliability. Future research should validate the NPSS across diverse populations, including clinical and non-clinical groups, culturally distinct samples, and different administration formats, to further establish its broader generalizability.

Another limitation is that neuroception is theorized as an unconscious process (Porges, 2004), yet the NPSS relies on self-report to measure psychological safety. While subjective awareness of autonomic states and safety cues can provide insight into neuroceptive processes, self-report methods inherently capture conscious reflections, which may not fully align with implicit neuroceptive mechanisms. Future research should explore multi-method validation, incorporating physiological measures (e.g. heart rate variability, skin conductance) alongside self-report responses, to strengthen the construct validity of the NPSS in capturing neuroception-related experiences. Additionally, this study relied on online data collection, which may introduce risks related to inattentive responding or data validity. To mitigate these concerns, data quality checks were implemented, including screening for duplicate responses, analyzing response times to

detect inattentive responding, and examining response patterns indicative of random answering. While these steps helped ensure data integrity, future research should continue exploring alternative validation methods, such as clinician-administered assessments, to confirm the scale's reliability in different administration formats.

4.2. Implications and future directions

Recent studies have supported the factor structure, construct validity, and measurement invariance of the NPSS in various populations, including an Italian validation study (Poli & Miccoli, 2024), and a cross-cultural psychometric evaluation confirming measurement invariance (Spinoni et al., 2024). These findings indicate that scores on the NPSS is a promising measure of psychological safety with applicability beyond the initial validation samples. Consistent with recent research on the Italian version of the NPSS (Poli & Miccoli, 2024), our study revealed satisfactory psychometric properties and provided convincing evidence for three core domains of psychological safety: 'social engagement,' 'compassion,' and 'body sensations.' Feelings of safety reflect core fundamental processes that enable humans to survive through the opportunistic features of trusting social engagements, which have co-regulatory capacities to mitigate metabolically costly defense reactions (Porges, 2022). The extent to which one feels socially connected and experiences bodily safety are critical factors in shaping perceptions of psychological safety (Maté, 2011). Compassion offers a calm vagal state, in which our 'safety of self' projects acceptance toward others (Porges, 2018). Together, these key dimensions of the NPSS provide a novel and theoretically informed means of measuring psychological safety and highlight its potential utility in clinical practice, particularly in the context of working with trauma survivors (Morton et al., 2024). The communality and item-total correlation analyses support the NPSS's robustness, with most items contributing meaningfully to psychological safety. However, some items with lower communalities may capture more nuanced or situational aspects rather than core dimensions. Future research should examine their consistency across diverse populations and consider refinements to enhance their alignment with the overarching construct.

Future research should explore how scores on the NPSS can support the evaluation of interventions, particularly in the growing field of digital mental health technologies. Given its foundation in PVT, the NPSS could inform AI-driven mental health platforms, VR-based therapies, biofeedback tools, and digital interventions designed for trauma recovery, stress management, and emotional regulation (Cogan, 2024). It may also serve as a key measure for assessing psychological safety in digital interventions, helping to refine and personalize AI-assisted mental health support. As technology-driven care expands, integrating the NPSS could enhance the development, evaluation, and optimization of trauma-informed digital tools.

5. Conclusion

The research described in this paper establishes that the NPSS is a novel measure with strong measurement properties, including excellent reliability and good convergent, discriminant, and concurrent validity. It displays a three-factor model indicating that 'social engagement,' 'compassion,' and 'body sensations' are key influences on psychological safety in a sample of adults residing in the UK. However, future research should compare its performance across different cultures and contexts. We envisage that the NPSS will enable policymakers, practitioners, and individuals using services to meaningfully capture and discuss psychological safety, allowing them to track changes over time. The NPSS is likely to have significant implications for multidisciplinary research, policy, and practice, as well as informing technological advancements in psychotraumatology in the years ahead.

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