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Brain Body Center Sensory Scales (BBCSS)

Adult Form Self-Report

The Brain Body Center Sensory Scales (BBCSS) are designed as a general, preliminary assessment of behaviors related to sensory processing profiles, including auditory, visual, and tactile processing, and feeding behaviors. Individual responses to different environmental stimuli vary widely, and learning more about an individual's sensory processing is an important component of any comprehensive behavioral evaluation.

If you are unsure whether you have ever displayed the behavior in question, or if you have NEVER displayed the behavior, please answer Not sure/Not Applicable.

BBC Sensory Scales Adult Form

Auditory Processing (336699)

1. How often do you respond negatively to unexpected or loud noises (for example, hide or cringe at noise from ambulance, train, fire or car alarm, fireworks)?
   ☐☐ ☐☐ ☐☐ ☐☐ ☐☐
   Almost Always Frequently/ Often Sometimes/ Occasionally
   Almost Never Not Sure/ Not Applicable

2. How often do you become distracted, or have difficulty following verbal instructions when there is a lot of noise around?
   ☐☐ ☐☐ ☐☐ ☐☐ ☐☐
   Almost Always Frequently/ Often Sometimes/ Occasionally
   Almost Never Not Sure/ Not Applicable

3. How often do you hold your hands over or plug your ears?
   ☐☐ ☐☐ ☐☐ ☐☐ ☐☐
   Almost Always Frequently/ Often Sometimes/ Occasionally
   Almost Never Not Sure/ Not Applicable

4. How often do you not hear what others say (for example, you fail to pay attention to what others say)?
   ☐☐ ☐☐ ☐☐ ☐☐ ☐☐
   Almost Always Frequently/ Often Sometimes/ Occasionally

Almost Never Not Sure/ Not Applicable

5. How often do you have trouble working with background noise (for example, air conditioner, traffic noises, airplanes)?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

6. How often do you not respond when your name is called, even though you know your hearing is not a problem?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

7. How often are you unusually angry, frightened, or in pain when others cry or scream?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

8. How often do others have to speak loudly or get very close to your face to get your attention?

Almost Always Frequently/ Often Sometimes/ Occasionally

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Almost Never Not Sure/ Not Applicable

9. How often are you unaware of continuous noise in the environment (for example, TV, stereo)?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

10. How often are you overly aware, distracted, or disturbed by continuous noise in the environment (for example, TV, stereo)?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

11. How often do you take a long time to respond when spoken to, even to familiar voices?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

12. How often do you startle easily at sound, compared to others, with loud or high-pitched noises (for example, vacuum, blender, fire alarms)?

Almost Always Frequently/ Often Sometimes/ Occasionally

Almost Never Not Sure/ Not Applicable

13. How often do you distracted by sounds not normally noticed by other people (for example, airconditioning fans, trains or planes outside)?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

14. How often do you respond negatively (i.e. become distracted or anxious) when entering places with continuous background noises (for example, grocery stores, schools, shopping malls)?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

Visual Processing

15. How often are you bothered by bright lights after others' eyes have adapted to the same light?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

16. How often do you cover your eyes or squint?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

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Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

17. How often are you unable to tolerate bright lights?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

18. How often are you unable to tolerate flashing lights?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

19. How often do you get agitated when exposed to bright lights?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

20. How often are you sensitive to bright lights (for example, squint or close eyes)?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

21. How often are you sensitive to flashing lights (for example, squint or close eyes)?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

22. How often do you hesitate to go outside when it’s sunny?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

23. How often are you easily distracted by movement only you can see?
☐☐ ☐☐ ☐☐ ☐☐ ☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

24. How often are you easily distracted by movements of objects (i.e. mechanical objects or repetitive movements)?
☐☐ ☐☐ ☐☐ ☐☐ ☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

Tactile Processing (Touch)

25. How often are you distressed or overly-sensitive to tooth-brushing?
☐☐ ☐☐ ☐☐ ☐☐ ☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

26. How often are you distressed or overly-sensitive to face-washing?
☐☐ ☐☐ ☐☐ ☐☐ ☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

27. How often are you distressed or overly-sensitive to fingernail-cutting?
☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

28. How often are you distressed or overly-sensitive to hair-brushing?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

29. How often do you remove labels or tags from most clothing, or ask that they be removed?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

30. How often do you refuse to wear certain fabrics or find certain fabrics irritating?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

31. How often do you find certain garments are too tight, scratchy or irritating?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

32. How often do you prefer to not wear certain clothing items?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

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33. How often do you resist hugging?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

34. How often do you react negatively or overly sensitively to hand-holding?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

35. How often do you react emotionally or overly sensitively to being touched?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

36. How often do you react emotionally or overly sensitively when touching very cold objects with your hands?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

37. How often do you react emotionally or overly sensitively when very cold objects touch your face?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

Ingestion and Digestion

38. How often do you avoid certain tastes?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

39. How often do you resist certain textures of food?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

40. How often do you avoid certain food smells?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

41. How often do you resist certain temperatures of food?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

42. How often do you gag?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

43. How often do you vomit?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

44. How often do you have acid reflux?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

45. How often do you have excessive intestinal gas?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

46. How often are you constipated?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

47. How often do you experience stomach or intestinal cramping?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

48. How often do you have difficulty swallowing solid foods?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

49. How often do you suck on objects other than food (for example, pen, lip, own tongue)?

☐☐ ☐☐ ☐☐ ☐☐ ☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

50. How often do you eat (or want to eat) significantly less than you think is appropriate for your size or age?

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

Evaluating Sensory Processing in Fragile X Syndrome: Psychometric Analysis of the Brain Body Center Sensory Scales (BBCSS)

Abstract

Individuals with fragile X syndrome (FXS), especially those co-diagnosed with autism spectrum disorder (ASD), face many sensory processing challenges. However, sensory processing measures informed by neurophysiology are lacking. This paper describes the development and psychometric properties of a parent/caregiver report, the Brain-Body Center Sensory Scales (BBCSS), based on Polyvagal Theory. Parents/guardians reported on 333 individuals with FXS, 41% with ASD features. Factor structure using a split-sample exploratory-confirmatory design conformed to neurophysiological predictions. Internal consistency, test–retest, and inter-rater reliability were good to excellent. BBCSS subscales converged with the Sensory Profile and Sensory Experiences Questionnaire. However, data also suggest that BBCSS subscales reflect unique features related to sensory processing. Individuals with FXS and ASD features displayed more sensory challenges on most subscales.

Keywords Fragile X · Autism spectrum disorders · Polyvagal theory · Autonomic nervous system · Psychometrics · Sensory processing

Introduction

Fragile X syndrome (FXS), which results from a mutation on the on the 5′ untranslated region of the *FMR1* gene, is the most common inherited form of intellectual disability. FXS occurs when the CGG trinucleotide repeat exceeds 200; typically, individuals have approximately 30 CCG

repeats. This expansion reduces or prevents the production of fragile X mental retardation protein (FMRP), which is needed for normal brain development. Given that FXS is an X-linked condition, prevalence rates are higher in males than females (Riley et al. 2017). Individuals with FXS have higher rates of several co-occurring psychiatric and medical conditions, including anxiety, attention problems, and hyperactivity (Bailey et al. 2008) as well as poorer affiliative social behavior including social gaze aversion and social avoidance (Cohen et al. 1988, 1989, 1991; Hall et al. 2015). FXS is also the most common single-gene cause of autism spectrum disorders (ASD), with ASD prevalence estimates ranging between 30 and 50% of males and 10% of females with FXS (Raspa et al. 2017).

Sensory processing related abnormalities are well documented in FXS. When compared with typically developing controls, children with FXS often show higher rates of sensory challenges, including tactile sensitivity, taste/smell sensitivity, stimulation seeking behaviors, and auditory filtering (Rogers et al. 2003). These rates are statistically similar to children with ASD (McIntosh et al. 1999; Rogers et al. 2003) and children co-diagnosed with FXS and ASD (Bailey et al. 1998). Likewise, studies of children with ASD show higher rates of sensory challenges when compared with children with other developmental delays and typically developing children using parent-reported measures (Baranek et al. 2006; Tomchek and Dunn 2007) and parent interviews (Leekam et al. 2007). Similarities in sensory processing in FXS and ASD may be due to similar pathophysiological and

anatomical abnormalities (Belmonte and Bourgeron 2006; Hagerman 2006; Feinstein and Reiss 1998). Longitudinal studies using both observational and parent-reported measures have shown that sensory processing problems begin early in children with FXS (Baranek et al. 2008). Other common sensory challenges are selective eating (Raspa et al. 2010) and gastrointestinal issues (Kidd et al. 2014).

To facilitate study of sensory processing abnormalities, several questionnaires are available for research and clinical applications. The most widely-used of these is the Sensory Profile (SP), available in multiple age-specific forms (Ermer and Dunn 1998; Brown et al. 2001; Dunn and Daniels 2002), based on Dunn's model of sensory processing (Dunn 1997, 2007). Dunn's model, building on the work of Ayres (1964, 1965, 1972), proposes that neurological thresholds and behavioral strategies for self-regulating sensory experiences form the basis for individual differences in sensory patterns (Dunn 1997). This model provides the foundation for the four domain scores of the Sensory Profile, which describe the extent to which individuals have: (a) a high sensory threshold with passive behavioral responses (Low registration); (b) a high sensory threshold with active behavioral self-regulation (Sensation seeking); (c) a low threshold with passive responses (Sensory sensitivity); and (d) a low threshold with active self-regulation (Sensation avoiding).

Despite its ease of interpretation, this theoretical model and the resulting measurement tool presents challenges for researchers and clinicians. A single threshold-based model, even when thresholds may

differ across sensory domains, cannot account for the concurrent hyper- and hypo-sensitivities observed in FXS and ASD populations, including poor responding to individual voices coupled with an aversion to noisy environments such as a crowded restaurant (Stackhouse et al. 2014). Indeed, Sensory Profile scores show positive correlations across high- and low-sensory threshold domains (e.g., Ben-Sasson et al. 2007; Engel-Yeger 2012), reflecting that simultaneously elevated and dampened sensory responsivity can and do co-occur. These correlated domains of the SP are at odds with the categorical structure of the theoretical model and intervention recommendations (see Dunn 2007; Dunn et al. 2002), posing challenges for explaining individual differences and developing treatments for individuals with both hypo- and hyper-sensitivities in a single domain. Furthermore, this model lacks a plausible mechanism or organizing principles for the neural regulation involved in shifting sensory processing. Though Dunn's model acknowledges that sensory processing may be regulated by experience and bio-behavioral state (Dunn 1997), the lack of an integrated neural mechanism for sensory modulation has steered research toward treating sensory processing as a fixed trait (see Dunn 2001) and interventions toward changing environments to better accommodate an individual's sensory processing profile (see Dunn 2007; Dunn et al. 2002).

Another widely-used sensory processing scale is the Sensory Experiences Questionnaire (Baranek 1999; Baranek et al. 2006; Little et al. 2011), which was developed for identifying sensory features of

children with autism. It is composed of subscales that assess hyper-responsiveness, hypo-responsiveness, and sensory seeking within individual sensory domains as well as social and non-social contexts. In contrast to a single threshold model, this scale is based on a conceptual model of sensory processing problems arising from a narrowed optimal engagement band, with a higher threshold required for orientation and a decreased threshold for aversive responses (Baranek et al. 2001; Baranek 1999). Although providing a conceptual explanation of concurring hyper- and hypo-sensitivities, stimuli eliciting hyper-reactivity must have stronger signals than those that result in hyporesponsivity, at least within social or non-social domains. However, the very low-amplitude auditory stimuli that can elicit intense aversive reactions in individuals with ASD, such as particularly high or low frequency appliance noise not normally noticed by others (Talay-Ongan and Wood 2000), pose a challenge to this model. Most importantly, like Dunn's model of sensory processing, this conceptual model provides room for state-dependent sensory modulation but lacks a proposed neural mechanism that gives rise to such differences.

An approach that provides a neurophysiological framework for the study of sensory processing is based on the Polyvagal Theory (Porges 1995, 2001, 2007, 2011). This theoretical framework traces the evolution of the mammalian nervous system as it transitioned from optimization for defense and life-threat responses toward an affiliative, social way of life that required the dampening of primitive defense systems. Polyvagal Theory hypothesizes that the nervous system

dynamically detects and evaluates sensory signals from within the body and from the environment as cues of safety, danger, or life-threat. The theory proposes that these exteroceptive and interoceptive inputs are integrated to inform a neurophysiological state that can flexibly regulate sensory information to promote vigilance for evolutionary danger cues or, conversely, attention to social affiliative cues via the motor pathways of the autonomic nervous system. This focus on state-regulated sensory processing modulation may provide a foundation for improved documentation of sensory processing problems and provide a conceptual bridge between neuroscience, physiology, and clinical approaches to studying sensory systems and their pathology. Notably, this threat-response approach is consistent with Cohen's (1995) proposal that the behavioral phenotype of individuals with FXS, including tactile and auditory hypersensitivities, may be caused by hyperarousal.

Polyvagal Theory proposes that evolutionarily-salient cues, outside the realm of conscious awareness, reflexively trigger physiological state changes via motor pathways of the autonomic nervous system, modulating sensory processing. For instance, safety-related states may promote the regulation of the middle ear muscles to dynamically boost the frequency band in which spoken language intelligibility occurs, promoting speech orientation and comprehension for affiliative social interactions. However, as danger-responsive physiological states shifts to support fight/flight behaviors, these muscles can be regulated to dampen language-related vocal frequencies to boost salience of high

frequency signals, associated with distress calls, or low frequency signals, evolutionarily associated with predator calls (see Kolacz et al. in press; Porges and Lewis 2009). Other sensory domains can be similarly regulated to promote threat vigilance, such as heightened sensitivity for visual movement, or defense- oriented states and responses that are unsuited for affiliative social interaction, such as aversion to friendly touch. Physiological profiles have been observed to predict differences in children's temperamental affective discomfort to sensation (Kolacz et al. 2016). These sensory physiological pathways also link with the regulation of swallowing muscles (Kolacz et al. in press), and control of gastrointestinal functions in response to metabolic needs (Porges 2011; also see Zhu et al. 2016; Zhang et al. 2006; Herman et al. 2009).

Based on the anatomical and functional organization described above, a behavioral profile marked by aversion to or neglect of social affiliative interactions, heightened sensitivity to threat cues, and digestive/ ingestive difficulties—common in individuals with FXS and ASD—would be expected to be marked by a physiological withdraw of socially-supportive circuits and stronger activation of defense-supporting circuits. This physiological profile is evidenced in individuals with FXS and ASD in whom vagal regulation of the heart, which reflects the calming affiliative-promoting circuits and gives rise to respiratory sinus arrhythmia, is tonically low and lacks the normal challengeinduced regulatory pattern of their typically developing peers (Klusek et al. 2015; Heilman et al. 2011; Roberts et al. 2001). In

addition, males with FXS have exaggerated sympathetic activity, a fight/flight mobilization response, during conversations involving eye contact (Belser and Sudhalter 1995) and in response to sensory stimuli in multiple domains (Miller et al. 1999). Notably, more pronounced sympathetic responses to sensory stimuli are related to lower expression of FMRP (measured by percent of FMRP-positive lymphocytes; Miller et al. 1999).

The converging evidence reviewed above is consistent with sensory processing as linked with a neuro-physiological regulation mechanism for responding to environmental threat and safety cues. To promote research into these functions in FXS and ASD populations, there is a need for a questionnaire instrument that can assess patterns of everyday sensory responses informed by an understanding of neurophysiological processes. The Brain-Body Center Sensory Scales (BBCSS; Porges 2012), a caregiver-report questionnaire, was designed to address this gap. In this paper, we present results of a psychometric study evaluating its factor structure, reliability, and validity study.

We hypothesized that factors would be best described by underlying threat-related neurophysiological regulation, rather than singleor dual-model sensory thresholds. Because of the exploratory goal of examining the BBCSS factor structure, our specific hypotheses about relations of the BBCSS subscales with validity instruments and differences between children with and without ASD were limited in specificity. We expected to find moderate levels of convergence with the passive subscales of the Sensory Profile forms at both ages

(sensitivity and registration/bystander, low registration) and lower convergence with the active subscales, which reflect behavioral strategy responses to senory needs. We also expected to find moderate correlations with modality-, context-, and hypo-/hyper-reactivity specific subscales of the SEQ, dependent on whether the BBCSS subscales emerge to reflect such specificity. However, we also expected that the derived subscales would demonstrate substantial unique variance and structural divergence reflecting the distinct approach posed by our organizing theoretical model. Given the general elevated severity of the ASD + FXS phenotype compared to FXS without ASD (Bailey et al. 2001; Kaufmann et al. 2004; Lewis et al. 2006; Hernandez et al. 2009), differences between individuals with FXS only and FXS and ASD were expected as well, with co-diagnosis relating to more impaired sensory behaviors.

Conclusion

Despite these considerations, this study demonstrates several strengths. Firstly, in comparison to typical studies of indi- viduals with FXS, the sample in this study was relatively large and provided an opportunity for psychometric assess- ment targeted to this specific population. Furthermore, to our knowledge, this is the first sensory processing questionnaire developed from an evolutionary neurophysiological founda- tion. Thus, the development of the BBCSS and its foun- dation in the Polyvagal Theory provides a novel direction for understanding the evolutionary and neurophysiological mechanisms that give rise to

sensory processing difficulties and points the way for the development of more effective interventions.
Sensory interventions are one of the most common requests by parents of children with FXS and ASD (Green et al. 2006; Stackhouse et al. 2014) but the effectiveness of current sensory interventions is poor to modest (Case- Smith et al. 2015). By refocusing theoretical approaches away from general hypo- and hyper-sensitivity frameworks and assessments, researchers and clinicians can move toward an understanding of the specific environmental features that cue neurophysiological mechanisms for modulating sensory processing. This theoretical and methodological reframing may point toward techniques that aim to utilize these envi- ronmental features, optimizing natural safety and threat cues to "retune" the nervous system's sensory processing from threat-related vigilance and mobilization states toward sup- porting affiliative social interactions.

Brain Body Center Sensory Scales (BBCSS)
Child Form

The Brain Body Center Sensory Scales (BBCSS) are designed as a general, preliminary assessment of behaviors related to sensory processing profiles, including auditory, visual, and tactile processing, and feeding behaviors. Individual responses to different environmental stimuli vary widely, and learning more about a child's sensory processing is an important component of any comprehensive behavioral evaluation.
If you are unsure whether your child has ever displayed the behavior in question, or if your child has NEVER displayed the behavior please answer Not sure/Not Applicable.
BBC Sensory Scales Child Form
Child form ~ Auditory Processing

1. How often does your child respond negatively to unexpected or loud noises (for example, hides or cries at noise from ambulance, train, fire or car alarm, fireworks)?
   ☐☐☐☐☐
   Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

2. How often does your child become distracted, or have difficulty following verbal instructions when there is a lot of noise around?
   ☐☐☐☐☐

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Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

3. How often does your child hold his/her hands over the ears?
? ? ? ? ?
Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

4. How often does your child appear not to hear what you say (for example, does not seem to pay attention to what you say, appears to ignore you)?
? ? ? ? ?
Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

5. How often does your child have trouble working with background noise (for example, air conditioner, traffic noises, airplanes)?
? ? ? ? ?
Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

6. How often does your child not respond when his/her name is called, even though you know the child's hearing is not a problem?
? ? ? ? ?
Almost Always Frequently/ Often Sometimes/ Occasionally

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Almost Never Not Sure/ Not Applicable

7. How often is your child unusually angry or frightened or appear in pain when others cry or scream?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

8. How often do you have to speak loudly or get very close to your child's face to get your child's attention?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

9. How often does your child seem unaware of continuous noise in the environment (for example, TV, stereo)?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

10. Howoftendoesyourchildseemoverlyaware,distracted,ordisturbedby continuousnoiseintheenvironment (for example, TV, stereo)?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally

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Almost Never Not Sure/ Not Applicable

11. Howoftendoesyourchildtakealongtimetorespondwhenspokento,eventofamiliarvoices?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

12. Howoftendoesyourchildstartleeasilyatsound,comparedtootherchildrenthesameage,withloudor high- pitched noises (for example, vacuum, blender, fire alarms)?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

13. How often is your child distracted by sounds not normally noticed by other people (for example, air conditioning fans, trains or planes outside)?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

14. Howoftendoesyourchildrespondnegatively(i.e.tantrum,becomedistractedoranxious)whenentering places with continuous background noises (for example, grocery stores, schools, shopping malls)?

□□□□□
Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

Child form ~ Visual Processing

15. How often is your child bothered by bright lights after your eyes or other children's eyes have adapted to the same light?

□□□□□
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

16. How often does your child cover his/her eyes or squint?

□□□□□
Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not

17. How often does your child seemunabletotoleratebrightlights?

□□□□□
Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not

18. How often does your child seemunabletotolerateflashinglights?

□□□□□
Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not

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19. How often does your child getfussywhenexposedtobrightlights?

? ? ? ? ?

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

20. How often does your child seemsensitivetobrightlights(forexample,criesorcloseseyes)?

? ? ? ? ?

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

21. How often does your child seemsensitivetoflashinglights(forexample,criesorcloseseyes)?

? ? ? ? ?

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

22. How often does your child hesitatetogooutsidewhenit'ssunny?

? ? ? ? ?

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

23. How often does your child seem easily distracted by movement he/ she can see?

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☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
24. How often does your child seem easily distracted by movements of objects (i.e. mechanical toys or cars)?
☐☐☐☐☐

Child form ~ Tactile Processing (Touch)
25. Howoftendoesyourchildseemdistressedbytooth-brushing?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
26. Howoftendoesyourchildseemdistressedbyface-washing?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
27. Howoftendoesyourchildseemdistressedbyfingernail-cutting?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
28. Howoftendoesyourchildseemdistressedbyhair-brushing?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

29.
Howoftendoesyourchildinsistthatlabelsortagsberemovedfrommostclothing?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
30.
Howoftendoesyourchildrefusetowearcertainfabricsorcryorfussinresponsetowearingcertainfabrics?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
31.
Howoftendoesyourchildcomplainthatcertaingarmentsaretootightorscratchy?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
32. Howoftendoesyourchildprefertonotwearclothing?
☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable
33. Howoftendoesyourchildresisthugging?
☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

34. Howoftendoesyourchildreactnegativelyoraggressivelytohand-holding?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

35. Howoftendoesyourchildreactemotionallyoraggressivelytobeingtouched?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

36. Howoftendoesyourchildreactemotionallyoraggressivelywhentouchingverycoldobjectswithhis/herhands?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

37. Howoftendoesyourchildreactemotionallyoraggressivelywhenverycoldobjectstouchhis/herface?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

Child form ~ Ingestion and Digestion

38. Howoftendoesyourchildavoidcertaintastes?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

39. Howoftendoesyourchildresistcertaintexturesoffood?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

40. Howoftendoesyourchildavoidcertainfoodsmells?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

41. Howoftendoesyourchildresistcertaintemperaturesoffood?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

42. Howoftendoesyourchildgag?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

43. Howoftendoesyourchildvomit?

☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

44. Howoftendoesyourchildhaveacidreflux?

☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

45. Howoftendoesyourchildhaveexcessiveintestinalgas?

☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not

46. Howoftendoesyourchildbecomeconstipated?

☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

47. Howoftendoesyourchildexperiencestomachorintestinalcramping?

☐☐☐☐☐
Almost Always Frequently/ Often Sometimes/ Occasionally Almost Never Not Sure/ Not Applicable

48. How often does your child seem to have difficulty swallowing solid foods?

☐☐☐☐☐

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

49. Howoftendoesyourchildsuckonobjectsotherthanfood(forexample,pacifier,owntongue,thumb)?

? ? ? ? ?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

50. Howoftendoesyourchildeat(orwanttoeat)significantlylessthanyouthinkisappropriateforhis/her size or age?

? ? ? ? ?

Almost Always Frequently/ Often Sometimes/ Occasionally
Almost Never Not Sure/ Not Applicable

Neuroception of Psychological Safety Scale - Generic Version (NPSS-G)

Morton, L., Cogan, N., Kolacz, J., Calderwood, C., Nikolič, M., Bacon, T., Pathe, E., Williams, D., Porges, S. (2021) ©

Please rate how well the following statements describe your feelings over the past week.

Strongly Disagree (score = 1), Disagree (score = 2), Neither Agree or Disagree (score = 3), Agree (score = 4), Strongly Agree (score = 5).

- 1 I felt valued
- 2 I felt comfortable expressing myself
- 3 I felt accepted by others
- 4 I felt understood
- 5 I felt like others got me
- 6 I felt respected
- 7 There was someone who made me feel safe
- 8 There was someone that I could trust

- 9 I felt comforted by others
- 10 I felt heard by others
- 11 I felt like people would try their best to help me
- 12 I felt cared for
- 13 I felt wanted
- 14 I didn't feel judged by others
- 15 I felt able to empathise with other people
- 16 I felt able to comfort another person if needed
- 17 I felt compassion for others
- 18 I wanted to help others relax
- 19 I felt like I could comfort a loved one
- 20 I felt so connected to others I wanted to help them

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- 21 I felt caring
- 22 My heart rate felt steady
- 23 Breathing felt effortless
- 24 My voice felt normal
- 25 My body felt relaxed
- 26 My stomach felt settled
- 27 My breathing was steady
- 28 I felt able to stay still
- 29 My face felt relaxed

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Neuroception of Psychological Safety Scale - Generic Version (NPSS-G)
Morton, L., Cogan, N., Kolacz, J., Calderwood, C., Nikolič, M., Bacon, T., Pathe, E., Williams, D., Porges, S. (2021) ©
Please rate how well the following statements describe your feelings during (specify a particular situation, timeframe, or experience).
For example; 'Your experiences at work over the past week', 'Your recent hospital stay', 'Your experiences in your classroom' or 'Your time spent on social media over the past week'

_____ _____

The statements and their scoring are the same NPSS-G statements listed above
Guidance notes:

- This scale aims to provide a standardised measure of psychological safety grounded in The Polyvagal Theory.
  - A higher score indicates higher feelings of psychological safety, it is important to note that this is likely to vary depending on context (for example, being at work versus being at home).
  - The establishment of the psychometric properties of the NPSS-S are under development please contact (nicola.cogan@strath.ac.uk or liza.morton@gla.ac.uk) for further

information.

- While this measure is free to use, please contact us for permission beforehand.

- Please keep us updated with your feedback on the scale to assist us with its development
and guidance for use.

- Citation:
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A New Measure of Feeling Safe: Developing Psychometric Properties of the Neuroception of Psychological Safety Scale (NPSS)

Liza Morton[1], Nicola Cogan[1], Jacek Kolacz[2, 3], Calum Calderwood[1], Marek Nikolic[1], Thomas Bacon[4],

3

Emily Pathe[5], Damien Williams[1], and Stephen W. Porges[2, 6]

[1] School of Psychological Sciences and Health, University of Strathclyde

[2] Traumatic Stress Research Consortium (TSRC), Kinsey Institute, Indiana University Bloomington
Department of Psychiatry and Behavioral Health, The Ohio State University Wexner Medical Cente [4] Department of Psychology, NHS Fife, Scotland

[5] Department of Psychology, NHS Lanarkshire, Scotland

[6] Department of Psychiatry, University of North Carolina at Chapel Hill

Objective: Psychological safety is increasingly recognized as central to mental health, wellbeing and posttraumatic growth. To date, there is no psychometrically supported measure of psychological safety combining psychological, physiological and social components. The current research aimed to develop and establish the neuroception of psychological safety scale (NPSS), informed by Polyvagal Theory.

Method: The study comprised of 3 stages: (a) item generation, (b) item reduction, and (c) assessment of factor structure and internal consistency. Exploratory and confirmatory factor analysis was conducted from 2 samples who completed a survey online (exploratory n = 342, confirmatory n = 455). Results: Initially, 107 items were generated. Item reduction and exploratory factor analysis resulted in a 29-item NPSS with subscales of compassion, social engagement and body sensations. The NPSS was found to have a consistent factor structure and internal consistency. Conclusion: The NPSS is a novel measure of psychological safety which can be used across a range of health and social care settings. This research provides a platform for further work to support and enhance understandings of the science of safety through the measurement of psychological, relational and physiological components of safety. The NPSS will help shape new approaches to evaluating trauma treatments, relational issues and mental health concerns. Research to establish the convergent, discriminant and concurrent validity of the NPSS and to explore its use with diverse community and clinical populations is underway. Psychological safety is recognized as central to mental health, wellbeing (Sullivan et al., 2018) and posttraumatic growth (Nor- man et al., 2020) with increasing clinical interest and research attention toward its importance. Feeling safe is recognized as a distinct state important for rest, restoration and social bonding (Porges, 2011). As social beings perceived threat is often interper- sonal while safety with other people is communicated using com- passion (Gilbert, 2017). Compassionate

interventions, such as the use of soothing voice tones and breathing, reduce the fight/flight response, decelerate heartbeat and facilitate parasympathetic rest and restoration (Kirby et al., 2017). A safe and compassionate early environment shapes the nervous system and aids the devel- opment of self-soothing strategies that enable self-regulation in later life (Gilbert, 2017). Trauma symptoms arise from unregu- lated threat preoccupation, when self-regulation is not available, which affects our biology, social interaction, and maturation (Mot- san et al., 2021; van der Kolk, 1994).

To date, psychological safety research has largely been considered within organizational and group contexts, describing the process of assessing risk in interpersonal relationships and occupational envi- ronments. The Team Psychological Safety Scale (Edmondson, 1999) is a 7-item self-report scale that measures perceptions of feeling safe within teams which has good reliability and validity (Ming et al., 2015). Increased sense of psychological safety at work facilitates em- ployee communication, improvements in learning, teamwork and work performance (Edmondson & Lei, 2014; O'Donovan et al., 2020). The positive impact of psychological safety has been found in other organizational contexts, including public spaces, education (Wanless, 2016), community building (Singh et al., 2018), and com- municating in medical teams (Real et al., 2021) and in health care workplaces to reduce levels of psychological distress and trauma (Ahmed et al., 2021). However, psychological safety and its mea- surement differs within teams differs from the individual.

Psychological safety for the individual, rather than within teams, has also begun to gain attention within mental health set- tings regarding clinical understanding of trauma related conditions and trauma informed practices (Isobel et al., 2020) where tradi- tional measures focus on pathology rather than prevention and positive adaptation. Difficulty in assessing danger or safety and modulating fear response is reported in individuals suffering Post Traumatic Stress Disorder (PTSD; Jovanovic et al., 2012). A novel manualized cognitive-behavioural treatment for PTSD called 'Seeking Safety' which prioritizes feeling safe (Najavitis, 2001) delivered improved outcomes in symptoms of PTSD and psychiat- ric distress compared to controls (Desai et al., 2008). 'The Feeling Safe Program' aims to address safety feelings when treating perse- cutory delusions in psychosis and a clinical trial of this interven- tion showed recovery (Freeman et al., 2016).

The following psychological scales include a component of psy-chological safety. In the Activation and Safe/Content Affect Scale (Gilbert et al., 2008) safe affect is shown to negatively correlate with measures of depression, anxiety, stress, self-criticism, and insecure attachment. The same research team developed the Scale of Childhood Memories of Emotional Warmth and Safety (Richter et al., 2009). The Therapeutic Environment Scale includes a 'feel- ing safe with others' subscale, validated using clinical samples (Veale et al., 2016). The Child Safety Behavior Scale has been developed to measure safety-

seeking behaviors (Alberici et al., 2018) but is less concerned with affective states.
In medical settings concern for the sense of safety experienced by patients (Ellegaard et al., 2020; Morton, 2020) and when exposed to disempowering aspects of care (Morton et al., 2020) is of interest in terms of quality of experience and speed of recovery. In one study, feeling safe during the process of hospitalization was found to increase feelings of control, calm and hope (Mollon, 2014). Feeling safe has also been found to improve healing and re- covery during maternity care of women who have experienced childhood sexual trauma, while feeling unsafe with professionals could be experienced as retraumatization (Morton, 2020).
In sum, to date psychometric measures of feeling safe have been restricted to specialized contexts such as team safety (Edmondson, 1999) childhood memory of safety (Richter et al., 2009), as a subscale (Veale et al., 2016), or as a dimension of a broader scale under factor analysis (Gilbert et al., 2008) rather than the central construct. Due to the importance of safety within a therapeutic context and the lack of a general dedicated means of measurement that considers relationship dynamics (Roussin et al., 2016), there is a need for the development of a refined psychometrically validated scale of psychological safety.
The Polyvagal Theory (PVT) offers a comprehensive explana- tion of psychological safety grounded in an evidence-base of neu- rophysiology, psychology and evolutionary theory. PVT describes how situations are subconsciously assessed for safety or threat by the

autonomic nervous system, termed “neuroception,” leading to corresponding physiological, affective, and behavioral 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. Situa- tions detected as unsafe will shift bio-behavioural systems that would restrict interpersonal social engagement, while optimizing physiological state, via the autonomic nervous system to support defensive survival strategies either via the dorsal vagal pathway leading to immobilizing, death feigning, or dissociating or via the sympathetic system leading to fight/flight behaviors 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 educa- tional practices in the use of safe therapeutic presence (Geller & Porges, 2014), recognition of client’s nonverbal safety-signaling (Mair, 2021) and interpreting representations of fear and safety in art therapy (Gerge, 2017). It has also acted as the basis of the Body Perception Questionnaire (Cabrera et al., 2018) and the Brain-Body Center Sensory Scales (Kolacz et al., 2018) support- ing the utility of PVT as the grounding for a new general scale of safety. As such, the current study aimed to develop such a self- report measure, the Neuroception of Psychological Safety Scale (NPSS) informed by the PVT (Porges, 2004, 2011, 2021).

Method

Phase 3: Internal Reliability and Dimensionality

Results

Discussion

The study reports that the NPSS is a psychometrically sound measure that captures the multiple dimensions of psychological safety that people experience but that, until now, have been diffi- cult to operationalize and measure. The first phase resulted in gen- eration of 107 items pertaining to what it means to feel safe by psychologists and researchers with expertise in trauma and the PVT creating the comprehensive NPSS. The second phase evaluated the items and assessed factor structure, thus creating the 27-item NPSS scale with three subscales consistent with understanding of safety as proposed by the PVT and literature in psychological safety. The first factor, termed Social Engagement, is characterized by being accepted, understood, cared for, being able to express oneself with- out being judged, and having someone to trust. The items indicated evaluation of the social environment as nonthreatening and safe to engage socially—a property ascribed to the Social Engagement System (SES; Porges, 2011). The second factor captured items related to the ability to be compassionate and feeling connected, empathetic, caring and wanting to help. Being compassionate regulates our autonomic nervous system (Kirby et al., 2017) while regulation occurs through the ability to self-soothe (Mok et al., 2019) and communicating safety. In therapy, compassion is increasingly seen as central to promote safety and develop/ reengage self-soothing strategies (Gilbert, 2017). The third fac- tor 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).

Correlation was stronger between the first and second factors which may suggest a bidirectional link between the feeling of being accepted within a group and compassion (Liu, 2017). We found a gender difference on the Body Sensations subscale but not on the other two subscales with males scoring significantly lower. Body awareness has also shown to be impacted by age (Cabrera et al., 2018) and psychopathology (Bernatova & Svetlak, 2017), which may be considered in further evaluative efforts.

In the third phase the NPSS was evaluated with CFA. The three-factor structure showed adequate fit, and the scale showed good reliability. In both phase two and three, scores distribution was leptokurtic and negatively skewed. This ceiling effect observed is attributed to sampling from the convenience general population sample and participants being prompt to ‘think about a recent specific situation when you felt safe’ which may have led to participants responding about a situation when they felt optimally safe.

Applicability of the NPSS may be improved by inquiring about a specific situation or event, for example, ‘please rate the follow- ing statements in relation to [insert your event].’ However, the original

wording may be useful when determining the baseline safety is desirable, for example when the objective is mental health recovery (Lewis et al., 2019). The applicability of the NPSS could also be increased by formalizing a procedure for scoring and inter- preting subscale measures, as the bodily sensations subscale may be more useful in gauging feelings of safety in asocial situations. Though the NPSS is a relatively brief instrument, future studies are needed to explore whether a shorter form may be developed to expand clinical utility for cases in which rapid measurement is a priority.

This study has several limitations and suggestions for future work. First, since participants self-selected through convenience sampling rather than being randomly selected, they may have had stronger feelings about psychological safety than those in the larger population in general. While recruiting participants through social media has many advantages, it also has its potential biases, that may limit generalizability (Benedict et al., 2019). Future

Purpose in Life Scale.pdf

Purpose in Life Scale
Stephen W. Porges and Jacek Kolacz © 2018
How much do you agree or disagree with the following statements?
Strongly-disagree Somewhat-disagree Neither-agree-nor-disagree
Somewhat-agree Strongly-agree

1 I feel that my life has meaning
2 Even when things are bad, I still have hope
3 My work drains my energy
4 I feel that life is worthwhile
5 It feels good to set goals for myself
6 I feel that there are things in the future to be hopeful about
7 I get enjoyment out of the things I do
8 I feel a curiosity about the world
9 I enjoy working to make my plans a reality
10 I am enthusiastic about getting out of bed in the morning
11 I feel that my life is interesting
12 I would like to disappear or become invisible