

Sensipal Plush: Sensory Therapy for State Anxiety in Emerging Adulthood with Social Anxiety

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Abstract

Social anxiety disorder is a significant mental health concern, particularly prevalent during emerging adulthood (ages 18–25) due to developmental transition pressures. This condition often triggers acute state anxiety, manifesting as immediate physiological responses, which can make conventional cognitive interventions difficult to implement effectively during moments of high distress. This study aimed to design and evaluate the empirical effectiveness of SensiPal, a novel Huggable Sensory Therapy Plush prototype that integrates Deep Pressure Therapy (DPT), tactile stimulation, and white noise as an anxiety reduction tool. The research employed a one-group pretest-posttest quasi-experimental design conducted as a field experiment in a high-stimulus public environment. Thirty emerging adults with high social anxiety tendencies participated. Anxiety levels were measured using the State-Trait Anxiety Inventory State Form (STAI-S) before and after stress induction and a 12-minute SensiPal intervention. The Paired Sample t-Test results indicated a highly significant decrease in average state anxiety scores, from 21.20 pre-intervention to 15.57 post-intervention. The intervention demonstrated a large effect size (Cohen's $d = 1.455$), reflecting a very strong therapeutic impact in a real-world setting. In conclusion, SensiPal is highly effective in instantly reducing state anxiety. Its multisensory integration offers an innovative, portable coping mechanism that supports independent self-soothing and emotional stabilization for individuals facing real-world social pressures.

INTRODUCTION

Anxiety disorders represent a significant global mental health challenge, with the World Health Organization, (2023) reporting 301 million cases annually, a figure that continues to rise due to complex environmental and societal factors. In Indonesia, social anxiety disorder has become a notable concern, characterized by excessive fear of negative evaluation that limits social interactions and daily activities (Hur et al., 2019). According to the DSM-5-TR, social anxiety disorder involves an intense and persistent fear of social situations (American Psychiatric Association, 2022). Emerging adulthood (ages 18–25) is a particularly vulnerable phase, as developmental pressures, identity exploration, and instability increase susceptibility to anxiety, with prevalence rates reaching 68.7% by 2024 (Wire, 2025; Kunu, 2024).

Academic, professional, and interpersonal expectations during this transitional phase often act as primary triggers of social anxiety (Arnett, 2000; Arnett, 2006; Galanaki & Leontopoulou, 2017; Hur et al., 2019).

The impact of social anxiety extends across multiple life domains. Interpersonal avoidance contributes to social skill deficits, increasing risks of loneliness and isolation (Lim et al., 2016). Psychosocial pressures can cascade into academic failure and reduced economic stability due to persistent psychological strain (Dryman et al., 2016; Laldinpui et al., 2024; Jallaleng et al., 2022; Jatmiko, 2017). Cognitively, heightened social sensitivity can distort self-perception and judgments of others, triggering excessive self-awareness (Rapee & Heimberg, 1997; Nikolić, 2020). Physiologically, social anxiety activates the autonomic nervous system, eliciting immediate fight-or-flight responses—such as increased heart rate, tremors, and shortness of breath—that often precede conscious cognitive processing, making individuals feel physically threatened (National Institute of Mental Health, 2022).

Although prior research has extensively examined social anxiety, most studies focus on trait-level characteristics using longitudinal designs or large-scale surveys (Karasewich & Kuhlmeier, 2020; Schneier et al., 2002; Brown et al., 2023; Skaug et al., 2024; Van Zalk & Van Zalk, 2018). Such macro-level approaches are less sensitive to real-time fluctuations in state anxiety, which emerge in response to acute social stressors. Unlike trait anxiety, state anxiety occurs as an immediate reaction to situational pressures (Karasewich & Kuhlmeier, 2020). Individuals with high social anxiety are particularly prone to sharp increases in state anxiety during performance-demanding social contexts (Spielberger & Cattell, 1966; Spielberger, 2010; Setyananda et al., 2021). In these moments, conventional interventions such as Cognitive Behavioral Therapy (CBT) or pharmacological treatments may be limited by cognitive demands or side effects, as excessive autonomic activation can inhibit higher-order cognitive processes (Bandelow et al., 2017; Garber et al., 2016; Ahmadi et al., 2024) and (Nguyen et al., 2025). Therefore, interventions that target physiological regulation directly are critical to rapidly reduce acute anxiety before cognitive approaches can be applied (Price & Hooven, 2018; Taylor et al., 2010).

Sensory-based interventions have emerged as promising innovations to manage anxiety by modulating physiological arousal (Machingura et al., 2017; Kandlur et al., 2023; Wright et al., 2022). Three sensory modalities have demonstrated particular efficacy: (1) Deep Pressure Therapy (DPT), which provides calming effects through sustained pressure and helps regulate stress responses (Bontula et al., 2023; Maula et al., 2024; Yu et al., 2024); (2) tactile stimulation, where self-soothing touch reduces cortisol responses to stress (Hong, 2018; Dreisoerner et al., 2021); and (3) white noise, which promotes auditory comfort and attenuates amygdala overactivation that triggers stress reactions (Creswell et al., 2019; Ghasemi et al., 2023; Simon et al., 2016). While some products employ these sensory approaches, most are limited to a single modality.

Critical review of existing tools highlights a gap in real-world usability. Weighted blankets, for example, deliver effective DPT but are cumbersome for public settings (Eron et al., 2020; Yu et al., 2024). Portable vests, such as weighted, compression, or hugging vests, offer mobility but are constrained by inconsistent usage styles and lack integrated auditory or tactile distraction (Maula et al., 2024; Taylor et al., 2017). Auditory devices such as white noise machines are primarily optimized for sleep, limiting their effectiveness as active coping tools

in social environments (Zhu & Zheng, 2024; Riedy et al., 2021).

The literature gap indicates a need for portable, multisensory interventions that integrate DPT, tactile stimulation, and white noise into a single device suitable for social contexts. This gap motivated the development of SensiPal, a Huggable Sensory Therapy Plush prototype. The three integrated elements are designed to synergistically activate the parasympathetic nervous system, reduce environmental overstimulation, and modulate both physiological and psychological anxiety responses (Bontula et al., 2023).

Accordingly, this study aims to describe the design of SensiPal and empirically test its effectiveness in reducing state anxiety induced by social situations. Practically, the successful development of SensiPal represents a shift from clinical-dependent interventions toward portable, self-regulated coping strategies. Theoretically, the study contributes to the literature on bottom-up emotional regulation by demonstrating how portable, multisensory tools can empower emerging adults to navigate real-world social pressures independently.

RESEARCH METHOD

Research Design and Sample

This study employed a quantitative approach with a one-group pretest-posttest quasi-experimental field design to evaluate the effectiveness of the SensiPal therapy tool in reducing social anxiety during emerging adulthood (Hastjarjo, 2019). The field setting maximized ecological validity, while internal validity was maintained through standardized instructions, consistent timing, and a fixed intervention duration (Asiamah et al., 2019). Using purposive sampling, 30 participants (N=30) aged 18-25 residing in East Java were selected based on a Social Phobia Inventory (SPIN) screening score of at least 19 (Campbell et al., 2020). Participation was voluntary with signed informed consent. The study received ethical approval from the *Komisi Etik Penelitian Kesehatan Universitas Ciputra* (No. 048/EC/KEP-UC/III/2026).

Research Instruments

The dependent variable was measured using an 8-item Indonesian adaptation of the State-Trait Anxiety Inventory State Form ($\alpha = 0.816$), selected for its sensitivity to detecting momentary anxiety fluctuations (Setyananda et al., 2021; Skapinakis, 2014; Thomas & Cassady, 2021; Vigneau & Cormier, 2008). Participant screening was conducted using the Indonesian version of the Social Phobia Inventory ($\alpha = 0.94$), which measures three main dimensions: fear, avoidance, and physiological symptoms (Connor et al., 2000; Rizkia et al., 2024). Additionally, open-ended questions were also given to capture participants' subjective experiences with the therapy tool.

Data Collection Technique

The data collection procedure was carried out systematically in three main stages within a naturalistic field setting. In the pre-intervention stage, participants were exposed to anticipatory stress induction through a public presentation preparation scenario, after which they completed a pre-test using the STAI-S scale. During the intervention stage, participants received treatment by using the SensiPal sensory therapy device for 12 minutes. SensiPal is a prototype huggable sensory plush designed to integrate Deep Pressure Therapy (DPT), tactile

stimulation, and white noise to provide calming, multisensory stimulation. In the post-intervention stage, participants completed the STAI-S scale again as a post-test measure and participated in a debriefing session, fulfilling the researcher’s ethical responsibility to inform and support participants.

Data Analysis Method

Data analysis was conducted using JASP software to test the effectiveness of the tool in reducing momentary anxiety triggered by social situations. The normality test using Shapiro-Wilk showed that the data was distributed normally ($W=0.962$; $p=0.357$), so that the analysis was carried out with parametric statistics using the Paired Sample t-Test to compare pre-test and post-test scores. In addition to the significance test, the effectiveness analysis was also calculated using the N-Gain Score to see the percentage improvement or decrease in participants' condition after the intervention was given. All items in the scale are still used because the overall reliability coefficient has met an acceptable category for a psychological measuring tool.

RESULTS AND DISCUSSION

Participant Demographics

Table 1. Characteristics by Age

Age	Quantity	Percentage
18	1	3.3
19	2	6.7
20	2	6.7
21	5	16.7
22	7	23.3
23	2	6.7
24	2	6.7
25	9	30
Total	30	100

The experimental group comprised 30 participants ($N = 30$) within the emerging adulthood category. The age distribution consisted of one 18-year-old (3.3%); two 19-year-olds (6.7%); two 20-year-olds (6.7%); five 21-year-olds (16.7%); seven 22-year-olds (23.3%); two 23-year-olds (6.7%); two 24-year-olds (6.7%); and nine 25-year-olds (30%). Regarding gender, the sample included 16 males (53.3%) and 14 females (46.7%).

Social Anxiety Screening Results

Initial screening of the 30 participants yielded entirely valid responses with no missing data. Assessments were determined by summing all item scores (0–68), with a score of 19 established as the clinical threshold indicating the presence of social phobia. Severity was categorized into five levels: None (0–20), Mild (21–30), Moderate (31–40), Severe (41–50), and Very severe (51–68). The mean severity level for the participants was 3.933, indicating that the average participant fell within the 'Severe' anxiety category.. The majority of participants reached Level 4 (Severe) social anxiety at 46.67% ($n = 14$), followed by Level 5

(Very severe) at 26.67% ($n = 8$), and Level 3 (Moderate) at 23.33% ($n = 7$). Only one participant (3.33%) was categorized at Level 1 (None), and no participants were recorded at Level 2 (Mild).

Pre-Test dan Post-Test Results

Table 2. Normality Test Results and Paired Sample T-Test

Test Type	Parameters	Statistical Value	df	p-value
Normality Test	Shapiro-Wilk (W)	0,962	-	0,357
Hypothesis Test	Paired Sample T-Test (t)	7,967	29	< 0.001

Prior to hypothesis testing, a normality assumption test was conducted using the Shapiro-Wilk test to ensure the appropriateness of using parametric analysis. The test results from JASP indicated that the distribution of the differences between pre-test and post-test scores met the normality assumption ($W=0.962$; $p=.357$), therefore, the analysis proceeded with parametric tests. To evaluate the effectiveness of the SensiPal intervention in reducing social anxiety, a paired samples t-test was performed. The analysis revealed a significant difference between pre-test and post-test scores ($t=7,967$; $df=29$; $p < 0,001$), indicating that the use of SensiPal influenced the reduction of participants' social anxiety levels.

Table 3. Descriptive Statistics and Effect Size

Variable Measurement	Sample (N)	Red (M)	Standard Deviation (SD)	Effect Size (Cohen's d)
Pre-test	30	21,20	4,189	1,455
Post-test	30	15,57	4,125	

Descriptive analysis showed that the mean social anxiety score decreased from 21.20 ($SD=4.189$) at pre-test to 15.57 ($SD=4.125$) at post-test. This decline indicates a reduction in social anxiety levels after participants used the SensiPal device. Additionally, the calculated effect size (Cohen's $d=1.455$) represents a large effect. These results demonstrate that the intervention has a relatively substantial impact on reducing social anxiety among emerging adults.

DISCUSSION

The aim of this study was to examine the effectiveness of SensiPal, a sensory therapy tool, in reducing state anxiety among emerging adults with social anxiety tendencies. The findings indicate that the intervention significantly reduced state anxiety in participants exposed to social stressors, with mean scores dropping from 21.20 pre-intervention to 15.57 post-intervention, consistent with our hypothesis regarding SensiPal's effectiveness.

The elevated pre-test scores reflect the impact of two stressor types: environmental factors and experimentally induced stress. The research was conducted in a busy commercial outlet, exposing participants to high social density, noise, and other uncontrolled environmental stimuli, which naturally heightened alertness and anxiety responses. Additionally, participants performed an impromptu public speaking task as a controlled stressor. The combination of these conditions likely brought state anxiety to its peak. These findings align with prior research indicating that sensory stimulation through deep pressure and tactile input can rapidly modulate the autonomic nervous system's stress response (Bundy & Lane, 2020; Ghasemi et al., 2023).

The white noise component of SensiPal further functioned as a sensory shielding mechanism, buffering participants from environmental noise (Bontula et al., 2023).

The novelty of this research lies in the integration of three sensory elements into a single, portable device designed for real-world social contexts. Previous studies have predominantly examined individual sensory modalities or tested interventions in clinical settings (Bontula et al., 2023; Maula et al., 2024; Macdonald et al., 2021; Son et al., 2024; Zhu & Zheng, 2024). SensiPal demonstrated the combined effect of multisensory stimulation in situ, creating a temporary sense of safety for participants without imposing cognitive effort. This outcome is consistent with sensory integration principles, whereby coordinated multisensory input can elevate the threshold for physical comfort (Bontula et al., 2023; Bundy & Lane, 2020; Ghasemi et al., 2023). While the study does not isolate the contribution of each sensory component, the cumulative effect appears meaningful. SensiPal is thus positioned as a self-regulation tool for immediate relief during social stress rather than as a treatment for social anxiety disorder (Dreisoerner et al., 2021; Pang et al., 2022).

The effectiveness of SensiPal can also be interpreted through a bottom-up emotional regulation framework (Zilverstand et al., 2017). In individuals with high social anxiety, acute stress often compromises top-down cognitive self-regulation. SensiPal's gentle pressure and white noise provide direct physiological input, enabling calming effects without deliberate mental effort. Consistent with Polyvagal Theory (Porges & Rosas, 2022), stable tactile and auditory stimulation signals safety to the nervous system, reducing the fight-or-flight response and promoting a sense of calm. The 12-minute intervention proved sufficient, aligning with prior evidence that approximately 10–15 minutes are required for physiological stabilization following acute stress (Eron et al., 2020). This duration allowed participants to transition from peak anxiety to a more relaxed state while maintaining engagement with their tasks.

CONCLUSION

This study demonstrates that the SensiPal prototype is significantly effective in reducing state anxiety by integrating Deep Pressure Therapy (DPT), tactile stimulation, and white noise into a single device. By employing a somatic-sensory approach, the tool facilitates self-soothing through bottom-up emotion regulation, providing a rapid and independent alternative to traditional cognitive interventions for individuals experiencing acute social stress. These findings suggest that mental health practitioners could utilize sensory tools to help clients regulate physiological arousal and clear inhibited thought processes during moments of acute anxiety. However, the study's reliance on subjective self-reports and a relatively small sample size indicates the need for further validation. Future empirical research should expand on these findings using randomized controlled trials with larger and more diverse populations, incorporating objective physiological measures, such as heart rate variability, to quantify the specific impact of each sensory component. Additionally, as sensory-assistive devices like SensiPal move toward commercial and clinical application, legal and regulatory considerations must be addressed. Future research is recommended to examine medical device classification, data privacy standards for integrated biofeedback, and ethical implications of deploying such tools in public or professional settings. These investigations will be essential for ensuring safe, effective, and ethically responsible use of multisensory interventions for anxiety management.

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