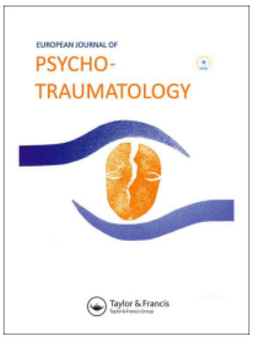

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CLINICAL RESEARCH ARTICLE

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From Somatic Experiencing to felt safety: assessing the effects of a body-oriented intervention in adults with various degrees of child maltreatment

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ABSTRACT

Background: Child maltreatment (CM), i.e. neglect and abuse of children by their caregivers, has been linked to reduced psychological safety and a sense of disrupted body boundaries (DBB), both of which have been proposed to impair social functioning. However, evidence-based interventions to increase psychological safety and to reduce DBB are lacking.

Objectives: We conducted two experiments across two separate studies. Study I examined the effect of a brief (60-minute) body-oriented intervention, derived from Somatic Experiencing (SE), on psychological safety. Study II investigated the effect of the same intervention on DBB.

Methods: In both studies, adults with varying levels of CM exposure, based on total self-report scores across subtypes, were randomized to an SE group or to a psychoeducation control group. Study I included participants with a lack of psychological safety ($n = 89$); Study II included participants with DBB ($n = 55$).

Results: In Study I, compared to controls, the SE group showed an increase in psychological safety ($d = -.95$, $p < .001$). SE group-specific changes were also found for different types of positive and negative affect and for social connectedness. Heart Rate (HR) decreased, and Heart Rate Variability (HRV) increased across groups. In Study II, compared to controls, the SE group showed a reduction in DBB ($d = 1.13$, $p < .001$) and an increase in interoceptive awareness, a proposed mechanism of action.

Conclusions: A brief, SE-based intervention can facilitate momentary states of perceived safety and improve social connectedness in adults with different levels of CM. Future research should explore longer-lasting positive effects of SE.

De la Experiencia Somática a la seguridad sentida: evaluación de los efectos de una intervención centrada en el cuerpo en adultos con distintos grados de maltrato infantil

Antecedentes: El maltrato infantil (MI), es decir, la negligencia y el abuso por parte de los cuidadores, se ha asociado a una disminución de la seguridad psicológica y a una alteración de los límites corporales (ALC), factores que pueden afectar el funcionamiento social. Sin embargo, existen pocas intervenciones basadas en evidencia orientadas a incrementar la seguridad psicológica y reducir la alteración de los límites corporales.

Objetivos: Se realizaron dos estudios experimentales. El Estudio I examinó el efecto de una intervención corporal breve (60 minutos), derivada de la Experiencia Somática (Somatic Experiencing, SE), sobre la seguridad psicológica. El Estudio II evaluó el efecto de la misma intervención sobre la alteración de los límites corporales.

Métodos: En ambos estudios, adultos con distintos niveles de exposición a MI fueron asignados aleatoriamente a un grupo de SE o a un grupo control de psicoeducación. El Estudio I incluyó participantes con baja seguridad psicológica ($n = 89$) y el Estudio II participantes con alteración de límites corporales ($n = 55$).

Resultados: En el Estudio I, el grupo SE mostró un aumento significativo de la seguridad psicológica en comparación con el grupo control. También en ese grupo se observaron cambios específicos en diferentes tipos de afecto positivo y negativo, así como la conexión social. La frecuencia cardíaca disminuyó y la variabilidad de la frecuencia cardíaca aumentó en ambos grupos. En el Estudio II, el grupo SE presentó una reducción significativa de la alteración de límites corporales y un aumento de la conciencia interoceptiva, propuesto como un mecanismo de acción.

Conclusiones: Una intervención breve basada en Experiencia Somática puede facilitar estados momentáneos de seguridad percibida y mejorar la conexión social en adultos con distintos niveles de maltrato infantil. Futuros estudios deberían explorar los efectos a largo plazo de esta intervención.

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KEYWORDS

Body-oriented therapy; social safeness; somatic experiencing; abuse; neglect; brief intervention; autonomic responses; trauma

PALABRAS CLAVE

Experiencia somática; abuso; negligencia; terapia centrada en el cuerpo; seguridad social; respuestas autonómicas; funcionamiento social

HIGHLIGHTS

- A one-hour, body-oriented psychological intervention helps adults with difficult childhood experiences feel safer.
- Somatic Experiencing supports awareness of internal bodily sensations.
- Findings suggest that brief body-oriented exercises can increase social well-being.

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Child Maltreatment (CM), i.e. abuse and neglect of children by their caregivers or other trusted persons, is a global problem. Prevalence estimates for the adult population range from 17–65% for neglect, 6–27% for sexual abuse, 22–60% for physical abuse, and 6–61% for emotional abuse (Moody et al., 2018). CM increases the risk for mental and physical disorders across the lifespan and is linked to a broad range of problems in social functioning (e.g. Scott et al., 2023), including loneliness, social isolation, and lack of social support (Pfaltz et al., 2022). Impairments in social functioning can be considered particularly problematic, as *positive* social relationships can protect from negative consequences of stress (Pfaltz et al., 2022) and are considered resilience factors after trauma, including CM (e.g. Yule et al., 2019; Zalta et al., 2021). In contrast, dysfunctional or lacking close relationships are risk factors for mental and physical ill-health (Charuvastra & Cloitre, 2008; Pfaltz et al., 2022).

One factor that might contribute to impaired social functioning among individuals exposed to CM is reduced *Psychological Safety* – the perception of the social environment as non-threatening and safe to engage with, and to be compassionate and feel connected, empathic, and caring. Moreover, it includes bodily sensations such as a steady heartbeat and breathing, signalling calmness and relaxation (Morton et al., 2024). These mental and bodily aspects of psychological safety contribute to a positive affective state – considered important for social engagement, secure attachment and physical recovery (Morton et al., 2024). This positive calm safe affective state can be understood as increased activity of the vagus nerve (Porges, 2007), reflected in lower heart rate (HR) and higher heart rate variability (HRV), indicating activation of the parasympathetic nervous system and effective emotion regulation (Thayer et al., 2012). A perceived lack of psychological safety can contribute to negative affective states like loneliness (Power et al. 2017), and might be related to disruptions in physical and psychological boundaries (Krzewska & Dolińska-Zygmunt, 2013; Talmon & Ginzburg, 2017). More specifically, individuals exposed to CM can experience a sense of *Disrupted Body Boundaries* (DBB). They may feel, for example, that their body is vulnerable to threats from others, and that the boundary between their body and the outside world is blurred (Krzewska & Dolińska-Zygmunt, 2013). Research shows that adults who have experienced CM (Talmon & Ginzburg, 2018) or lacked warmth and safety in childhood tend to report a sense of DBB (cf. Talmon et al., 2021). This aligns with research pointing to differences between individuals with and without exposure to CM when being approached by, or when approaching others: individuals exposed to CM tend to stop others and themselves earlier on, i.e. at greater distances, as they feel uncomfortable with closer physical proximity (e.g. Haim-Nachum et al., 2024; Hautle et al., 2024; Lüönd et al., 2022; Maier et al., 2018). A sense of DBB could also lead to interoceptive dysfunction; that is, difficulties in identifying and interpreting body sensations (Schaan et al., 2019). For instance, high sensitivity to bodily signals (e.g. increases in HR) may evoke a sense of threat in social situations (Krzewska & Dolińska-Zygmunt, 2016). DBB may, thus, make it difficult for individuals exposed to CM to develop and maintain positive social relationships. In sum, individuals exposed to CM tend to interpret social stimuli and situations as negative and unsafe (Haim-Nachum et al., 2024; Hautle et al., 2023; Maier et al., 2020; Talmon & Ginzburg, 2018) and show corresponding bodily threat responses to social stimuli (e.g. McCrory et al., 2013). While adaptive in abusive or neglectful environments, this may impair social functioning in non-threatening contexts.

Evidence-based interventions to improve psychological safety and to diminish DBB in individuals with CM are lacking. Given their heightened bodily threat responsivity (Pine, 2003), which may lead to negative emotional and maladaptive behavioural responses to social situations, individuals with CM might benefit from body-oriented interventions, promoting a bodily felt sense of safety. An approach with potential positive effects on psychological safety and DBB is Somatic Experiencing (SE; Payne et al., 2015).

SE, a body-oriented psychotherapy, supports clients exposed to stressful experiences, including traumatic ones, to regulate their emotions and physiological arousal. It focuses on areas of the body that, in the aftermath of threatening experiences, feel unpleasant, aiming to reduce excessive arousal via, e.g. small body movements (Payne et al., 2015). The therapist guides the patient's attention to external stimuli and internal sensations (breath, movement, sensory and motor experiences) that signal strength, calm and safety (e.g. strong legs, slow breathing). Building up the capacity to experience and maintain bodily felt states of safety serves as a basis to notice, explore, and understand learned stress responses, e.g. to social situations, in the absence of excessive fear. This is assumed to promote the ability to detect, be aware of and reflect on bodily signals (interoceptive awareness), creating opportunities to learn novel responses to and interpretations of social situations (Arnold et al., 2019).

Although SE is increasingly used in clinical practice and emerging RCTs suggest beneficial effects on PTSD and depression (Kuhfuß et al., 2021), studies in individuals with CM are lacking. Moreover, despite

anecdotal reports of SE establishing a basic sense of safety (Payne et al., 2015), research assessing the effects of SE on psychological safety (including its effects on the autonomic nervous system), DBB, and interoceptive awareness is lacking. As first steps to close these existing gaps, we conducted two experimental studies, assessing the immediate effects of a single SE session (intervention group) versus a psychoeducation condition (control group receiving psychoeducation on SE) on emotional and physiological aspects of psychological safety (Study I) and on a sense of DBB (Study II). Although psychological safety and DBB are theoretically related, they seem to tap into distinct aspects of perceived safety. Therefore, we sought to examine these variables in two distinct subgroups (i.e. individuals reporting a lack of psychological safety and those reporting experiences consistent with DBB) to better isolate the effects of SE on each aspect of safety. Additionally, we assessed whether an SE session (compared to the control condition) increases interoceptive awareness (Study II) and explored variables (e.g. severity of CM) that might impact the effect of SE (Study I and II). The rationale behind experimentally examining the immediate effects of a single session was to build a basis for future clinical trials, assessing long-term effects of (single or multiple) SE sessions, in case of positive results. Given that individuals with CM may respond differently to SE than individuals without CM, we included participants with various levels of CM (none, mild, moderate, and severe).

Study I hypothesized that self-reported psychological safety (H1), including a positive, safe and calm affective state (H2), would increase in the intervention group (from pre- to post SE session) but not in controls (pre- to post psychoeducation). Regarding physiological aspects of psychological safety, H3 predicted that HR would decrease, whereas HRV would increase in the intervention group only. Secondary hypotheses (H4) on other socially relevant variables predicted that social connectedness would increase, whereas negative affect and loneliness would decrease in the intervention group. Study II predicted decreases in DBB (H1) and increases in interoceptive awareness (H2) in the intervention group. In secondary analyses, both studies assessed whether the strength of the expected effects was moderated by levels of CM, positive childhood memories, depressive symptoms, and attachment styles. All hypotheses were preregistered (osf.io/r52v8).

1. Study I

1.1. Method

1.1.1. Study design and ethical approval

Participants were randomly assigned to one of two conditions: SE (a single SE-Session) or an active control (SE-Psychoeducation). Variables of interest were measured prior to and after the SE and the SE-Psychoeducation session. Randomization of participants was conducted at the level of condition only, using a block randomization scheme (random blocks of 6 with 264 slots) generated by the Robust Randomisation App (RRApp; Tu & Benn, 2017). Participants were assigned to the conditions in the order in which they enrolled in the study.

Ethical approval was obtained from The National Ethical Review Board in Sweden (2022-06604-01). All participants gave written informed consent.

1.1.2. Participants and procedure

Data were collected between March 2023 and February 2024. We recruited participants via social media and physical posters in public spaces (e.g. universities; hospitals). We sought individuals who experienced a lack of psychological safety in social situations who had been exposed to different CM-levels (none, mild, moderate, severe). Potential individuals were directed to a webpage with a study description and a sign-up link and were assigned to the next available spot in the randomization scheme.

1.1.2.1. Inclusion and exclusion criteria. Signed-up individuals were contacted by a research assistant and underwent a brief (10–15 min) telephone screening to assess eligibility, address questions about the study, and schedule a physical appointment at Mid Sweden University. Inclusion criteria were: (1) confirming, in line with the conceptualization of a lack of psychological safety (Morton et al., 2024), at least one of the following experiences: not always feeling appreciated or accepted by others, not fully feeling understood or finding it difficult to connect with others, distressing bodily sensation(s); (2) $\geq$ 18 years of age; (3) proficiency in Swedish (to complete questionnaires and instructions). Exclusion criterion: During the physical appointment, being unable to follow instructions or under the influence of alcohol/drugs or extreme exhaustion, having an acute psychiatric condition operationalized as shown by presenting symptoms of psychotic, disorganized, or catatonic behaviour (observed by a research-assistant or SE therapist).

Of a total of 212 individuals using the sign-up link, 55 were unreachable by phone, 28 declined participation (with or without providing any specific reason for it), 22 were unavailable during the offered time slots, 8 were unable to participate because they resided in another city, 4 did not meet inclusion criteria, and 6 declined due to illness. The final sample comprised 89 participants who completed the entire study protocol (see Table 1 for sample characteristics). One participant was mistakenly assigned an incorrect survey and was thus only included in the HR/HRV-analysis.

Table 1. Sociodemographic characteristics of participants in Study I.

Sample characteristic	Full sample ($N = 89$)		SE ($n = 43$)		Control ($n = 46$)		[a]t/[b]χ2	(df)	*p*
Age, *M (SD)*	40.61	(13.09)	39.91	(13.35)	41.26	(12.96)	−0.48[a]	86.17	.63
Gender *n, (%)*							4.75[b]	2	.09
Female	76	(85.39)	34	(79.07)	42	(91.30)			
Male	12	(13.48)	9	(20.93)	3	(6.52)			
Non-Binary	1	(1.12)	0	(0.00)	1	(2.17)			
Education, *M* (SD)	13.79	(2.60)	13.49	(2.91)	14.07	(2.25)	−1.04[a]	79.05	.30
Relationship status *n (%)*							1.03[b]	2	.60
In a relationship	54	(60.67)	24	(55.81)	30	(65.22)			
Single	32	(35.96)	17	(39.53)	15	(32.61)			
Prefer not to answer	3	(3.37)	2	(4.65)	1	(2.17)			
CTQ severity *n, (%)*							4.74[b]	3	.19
None/Minimal	14	(15.73)	7	(16.28)	7	(15.22)			
Low	40	(44.94)	15	(34.88)	25	(54.35)			
Moderate	27	(30.34)	15	(34.88)	12	(26.09)			
Severe	8	(8.99)	6	(13.95)	2	(4.35)			
CTQ total score, *M (SD)*	49.51	(14.37)	51.58	(16.07)	47.59	(12.43)	1.31[a]	79.03	.19
Emotional Abuse	12.45	(4.69)	12.77	(5.24)	12.15	(4.15)	0.61[a]	79.98	.54
Physical Abuse	6.85	(3.66)	7.16	(4.02)	6.57	(3.30)	0.76[a]	81.50	.45
Sexual Abuse	6.88	(3.94)	7.91	(4.82)	5.91	(2.59)	2.41[a]	63.41	.02
Emotional Neglect	14.98	(4.55)	15.07	(4.79)	14.89	(4.36)	0.18[a]	84.75	.85
Physical Neglect	8.35	(3.27)	8.67	(3.42)	8.04	(3.12)	0.91[a]	84.83	.37
EMWSS, *M (SD)*	34.25	(15.13)	34.72	(14.73)	33.80	(15.64)	0.28[a]	86.99	.78
PHQ-8, *M (SD)*	10.39	(6.23)	9.49	(5.72)	11.24	(6.61)	−1.34[a]	86.50	.18
ECR-9 Avo, *M (SD)*	25.09	(7.63)	24.58	(7.19)	25.57	(8.06)	−0.61[a]	86.82	.54
ECR-9 Anx, *M (SD)*	16.36	(3.79)	16.05	(4.06)	16.65	(3.53)	−0.75[a]	83.40	.46
ULS-8 Trait, *M (SD)*	20.82	(3.90)	20.65	(3.98)	20.98	(3.86)	−0.39[a]	86.16	.69

Notes: CTQ = Childhood Trauma Questionnaire–Short Form; CTQ severity = following Bernstein and Fink (1998), total scores ≤ 36 indicate none or minimal exposure, scores between 36 and 51 indicate low to moderate exposure, scores between 51 and 68 indicate moderate to severe exposure, and scores ≥ 68 indicate severe to extreme exposure; EMWSS = Early Memories of Warmth and Safeness Scale, PHQ-8 = The Patient Health Questionnaire; ECR-9 = Experiences in close relationships; Avo = Avoidant attachment dimension of ECR, Anx = Anxious dimension of ECR; ULS-8 = The short-form UCLA Loneliness Scale.
[a]Welch *t*-tests.
[b]Chi-square.

1.1.2.2. Pre-treatment. Prior to their study appointment, participants completed a pre-survey for sample characterization (see Table 1) and to assess trait variables potentially affecting the strength of expected effects (see Table 2 and supplementary material for details).

At the beginning of the study visit, participants were seated while the research assistant informed them of the group to which they had been randomly assigned and explained the procedures associated with that group. Participants were then given time to give informed consent (to re-read the participant information and ask questions) and instructed how to put on a heart-rate belt (Suunto Smart Sensor) around their chest. Approximately 20 min after arrival at the study site, the baseline ECG was recorded during a 5-min sitting period. Participants then completed baseline measures (primary and secondary outcomes) assessing their current state (see Table 2 and supplementary materials for details). Thereafter, participants received a 60-minute SE-session or SE-psychoeducation.

1.1.2.3. SE-sessions. SE-sessions were provided by one of four experienced, certified SE practitioners. Therapists followed a treatment manual (available upon request) used for studies I and II. Participants were randomly assigned to therapists who were unaware of the study (I or II) participants were enrolled in. As two therapists spoke English and one spoke Norwegian, a

Table 2. Scale characteristics and internal consistency pre-treatment for primary and secondary measures (and potential moderators) used in Study I.

Scale	Scale	Range	Items	*α*
NPSS[a]	1–5	29–145	29	.87
Social Eng[a]	1–5	14–70	14	.90
Compassion[a]	1–5	7–35	7	.81
BodyS[a]	1–5	8–40	8	.86
TPAS[a]	1–5	18–90	18	.87
Activated[a]	1–5	8–40	8	.87
Relaxed[a]	1–5	6–30	6	.90
Safe/Content[a]	1–5	5–20	4	.72
NA[b]	1–5	5–25	5	.67
UBC[b]	1–7	10–70	10	.84
ULS-8 (state)[b]	1–5	8–40	8	.80
ULS-8 (trait)[c]	1–5	8–40	8	.75
CTQ, total score[c]	1–5	25–125	25	.91
Emotional abuse[c]	1–5	5–25	5	.80
Physical abuse[c]	1–5	5–25	5	.88
Sexual abuse[c]	1–5	5–25	5	.93
Emotional neglect[c]	1–5	5–25	5	.89
Physical neglect[c]	1–5	5–25	5	.70
EMWSS[c]	0–4	0–84	21	.95
ECR-Avo[c]	1–7	6–42	6	.83
ECR–Anx[c]	1–7	3–21	3	.81
PHQ-8[c]	0–3	0–24	8	.88

Note: a = baseline measures for primary outcomes; b = baseline measures for primary outcomes, c = pre-survey measuring trait/moderator variables; *α* = Cronbach's alpha; NPSS = Neuroception of Psychological Safety Scale; Social Eng = Social Engagement subscale of NPSS, Compassion = Subscale of NPSS; BodyS = Body Sensations subscale of NPSS, TPAS = The Types of Positive Affect Scale; Activate, Relaxed and Safe/content = TPAS subscales, NA = Negative effect; UBC = Social Connectedness Scale; ULS-8 = The short-form UCLA Loneliness Scale; EMWSS = Early Memories of Warmth and Safeness Scale, CTQ-SF = Childhood Trauma Questionnaire–Short Form; ECR = Experiences in close relationships; Avo = Avoidant attachment dimension of ECR, Anx = Anxious dimension of ECR; PHQ-8 = The Patient Health Questionnaire.

Swedish- and English-speaking research assistant was present during the first five minutes of each session. If participants wished for the assistant to translate, the assistant remained for the entire session (occurred 9 times). One participant needed full translation. The remaining sessions involved occasional assistance with a few words.

During the first 5 min, while the assistant was present, the therapist provided a brief SE-psychoeducation. The remaining session consisted of two main interventions. The first intervention, *Contacting the Present via 5-Senses-Experience* (Levine, 2005), aimed to enhance physical comfort and safety via sensory awareness (e.g. sight, sound, touch). The participant remained seated and was guided to find a comfortable position and to focus on positive sensations in the present moment (e.g. related to feeling the chair supporting the body). Participants explored bodily sensations with support from the therapist (e.g. 'where in your body do you feel this sensation?') and the participant described these experiences verbally. If unpleasant emotions, thoughts, or sensations arose, the therapist redirected attention to positive sensations (e.g. sensations previously perceived as pleasant) or to external stimuli (e.g. the chair or the therapist). The intervention ended when a participant felt present (aware of their surroundings) and experienced at least one moment of comfort with corresponding bodily sensations.

The second intervention, *Awareness of Boundaries and Personal Space* (Hayduk, 1983), aimed to support participants in identifying and feeling comfortable within their personal space while exploring spontaneously occurring sensations, emotions, mental images, and thoughts. Participants were mostly in a standing position and were using a rope to define the boundaries of their personal space. They explored the experience of being aware of their space and boundaries, while the therapist was standing at different positions. If distressing sensations arose, the therapist supported participants in being in contact with them until a more comfortable state arose. Participants were sometimes also invited to explore the effects of affirming statements (e.g. 'These are my personal boundaries.' 'You may only cross them if I invite you to.'). The session ended when the participant, at least at one point, felt comfortable within their space while simultaneously focusing on external stimuli.

1.1.2.4. SE-psychoeducation. The control condition consisted of psychoeducation on SE's theoretical concepts and practices, led by a research assistant. Participants read an 11-page long text (around 20–30 min), developed based on Levine (2015), describing how and why SE was developed. It also described the two interventions that the SE-group received and other practical examples (e.g. case study of a patient), illustrating how SE might reduce trauma-related symptoms. Thereafter, participants watched a 34-minute video on an iPad, showing Levine explaining basic theoretical principles of SE and discussing the roles of the sympathetic and parasympathetic nervous systems in trauma. Moreover, the video showed Levine working with a patient to demonstrate SE techniques.

To limit between-group HR/HRV variance associated with differences in the experimental conditions, controls watched the end of the video in a standing position in a relaxed manner (e.g. leaning against a bookshelf while free to adjust their posture if needed) at approximately the same time that the SE-group engaged in the second intervention (which required them to stand).

1.1.2.5. Post-treatment. After the intervention, participants completed the same self-report measures as during pre-assessment. Thereafter, a second HR/HRV (5 min) baseline measure was recorded. Finally, participants answered 10 open-ended questions about their experience of the study (qualitative data analyses will be published separately) and were debriefed and compensated (5$ gift card and a movie ticket).

1.1.3. Questionnaires

To assess primary outcomes, we used the Neuroception of Psychological Safety Scale (psychological safety) and The Types of Positive Affect Scale (positive safe and calm affective state). To assess secondary outcomes, we used the Social Connectedness Scale (social connectedness), the negative items from the Positive and Negative Affect Schedule-short form (negative affect), and the short-form UCLA Loneliness Scale (loneliness). To assess potential moderators of SE's effects, we used the CTQ-SF (CM), the EMWSS (positive childhood memories), the PHQ-8 (depressive symptoms), and the ECR-9 (anxious and avoidant attachment dimensions). All scales demonstrated satisfactory to excellent internal consistency (see Table 2). For more information about the scales, see supplementary materials (Bernstein et al., 2003; Brennan et al., 1998; Capinha et al., 2021; Gerdner & Allgulander, 2009; Gilbert et al., 2008; Hays & DiMatteo, 1987; Kroenke et al., 2009; Lehmivaara et al., 2024; Lok & Dunn, 2023; Mattsson et al., 2020; Richter et al., 2009; Sarling et al., 2021; Watson et al., 1988; Wu & Yao, 2008).

1.1.4. Data analytic procedures

Information on effect sizes for short-term effects of SE is not available. Hence, in our preregistered power calculation, we estimated that 128 participants (64 per condition) are needed to achieve 80% power to detect medium size effects ($\alpha = .05$, 2-tailed). For two reasons, we deviated from this predetermined target sample size in both studies: First, financial constraints only allowed for recruitment during a limited period, proving our initial target sample sizes overly

ambitious. Second, our pre-registered power calculation was based on a 2-tailed test (although our hypothesis was directed). When reevaluating our initial power analysis using G*Power with 1-tailed α = .05 and 80% power, a total n of 101 was required to detect an effect size of d = .50. Due to the constraints mentioned, we fell slightly short of the initial target sample sizes (see Table 1).

No variable had severe violations of normality (Skewness <3, Kurtosis <5; see Blanca et al., 2017; Kline, 2016). Outliers were identified using standardized residuals (>3), and we report both unadjusted and adjusted analyses in case of outliers.

Levene's tests showed non-significant results for all variables except for NPSS, bodily sensations, UBC, and NA. However, given no extreme violations of the homogeneity of variance and that analysis of variance is considered to be robust for equal group sizes (Blanca et al., 2018), parametric statistics were used for main analyses. For baseline characteristics, chi square distributions were used for dichotomous variables and independent sample Welch t-tests for continuous variables. Spearman's rho (ρ) correlations were used to assess correlations for all outcomes at baseline (see supplementary materials).

HRV and HR data were analysed using Kubios HRV Scientific Lite (version 4.1.0; Tarvainen et al., 2014). We extracted and analysed 4 min of each 5-minute recording in order to minimize initial movement artefacts while allowing participants to settle into a state closer to a resting state. Data from participants with severe measurement errors (n = 9) due to defective or broken pulse bands or missing pre- or post-data (n = 3) were excluded. Raw R-R interval data were imported into Kubios and successive, automatically detected R waves were visually inspected. Artefacts were excluded or corrected using Kubios' built-in detection algorithm, in which we attempted to follow the correction at 5% maximum guidelines for low data quality (Kubios, 2023). While data for most participants remained within the 5% threshold, seven participants' data required higher correction levels (see Table 1a Supplementary material). Since over-correction (≥5%) can distort time-domain measures such as RMSSD, we conducted separate analyses – one including and one excluding these cases (see supplementary materials). A comparable pattern of results was found for the two analyses. Here, we report results from the sample including over-corrected beats (≥5%). For HR data, three outliers and for HRV, four outliers were identified and excluded (std.residuals ≥3). One participant had an unusual RMSSD that significantly deviated from other participants and was therefore excluded from the analysis.

For all self-report and physiological data, we used a 2 × 2 mixed ANOVA design with group (SE vs. control) as between-group factor and time (pre- and post-session) as within-group factor. Data were analysed with JASP (version 0.19.1; JASP Team, 2024).

Effect sizes for the Group x Time and Time effects were calculated using partial eta square (η^2p), with η^2p = .01 referring to a small effect size, .06 to a medium effect size and .14 to a large effect size. Effect sizes for pre- to post-intervention differences (for both groups separately) are reported using Cohen's d, with .20 indicating a small effect, .50 a medium effect and .80 a large effect (Cohen, 1988). For secondary analyses, we calculated pre–post change scores to examine associations with socio-emotionally relevant variables. We used Fisher's r-to-z transformation to test whether the strengths of these associations, as measured by independent correlation coefficients, differed significantly between groups.

1.2. Results Study I

At baseline, there were no significant differences in primary or secondary outcomes between groups and results did not differ significantly when excluding outliers from the analyses (for details and for Spearman's Correlations between primary and secondary outcomes at baseline, see supplementary materials). Table 2 presents the statistics from the 2 × 2 mixed ANOVAs conducted for all outcomes.

1.2.1. Primary outcomes

Figure 1 illustrates a significant Time x Group interaction for NPSS, with post-hoc tests showing a significant increase in NPSS in the SE group (p < .001) but not in controls, with a large effect size (see Table 3). Similar results were observed for NPSS subscales: Social Engagement and Body Sensations increased significantly from pre- to post-intervention in the SE group (p < .001) but not in controls. No significant effects were found for Compassion.

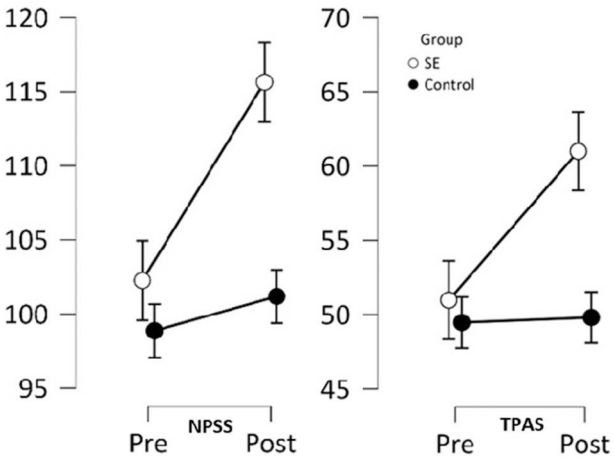

Figure 1. Estimated marginal means for Psychological Safety scores (NPSS) and Types of Positive Affect scores (TPAS) for the SE group and control group at pre- and post-intervention. Error bars represent 95% confidence intervals (CI).

Table 3. Pre- and post-intervention mean scores and effect-sizes for the interactions in the 2 (group) by 2 (time) repeated measures ANOVAs.

	SE		C									
	Pre	Post	Pre	Post							SE	C
											Effect sizes (sig.)	
Outcome	*M (SD)*	*M (SD)*	*M*	*M*	*df*	G (*F*)	η^2p	T (*F*)	η^2p	T × G (*F*)	η^2p	*d*	*d*
NPSS	102.26 (10.90)	115.64(14.55)	98.87 (4.76)	101.19(15.51)	1.87	10.27**	.11	50.04***	.37	24.84***	.22	−.95***	−.16
Social Eng	45.50 (8.04)	53.02 (9.52)	43.00 (9.05)	43.51 (10.18)	1.87	10.79**	.11	31.28***	.26	23.83***	.11	−.81***	−.06
Compassion	29.74 (3.96)	30.31 (4.16)	29.68 (3.46)	30.11 (3.80)	1.87	.03	.00	4.92	.05	.11	.00	−.15	−.11
BodyS	27.02 (5.33)	32.31 (5.87)	26.19 (7.63)	27.57 (6.98)	1.87	5.10*	.06	26.20***	.23	8.97**	.09	−.81***	−.21
TPAS	50.98 (10.24)	61.00 (11.49)	49.47 (10.83)	49.81 (12.20)	1.87	8.92*	.09	22.95***	.21	20.03***	.19	−.89***	−.03
Activated	21.52 (5.96)	24.45 (6.54)	19.77 (6.66)	18.96 (6.75)	1.87	9.07**	.09	2.48	.03	7.69**	.08	−.45*	.12
Relaxed	17.07 (5.33)	21.45 (4.81)	17.53 (5.09)	18.02 (5.59)	1.87	2.56	.03	16.07***	.16	10.26**	.11	−.84***	−.09
Safe/Content	12.38 (2.68)	15.10 (2.92)	12.17 (3.00)	12.83 (3.29)	1.87	4.76*	.05	35.02***	.29	12.99***	.13	−.91**	−.22
HR (beats/min)	74.69 (13.67)	69.08 (10.62)	76.71 (14.05)	70.79 (10.83)	1.74	.52	.00	70.24***	.49	.16	.00	.45***	.50**
HRV (RMSSD)	34.51 (17.62)	39.80 (18.00)	30.82 (21.86)	33.96 (21.60)	1.72	1.19	.02	12.19**	.14	.62	.00	−.26*	−.16
UBC	40.07 (8.18)	44.88 (10.56)	38.02 (10.72)	39.04 (11.62)	1.87	3.61	.04	15.03***	.15	6.34**	.07	−.46***	−.10
NA	7.90 (2.14)	6.33 (1.56)	7.87 (2.77)	7.87 (3.45)	1.87	2.22	.02	11.79***	.12	11.79***	.12	.60***	.00
ULS-8	17.93 (4.75)	16.86 (5.06)	19.19 (5.05)	18.79 (4.77)	1.87	2.58	.03	5.37*	.06	1.10	.01	.22	.08

Note: *G* = Group (SE vs control) between-subject effects; *T* = Time is the within-group variable PRE (1) and post (2); *T* × *G* = Time × Group is the between-within groups interaction; *M* = mean, *SD* = standard deviation; η^2p = Partial eta squared; * = $p < .05$; ** = $p < .01$; *** = $p < .001$; *d* = Cohen's *d* effect sizes from post hoc comparisons, *p*-value adjusted with Bonferroni.

Results of the Time x Group interactions for the TPAS (and its subscales Activated PA, Relaxed PA and Safe/Content PA) followed the results of the NPSS (see Table 3 and Figure 1). Results for HR and HRV (see Table 3) showed only a significant effect of Time, indicating HR decreases and HRV increases across groups.

1.2.2. Secondary outcomes

There was a significant Group x Time interaction for NA, indicating a significant increase in NA from pre- to post-intervention in the SE group ($p < .001$) but not in controls (Table 3). Social Connectedness increased in the SE group ($p < .01$) but not in controls. For loneliness, only a small effect of Time was found, with no group differences.

Higher levels of CM were moderately associated with a stronger pre–post increase in psychological safety in the SE-group ($\rho = .36$, $p = .02$), but not in controls ($\rho = -.17$, $p = .16$), with a significant group difference ($z = 2.48$, $p = .05$) (see Table 4). Less recall of positive childhood memories (EMWSS) was associated with a stronger pre–post increase in TPAS in the SE group ($\rho = -.31$, $p < .05$) but not in controls ($\rho = -.04$, $p = .96$), without a significant group difference ($z = -1.27$, $p > .05$). Higher depressive symptoms were associated with a stronger pre–post increase in TPAS in the SE-group ($\rho = .37$, $p = .02$) but not in controls ($\rho = -.08$, $p = .60$), with a significant group difference ($z = -2.12$, $p < .05$).

2. Study II

2.1. Method

2.1.1. Participants and procedure

This study followed the same design and procedure as Study I. Methodological deviations from Study I are described below.

2.1.2. Inclusion and exclusion criteria

Inclusion criteria were: (1) confirming, in line with the conceptualization of DBB (Talmon et al., 2021) at least one of the following experiences when being around other people: (a) feeling that one's personal space has been invaded; (b) bodily vulnerability and susceptibility to external influences, (c) a desire to escape; (d) the impression that the edges of one's body are being blurred; (e) feeling of being disconnected from the surrounding environment; (f) a sense of losing physical body boundaries; (g) perceiving that the body is not held together tightly enough; (2) ≥ 18 years of age; (3) proficiency in Swedish language. Exclusion criteria followed Study I.

The final sample size consisted of 54 participants who completed the entire study protocol (see Table 5 for sample characteristics). Of a total of 143 individuals using the sign-up link, 28 declined participation (with or without providing any specific reason for it), 27 were unreachable by phone, 8 unavailable during offered time slots, 11 could not participate due to residence in another city, 9 declined due to illness, 5 did not meet inclusion criteria, 1 dropped out at the beginning of the SE-Session. When this participant was invited to focus on bodily sensations, the participant reported not noticing any sensations and became sad. The participant decided to end their study participation without providing further reasons. Support and a conversation with the project leader were offered but were declined by the participant. There were no indications that this participant was an outlier on any of the pre-intervention variables. Thus, this participant had missing data on post measures and was included in the sample demographics (see Table 5) but not in the main analysis.

2.1.2.1. Pre and post treatment assessments. Prior to their study appointment, participants completed a pre-survey for sample characterization (see Table 5) and to assess trait variables that might influence the strength of the expected effects of SE (see Table 6 and supplementary materials for details). At the study visit, the procedure was identical to that of Study I, except that no psychophysiological data were collected. Before and after receiving an SE-session or SE-psychoeducation, participants completed questionnaires assessing their current state for DBB and interoception.

2.1.3. Questionnaires

To assess primary outcomes (DBB), we used the Body Boundaries Survey. For secondary outcomes

Table 4. Spearman's correlations between primary and secondary outcome (pre-post change scores) and socio-emotionally relevant variables, and Fisher r-to-z transformation to assess the significance of the difference between two independent correlation coefficients.

	CTQ		EMWSS		PHQ-8		AVO		ANX	
Variable	(SE/C)	z	(SE/C)	z	(SE/C)	z	(SE/C)	z	(SE/C)	z
NPSS	.36*/−.17	2.48*	−.30/.10	−2.16*	.18/.07	.51	.01/.04	−.14	.15/−.12	1.23
TPAS	.25/−.17	1.93	−.31*/−.04	−1.27	.37*/−.08	2.12*	.18/−.05	1.05	.08/−.00	.36
HR	−.29/.01	−1.29	.22/−.09	1.31	.07/−.03	.42	−.20/.07	−1.14	−.08/−.04	−.17
RMSSD	.03/−.10	.53	.02/.06	−.16	−.17/−.11	−.25	.15/−.09	.99	−.04/−.06	.08
UBC	.26/.11	.7	−.18/−.09	−.41	.00/−.32	1.48	−.00/−.00	0	.06/−.07	.58
NA	−.20/.19	−1.79	.15/−.01	.73	−.04/.36	−1.89	−.14/−.04	−.46	.13/.05	.36
ULS-8	−.11/.05	−.72	.03/.04	−.04	.01/.13	−.54	.13/−.04	.77	.18/−.23	1.87

Note: S = SE-group; C = Control-group; * = $p < .05$ (2-tailed).

Table 5. Sociodemographic characteristics of Study II.

Sample characteristic	Full sample ($N = 55$)		SE ($n = 28$)		Control ($n = 27$)		[a]t/[b]$\chi 2$	(df)	p
Age (in years), *M (SD)*	42.82	(14.22)	42.82	(14.87)	42.81	(13.79)	.00[a]	(52.92)	1.00
Gender (female), *n* (%)	49	(89.09)	26	(92.86)	23	(85.19)	.83[b]	(1)	.36
Education (in years)	14.16	1.99	13.86	(1.96)	14.48	(2.01)	−1.17[a]	52.80	.25
Relationship status, *n* (%)							.91[b]	(1)	.34
In a relationship	29	(52.73)	13	(46.43)	16	(59.26)			
Single	26	(47.27)	15	(53.57)	11	(40.74)			
CTQ severity, *n* (%)							5.66[b]	(3)	.13
None/Minimal	13	(23.64)	7	(25.00)	6	(22.22)			
Low	14	(25.45)	7	(25.00)	7	(25.93)			
Moderate	18	(32.73)	6	(21.43)	12	(44.44)			
Severe	10	(18.18)	8	(28.57)	2	(7.41)			
CTQ total score, *M (SD)*	53.00	(18.74)	55.54	(22.23)	50.37	(14.22)	1.03[a]	(46.14)	.31
Emotional Abuse	13.22	(5.87)	13.57	(6.21)	12.85	(5.59)	.45[a]	(52.75)	.65
Physical Abuse	7.95	(3.92)	8.14	(4.09)	7.74	(3.80)	.38[a]	(52.93)	.71
Sexual Abuse	7.69	(4.39)	9.18	(5.13)	6.15	(2.81)	2.73[a]	(42.19)	.00
Emotional Neglect	15.07	(5.62)	14.96	(5.76)	15.19	(5.58)	−.14[a]	(53.00)	.89
Physical Neglect	9.07	(3.73)	9.68	(4.53)	8.44	(2.59)	1.25[a]	(43.27)	.22
EMWSS, *M (SD)*	33.27	(18.62)	32.75	(19.65)	33.75	(17.84)	−.21[a]	(52.81)	.83
PHQ-8, *M (SD)*	25.20	(5.82)	12.89	(5.96)	9.93	(5.38)	1.94[a]	(52.79)	.06
ECR-9 Avo, *M (SD)*	25.20	(8.07)	25.57	(7.88)	24.81	(8.39)	.34[a]	(52.47)	.73
ECR-9 Anx, *M (SD)*	16.25	(4.67)	16.93	(4.35)	15.56	(4.97)	1.09[a]	(51.50)	.28
DBB-trait, *M (SD)*	55.75	(12.68)	56.32	(12.85)	49.04	(11.59)	2.21a	(52.77)	.03
MAIA-2-trait, *M (SD)*	89.71	(24.41)	91.50	(23.94)	87.85	(25.21)	.55[a]	(52.58)	.58
DBB-State, *M (SD)*	47.11	(13.20)	51.32	(14.64)	42.74	(10.03)	2.54[a]	(47.89)	.01
MAIA-2-State, *M (SD)*	89.91 (26.67)		88.46	(26.42)	91.41	(52.00)	−.41[a]	(52.73)	.69

Note: CTQ severity = following Bernstein and Fink (1998), total scores ≤ 36 indicate none or minimal exposure, scores between 36 and 51 indicate low to moderate exposure, scores between 51 and 68 indicate moderate to severe exposure, and scores ≥ 68 indicate severe to extreme exposure; EMWSS = Early Memories of Warmth and Safeness Scale, PHQ-8 = The Patient Health Questionnaire; ECR-9 = Experiences in close relationships; Avo = Avoidant attachment dimension of ECR, Anx = Anxious dimension of ECR; DBB = Body Boundaries Survey; MAIA-2 = Multidimensional Assessment of Interoceptive Awareness.
[a]Welch *t*-tests.
[b]Chi-square.

(Interoceptive Awareness), we used Multidimensional Assessment of Interoceptive Awareness (MAIA-2) and its subscales (describe in Table 6 notes). To assess potential moderators of SEs' effects, we used the CTQ-SF (CM), EMWSS (positive childhood memories), ECR-9 (anxious and avoidant attachment dimensions), and PHQ-8 (depressive symptoms).

Table 6. Scale characteristics and internal consistency at pre-treatment for primary and secondary measures (and potential moderators) used in Study II.

Scale	Scale	Range	Items	α
DBB-State[a]	1–5	17–85	17	.91
DBB-Trait[c]	1–5	17–85	17	.87
MAIA-2 (state)[b]	0–5	0–185	37	.91
NOT[b]	0–5	0–20	4	.82
ND[b]	0–5	0–30	6	.90
NW[b]	0–5	0–25	5	.71
AR[b]	0–5	0–35	7	.87
EAW[b]	0–5	0–25	5	.86
SR[b]	0–5	0–20	4	.91
BL[b]	0–5	0–15	3	.88
TRS[b]	0–5	0–15	3	.85
MAIA-2 (trait)[c]	0–5	0–185	37	.91
CTQ, total score[c]	1–4	25–125	25	.94
Emotional abuse[c]	1–4	5–25	5	.90
Physical abuse[c]	1–4	5–25	5	.82
Sexual abuse[c]	1–4	5–25	5	.94
Emotional neglect[c]	1–4	5–25	5	.95
Physical neglect[c]	1–4	5–25	5	.70
EMWSS[c]	0–4	0–84	21	.97
ECR-Avo[c]	1–7	6–42	6	.81
ECR-Anx[c]	1–7	3–21	3	.87
PHQ-8[c]	0–3	0–24	8	.85

Note: a = baseline measures for primary; b = and secondary outcomes; c = pre-survey measuring trait/moderator variables; α = Cronbach's alpha; MAIA-2-trait and its subscales showed satisfactory internal consistency (α's = .70–.89), reported in supplementary materials; MAIA-2 = Multidimensional Assessment of Interoceptive Awareness; MAIA-2s subscales: NOT = Noticing; ND = Not-Distracting; NW = Not-Worrying; AR = Attention Regulation; EAW = Emotional Awareness; SG = Self-regulation; BL = Body-Listening; TRS: Trusting.

2.1.4. Data analytic procedures

Data pre-processing and analyses followed Study I. No variable deviated significantly from normal distribution (Skewness <1; Kurtosis <1). Levene's test indicated no significant differences in variance for the outcome variables at pre-treatment, supporting the use of parametric statistics for the main analyses.

2.2. Results Study II

At baseline, there were no significant group differences in primary or secondary outcomes and results did not differ significantly when excluding outliers from the analyses (see supplementary materials). Table 7 presents the statistics from the 2 × 2 mixed ANOVAs conducted for all outcomes.

2.2.1. Primary outcome

Figure 2 shows a significant Time × Group interaction for DBB, with post-hoc testing indicating a significant increase in the SE group ($p < .001$), but not in controls, with a large effect size (see Table 7). Due to a significant group difference in DBB at baseline, an ANCOVA was conducted, showing a significant Group effect, $F(1.51) = 8.92$, $p < .004$, $\eta^2 p = .015$, indicating higher (pre-intervention adjusted) post-

Table 7. Pre- and post-mean scores and effect-sizes for the interactions in the 2 (group) by 2 (time) repeated measures ANOVAs.

	SE		C									SE	C
	Pre	Post	Pre	Post								Effect sizes	
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*df*	*G (F)*	η^2p	*T (F)*	η^2p	*T* × *G (F)*	η^2p	*d*	*d*
DBB	51.00 (14.82)	36.85 (11.35)	42.74 (10.03)	41.93 (13.41)	1.52	.29	.00	19.71***	.27	15.65***	.23	1.13***	.06
MAIA-2	88.37 (26.92)	127.41 (24.77)	91.41 (27.35)	101.63 (34.88)	1.52	2.46	.05	70.65***	.58	70.65***	.32	−.1.36***	−.36
NOT	11.74 (4.60)	16.00 (3.49)	11.81 (4.60)	12.22 (4.70)	1.52	2.70	.05	29.19***	.36	19.89***	.28	−.97***	−.09
ND	9.11 (5.72)	14.74 (7.71)	12.00 (7.84)	14.07 (8.12)	1.52	.39	.00	17.20***	.25	3.66	.07	−.76***	−.28
NW	11.48 (3.97)	16.67 (4.34)	13.22 (5.91)	14.93 (5.66)	1.52	.00	.00	30.18***	.37	7.71**	.13	−1.03***	−.34
AR	17.67 (7.05)	24.70 (5.12)	16.89 (8.10)	18.56 (8.74)	1.52	3.51	.06	30.55***	.37	11.63**	.18	−.95***	−.23
EAW	14.52 (6.30)	18.44 (5.09)	13.96 (6.12)	15.44 (6.02)	1.52	1.44	.03	18.89***	.27	3.86	.07	−.66***	−.25
SR	9.56 (4.24)	15.00 (2.77)	10.04 (5.36)	10.81 (5.36)	1.52	2.78	.05	31.85***	.38	17.92***	.26	−1.19***	−.17
BL	7.30 (3.72)	10.67 (2.63)	6.74 (3.99)	7.67 (4.28)	1.52	3.77	.07	25.70***	.33	8.32**	.14	−.91***	−.25
TRS	7.00 (4.57)	11.19 (3.26)	6.74 (3.70)	7.93 (3.41)	1.52	3.54	.06	40.48***	.44	12.63***	.20	−1.11***	−.31

Note: SE = SE-group; C = Control-group; G = Group 'SE' and 'SE-Education' between-subject effects; *T* = Time is the within-group variable PRE (1) and post (2); *T* × *G* = Time × Group is the between-within groups interaction. *M* = mean, *SD* = standard deviation; η^2p = Partial eta squared; *$p < .05$; **$p < .01$; ***$p < .001$; *d* = Cohen's *d* effect sizes from pos hoc comparisons, *p*-value adjusted with Bonferroni.

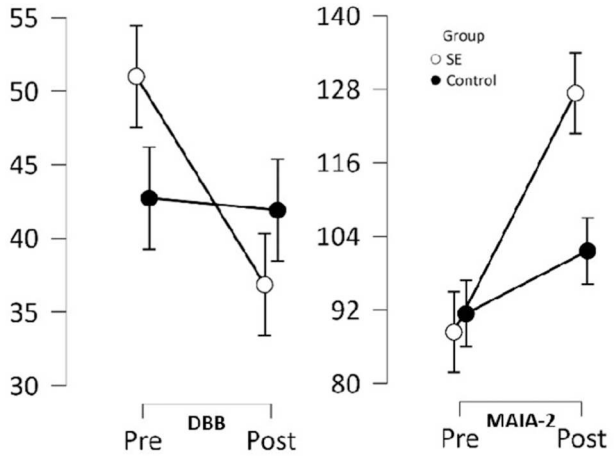

Figure 2. Estimated mean for a sense of Disturbed Body Boundaries (DBB) scores and Interoceptive Awareness (MAIA-2) scores for the SE group and control group at pre- and post-intervention. Error bars represent 95% confidence intervals (CI).

intervention DBB scores in the SE group compared to controls.

2.2.2. Secondary outcomes

Results for MAIA-2 showed a significant Time × Group interaction, with post-hoc tests showing a significant increase in the SE group ($p < .00$), but not in controls, with a large effect size (see Table 7). MAIA-2 subscales followed this pattern, except for the Not-Distracting and Emotional Awareness subscales, where non-significant interaction effects were found.

As Table 8 shows, higher levels of CM were moderately associated with stronger pre–post decreases in DBB in the SE-group ($\rho = .46$, $p < .05$), but not in controls ($\rho = .00$, $p > .05$) but the correlation coefficients were non-significant ($z = 1.72$, $p = .09$). Higher levels of CM were also moderately associated with stronger pre–post increases in MAIA-2 in the SE-group ($\rho = .53$, $p < .01$) but not in controls ($\rho = -.18$, $p > .05$), and the two correlation coefficients differed significantly between groups ($z = 2.65$, $p < .01$). Less recall of positive childhood memories (EMWSS) was associated with stronger pre–post increases in MAIA-2 in the SE group ($\rho = -.43$, $p > .05$) but not in controls ($\rho = .01$, $p > .05$), with non-significant correlation coefficients ($z = 1.61$, $p = .11$). As for MAIA-2 subscales, pre–post increase Emotional awareness differed significantly for CTQ ($z = 2.35$, $p < .05$) and for EMWSS ($z = -2.23$, $p < .05$) and Trusting for CTQ ($z = 2.58$, $p < .01$).

3. Discussion

In Study I, SE, but not the active control condition, significantly increased psychological safety (including two of its components, social engagement and body sensations) and a positive safe/calm affective state. Regarding secondary socio-emotional variables, social connectedness increased, and NA decreased only in the SE group, whereas loneliness decreased in both groups. Likewise, HR decreased and HRV increased in both groups. The strength of the effects of SE on psychological safety and on positive safe/calm affective states within the SE group was predicted by higher levels of experienced CM and lower levels of positive childhood memories. In Study II, SE, but not our active control condition, significantly decreased a sense of DBB and increased interoceptive awareness. The strength of the effects of SE on a sense of DBB and interoceptive awareness within the SE group was significantly linked to higher levels of CM and lower levels of positive childhood memories.

Results regarding psychological safety showed large effect sizes for both the total score and the Social Engagement subscale, indicating a strong immediate change in participants' perception of their social environment as less threatening and safer to engage with. This aligns with SE practitioners highlighting the development of a sense of safety as a key element of SE (Kuhfuß et al., 2021). Next to emotional aspects, psychological safety involves bodily sensations of safety (a physically calmer and safer state), for which we also found a large increase in the SE group. However, SE was not effective in increasing compassion for others, a third aspect of psychological safety. This

Table 8. Spearman's correlations between DBB and MAIA-2 and its subscales (pre-post change scores) and socio-emotionally relevant variables, and Fisher r-to-z transformation to assess the significance of the difference between two independent correlation coefficients.

	CTQ		EMWSS		PHQ-8		AVO		ANX	
Variable	(SE/C)	z	(SE/C)	z	(SE/C)	z	(SE/C)	z	(SE/C)	z
DBB	−.46*/.00	1.72	.36/.20	.60	−.27/−.06	.04	−.23/−.08	.53	−.19/−.03	.56
MAIA-2	.53**/−.18	2.67**	−.43*/.01	−1.54	.02/.00	.07	.24/.03	.74	.21/.09	.43
NOT	.19/−.17	1.26	−.12/−.02	−.35	.08/−.09	.59	.23/−.04	.42	.01/−.04	.17
ND	.19/.09	.35	−.11/−.22	.39	−.23/.22	−1.59	.09/.09	0	.07/.10	.07
NW	.40*/−.09	1.78	−.33/.05	−1.36	−.01/.10	−0.38	−.06/−.13	.24	.18/.13	.18
AR	.30/−.03	1.18	−.17/−.09	−.28	.10/.09	.03	.11/−.04	.52	.06/.17	−.39
EAW	.39*/−.26	2.35*	−.36/.26	−2.23*	.02/−.31	1.18	.15/−.07	.77	.09/−.05	.49
SR	.43*/−.02	1.66	−.41*/−.16	−.95	.14/−.20	1.19	.35/.29	−.55	.30/−.18	1.7
BL	.19/−.27	1.63	−.24/.12	−1.27	−.14/−.15	.04	−.13/−.12	−.04	.11/.12	−.04
TRS	.51**/−.18	2.58**	−.39*/.03	−1.53	.19/.04	.53	.20/.21	−.04	.31/.04	.97

Note: (c) = Control group correlations; *$p < .05$; **$p < .01$; ***$p < .001$; $N = 54$, SE, $n = 27$, Control, $n = 27$.

contrasts previous theorizing that the detection of safety cues in the environment can facilitate compassion for others (Porges, 2017). A possible explanation might be that our intervention specifically targeted safety related to one's own space and boundaries rather than compassion. Moreover, compassion towards others may require the presence of others outside the therapy session.

Results support our expectation that SE facilitates a state of calm and safety, with the largest effect size for a state of safety/content. Interestingly, activated positive affect had a small effect size, suggesting that SE may specifically facilitate safe and relaxed states rather than leading to general positive affect. This corroborates previous research showing that interventions (other than SE) using soothing voices, tones, and breathing increase relaxed, safe, and content affective states but have less impact on activated positive affect (Matos et al., 2017; Petrocchi et al., 2017).

Impaired social functioning is a risk factor for physical and mental disorders (e.g. Charuvastra & Cloitre, 2008). In that respect, our results regarding psychological safety, including calm and safe states, are important. They indicate that a body-oriented approach can increase momentary states of felt safety, with individuals with higher degrees of CM showing stronger benefits. Future research that replicates and builds on our findings by assessing long-term effects is needed. Moreover, the potential of SE to promote resilience by increasing social functioning should be evaluated.

Hypotheses regarding physiological components of psychological safety were only partially supported as HR decreased and HRV increased across groups. Although on a trend-level, there was relatively greater increase in HRV in the SE group, the Time × Group interaction was not significant, suggesting a general time effect rather than an SE-specific change. Methodological factors such as the type of chosen control condition (which may have induced HRV changes) may have contributed to this lack of interaction.

Results for other socio-emotionally relevant variables partially confirmed our predictions. First, social connectedness significantly improved in the SE group (small effect size), thus giving more evidence of the notion that focusing on physical comfort and safety via sensory awareness can facilitate social engagement. While negative affect decreased (medium effect size) only in the SE group, loneliness slightly decreased in both groups. This contrasts with previous research that has shown replicable links between an increased focus on bodily awareness and loneliness (e.g. Oldroyd et al., 2019). Possibly, focusing on one's boundaries may limit positive effects of SE on loneliness by inducing feelings of being separate from others. Moreover, diminishing loneliness might require more than a single session and/or the repeated experience of positive social affective states in daily life, which, in the longer run, might impact social behaviour and the quality of interactions, including perceived loneliness.

Results regarding DBB showed large effect sizes for the SE group, indicating a strong and immediate reduction in participants' reported sense of their bodies as unsafe and vulnerable to external threats (Krzewska & Dolińska-Zygmunt, 2013). Both participants with higher CM severity and less positive childhood memories showed a stronger pre–post reduction in perceived DBB. This aligns with SEs focus on bodily areas that feel unpleasant after threatening experiences, aiming to reduce excessive physiological arousal (Payne et al., 2015). Results regarding interoceptive awareness (MAIA-2 and most of its subscales) showed a strong overall increase in the SE group, with a large effect size. These results support the theorized central role of facilitating interoceptive awareness in SE (Kuhfuß et al., 2021; Payne et al., 2015). Future research should explore whether increases in different aspects of interoceptive awareness act as a mechanism of action, as proposed by researchers and practitioners (e.g. Payne et al., 2015).

3.1. Limitations and recommendations for future research

One limitation of our study is that we did not diagnose mental disorders. Individuals with exposure to CM can have multiple co-morbidities, which might impact the effects of SE. Furthermore, participants in both studies predominantly identified as female, which limits the generalizability of our findings. Future research should examine which clinical populations and genders/sexes may benefit most from SE-based interventions. Moreover, our study design precludes conclusions regarding long-term effects of a single or multiple sessions of SE.

Although on the group level, participants responded positively to SE, one dropout reported sadness and disconnection from their body sensations during the first exercise. This event highlights the importance of monitoring potential adverse events in future clinical trials. Next to the post-assessment outcome variables of the present studies, future research should also conduct follow-up assessments of broader aspects of social functioning (social support, loneliness, quality of social relationships), ideally as measured in daily life, enhancing ecological validity. This is important, given that several aspects of social functioning are strong predictors of both mental and physical health (See e.g. Pfaltz et al., 2022). Moreover, multiple measurement points will be needed to identify mechanisms that underlie the found effects. Interoceptive awareness increased significantly in our intervention group, making it an important candidate

for a potential mechanism. Finally, our physiological data need to be interpreted with caution: Respiratory rate and volume can significantly impact measures of RSA, both in the laboratory and in daily life (Grossman et al., 2004) and should thus be controlled for in future studies. Moreover, some of the data were lost due to technical issues or artefacts, resulting in a potential lack of power. While we matched the experimental conditions as closely as possible, the participants' position (standing or sitting) and movements during the sessions were not recorded but may have affected the results. As with all studies using baseline physiological measures, individual differences in stress or activity preceding the experimental conditions could have influenced baseline HR/HRV. Although an acclimation period was used to minimize these effects, future research should more systematically control individual arousal to reduce baseline variability.

4. Conclusions

Despite these limitations, our studies are a first step towards closing existing research gaps on the effects of body-oriented interventions on socially relevant variables. Our findings indicate strongly that a brief, SE-based intervention can significantly and positively affect momentary levels of psychological safety and disrupted body boundaries – problems that are common in individuals exposed to CM (Hautle et al., 2024; Talmon & Ginzburg, 2017). The positive association between CM and increases in psychological safety and disrupted body boundaries following SE suggests that individuals with higher levels of CM may particularly benefit from our intervention. Given the lack of previous research on SE in individuals with CM, this finding is important and should encourage additional research exploring body-oriented interventions' potential to strengthen social functioning and thus mental and physical health in those affected by CM.

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Author contributions

MP, JL, MC and BJ conceptualized and designed the study, with JB specifically contributing to the collection and analysis of the psychophysiological data. JL led the data collection and conducted the main data analysis in collaboration with BJ. The interpretation of the data was carried out by JL, MP, BJ, and JB. JL led the manuscript work under supervision of MP. MP, BJ, JB, and MC gave substantial input and critical revisions. All authors approved the final version of the manuscript for submission.

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The information needed to reproduce all the reported results is available at https://osf.io/cufxz/overview?view_only=6fa71bd5b990494c9545fbd8e31ec109.

Preregistration of Studies and Analysis Plans: This study was preregistered at OFs: https://osf.io/r52v8/overview.

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Data availability statement

Data supporting the study findings will be publicly available on OSF.io upon publication of this manuscript.

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