Street Dance Training Might Increase the Neural Response to Pleasant Emotional Stimuli

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Abstract
This study aims to assess whether training in street dance can enhance neural responses to positive emotional stimuli. A total of 30 participants were recruited and divided into two groups: a training group comprising 10 men and 5 women, and a control group with an identical composition. The training group engaged in 60-minute street dance sessions three times per week for four weeks. The control group maintained their usual daily routines and was explicitly instructed to avoid any new physical exercise during the study. Emotional states were assessed in the training group before and after the training programme. Functional magnetic resonance imaging (fMRI) data were collected in two sessions: one prior to and one following the training period. A significant increase in enjoyment was observed after the first session (17.99±2.58 to 23.06±3.47, P = 0.02) and the twelfth session (17.02±2.06 to 24.11±3.14, P = 0.003). Additionally, anxiety levels decreased significantly immediately after exercise (13.21±2.22 to 8.99±1.57, P = 0.03), with further reductions following the twelfth session (13.04±1.89 to 8.01±1.63, P = 0.04). The CES-D scores in the training group increased from 11.99±1.63 to 14.03±2.04, whereas in the control group, they changed from 10.96±1.21 to 12.69±2.55. However, no statistically significant interaction between groups over time was identified (P = 0.14). Brain regions associated with processing positive emotional stimuli included the cuneus, precuneus, insula, temporal pole, pMCC, and angular gyrus. Additionally, the training group exhibited enhanced neural responses in the cuneus, somatosensory region, IPL, and SPL when processing negative emotional stimuli. This study examined how street dance training influenced neural responses to emotional stimuli in young, healthy individuals. Both positive and negative emotional cues elicited activity in the occipital and posterior parietal cortices.
Keywords: Street Dance Training, Neural Response, Pleasant, Emotional Stimuli.

Introduction

Dance serves as a powerful medium of nonverbal communication, conveying deep emotions through movement. The intensity of passion in Béjart's Boléro almost overwhelms the audience, while the final farewell in Gisèlle evokes audible sobs as she returns to the tomb. For most, dancing without music seems unimaginable, as the art form is deeply intertwined with auditory expression. In both theatre and cinema, directors strategically utilise music to manipulate audience emotions, enhancing the emotive power of movement. Street dance emerged in urban environments beyond the confines of traditional dance institutions. It encompasses a diverse range of styles that have evolved within various communities and cultures, often performed in public spaces such as streets and clubs [1]. Defined by its spontaneous and collective nature, street dance draws inspiration from African, Latin, and urban musical and dance traditions. Notable street dancing forms include:
Breaking: Breaking, also known as breakdance, originated in the Bronx, New York, during the 1970s. It is characterised by dynamic movements, including spins, flips, and intricate footwork, typically performed to street and breakbeat music.
Popping: Popping involves the deliberate contraction and relaxation of muscles to create sharp, sudden movements. Often incorporating robotic and mechanical motions, it is commonly performed to funk music.
Locking: Locking, which emerged in Los Angeles during the 1960s, features rapid and well-defined pauses, or "locks," within movements. Known for its energetic and playful style, it is typically performed to funk music.
Waacking: Waacking, also referred to as punking, developed in the LGBTQ+ club scene of Los Angeles in the 1970s. This style is defined by expressive arm and hand movements and is frequently performed to disco or funk music.
House: House dance emerged in the 1980s within the club scenes of Chicago and New York. It is characterised by fast footwork, fluid movements, and improvisational elements, typically performed to house music.
Street dancing has gained global recognition as a cultural phenomenon, leading to the establishment of competitions, events, and communities dedicated to its various styles. Many dancers incorporate elements from different genres, creating a fusion of movement and personal expression (Blood & Zatorre, 2001). The most common street dance styles include locking, hip-hop,

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popping, house, breaking, krump, dancehall, and jazz. Psychological research has consistently demonstrated that emotional input from one sensory modality, such as hearing, influences the perception of stimuli in another, such as vision. This effect persists even when individuals are instructed to disregard the secondary input. Known as cross-modal bias, this phenomenon was first identified in the study of perception and illustrates how concurrent auditory stimuli can enhance visual perception, including intensity.

In emotion psychology, this phenomenon is often examined by assessing how individuals perceive emotions in response to visual stimuli under three experimental conditions: when auditory information is congruent with the visual emotion, when it is incongruent, or when no auditory stimulus is provided. Previous studies have shown that emotional cues in speech influence the perception of emotions in facial expressions, static emotional body postures, and dynamic body movements depicting common emotions. Van den Stock et al. conducted a study using instrumental classical music alongside six distinct emotional expressions—happiness, sadness, anger, disgust, and neutrality—combinations not commonly encountered in daily life (Gordon et al., 2020). Performers were instructed to evoke emotional expressions by recalling personal experiences associated with specific emotions and then executing a sipping action while embodying the corresponding emotional state.

The objective was to determine whether the cross-modal bias persists. Findings suggest that prior exposure to specific combinations of multimodal emotional stimuli is not a necessary condition for the cross-modal bias to manifest. Effective interpersonal communication may depend on an innate ability that does not require the spontaneous co-occurrence of two emotional signals. Numerous studies have demonstrated that physical activity enhances mental well-being. Research has identified correlations between physical exercise and mental health conditions, including depression, anxiety, stress, emotional states, self-esteem, and other psychological disorders. Recent meta-analyses of randomised controlled trials indicate that exercise is particularly beneficial for individuals with depression. Additionally, previous research has shown that physical activity has an immediate positive impact on emotional states in both mentally healthy young individuals and those diagnosed with schizophrenia. Long-term engagement in exercise has also been found to reduce symptoms of depression in healthy young individuals, while also alleviating psychiatric symptoms and improving self-efficacy in those with mental health conditions (Jin et al., 2019). However, the precise mechanisms through which exercise enhances mental health remain incompletely understood, making it challenging to fully explain these effects (Bradley et al., 2001).

The brain's response to emotional stimuli is believed to be closely linked to mental well-being. It has been suggested that individuals with depression exhibit atypical neural processing of emotional stimuli. Moreover, pharmaceutical antidepressant treatments have been shown to normalise these abnormalities. Consequently, cognitive state changes are regarded as being associated with variations in neural responses to emotional stimuli. Based on this, it is hypothesised that exercise may improve mental health by modulating the brain's response to emotional stimuli (Barbour, Edenfield, & Blumenthal, 2007). Street dancing was selected as the mode of exercise for this study, given its recognition as a movement-based psychotherapeutic approach within dance therapy. Furthermore, street dancing has been shown to enhance emotional states in both mentally healthy individuals and those experiencing depression or schizophrenia (Basso & Suzuki, 2016; Bastiaansen, Thioux, & Keysers, 2009; Blakemore & Frith, 2003; Calvo-Merino et al., 2005).

Recent neuroscientific research has re-evaluated the relationship between mental and physiological states. The neuroanatomical foundation of subjective experiences is thought to be based on an internalised representation of the body's physiological condition. Additionally, observing others activates the mirror neuron system, which is believed to facilitate the understanding of others' emotional experiences and internal states (Christensen et al., 2014; Craig, 2009; Csikszentmihalyi & Csikszentmihalyi, 1988; Drevets et al., 1997). This study hypothesised that changes in body-centred emotional processing systems may be linked to the psychological benefits of exercise. Moreover, it was expected that street dance training would enhance neural responses to positive emotional stimuli while having no effect on responses to negative stimuli. This hypothesis is supported by previous research suggesting that street dance exercise enhances positive emotions without influencing negative emotions in young, healthy individuals.

Material and Methods

The study included 30 participants, none of whom engaged in regular exercise more than twice per week or had any psychological or orthopaedic conditions. All subjects granted written informed permission, and the research obtained approval from the Institutional Review Board.

Methodology

The participants were divided into two groups: a training group comprising 10 men and 5 women, and a control group comprising 10 men and 5 women. The training group participated in 60-minute street dancing sessions three times per week for four weeks. The control group maintained their usual daily routines and was explicitly instructed to refrain from initiating any exercise during the study period. To assess the impact of exercise on affective states, the emotional states of the training group were evaluated before and after the training sessions. Functional magnetic resonance imaging (fMRI) data were acquired in two separate sessions, one prior to and one following the training period. In the training group, the post-training scan was conducted three days after the final dance session.

Training in Street Dancing

The intensity of street dancing training was maintained at approximately 70% of the participants' maximum heart rate. Sessions began with basic movements, with the complexity gradually increasing in accordance with each participant's level of proficiency. For an optimal and enjoyable experience, it is essential to align perceived challenges with an individual's perceived abilities. Therefore, the sessions incorporated a variety of street dancing routines tailored to participants' skill levels. The difficulty of different dance styles varies depending on several factors, including movement complexity, technical skill requirements, physical demands, and cultural or historical influences. The following provides a general overview of the difficulty levels of various popular dance styles, along with recommendations for structuring training sessions accordingly.

Breaking
Difficulty: High

Training Allocation: Breaking requires strength, flexibility, and agility. Training should involve regular sessions focusing on foundational moves, power moves, footwork, toprock, and freezes. Strength and flexibility exercises are essential for improving performance.

Krumping
Difficulty: High

Training Allocation: Krumping is an expressive dance form that conveys emotions through intense bursts of movement and body control. Training should include regular sessions focusing on physical explosiveness, control, and emotional expression. Emotional release and engagement are crucial components of training.

Popping
Difficulty: Moderate to High

Training Allocation: Popping involves precise muscle contractions to create robotic or wave-like movements. Training should incorporate regular sessions to develop isolations, flexibility, and strength. This style enhances body awareness and control.

Locking
Difficulty: Moderate to High

Training Allocation: Locking is characterised by distinct movements such as locks, points, claps, and twirls. Training should focus on swift execution of hand and leg movements through regular classes. The comedic nature of locking contributes to expressive and engaging performances.

House
Difficulty: Moderate

Training Allocation: House dance features intricate footwork and rhythmic movements. Training should emphasise coordination, speed, and musicality through regular practice. Exploring various step combinations and improvisation enhances skill development.

Hip Hop
Difficulty: Moderate

Training Allocation: Hip hop dance is defined by large, dynamic movements and rhythmic variations. Training should include regular sessions to develop isolation techniques, up-down motions, and rocking movements. Freestyle practice and staying informed on evolving hip hop trends can enhance performance.

Jazz
Difficulty: Moderate

Training Allocation: Jazz dance integrates elements from ballet, modern, and African dance, with contemporary jazz incorporating hip hop influences. Training should focus on isolations, waves, and rolls, with additional emphasis on flexibility, strength, musicality, and stylistic expression.

When structuring training, a balanced approach should be maintained, incorporating technique classes, conditioning, and dedicated practice sessions. Cross-training in strength development, flexibility exercises, and cardiovascular fitness can further enhance dance performance while reducing the risk of injury. This study utilised fMRI to examine brain activity in response to specific events or stimuli. Each volume was obtained by capturing 20 consecutive axial slice images using the following parameters: TE of 90.5 ms, TR of 4000 ms, FOV of 240 mm, section thickness of 6.0 mm, and a matrix size of 128 × 128. T1-weighted anatomical images were acquired for spatial transformation of fMRI data. These images were obtained using a rapid SPGR sequence, capturing a series of axial slices with the following parameters: FOV of 240 mm, TE of 2.4 ms, TR of 26.0 ms, FA of 30°, section thickness of 2.3 mm, and a matrix size of 256 × 256. No structural abnormalities were detected in any of the 22 participants.

Task Involving the Activation of Emotions

The subjective ratings provided by the International Affective Picture System (IAPS) were utilised to classify emotional images into three categories: pleasant, unpleasant, and neutral. A total of 120 slides were generated, comprising 40 images from each category. The mean valence and arousal scores for the 480 images were as follows: 7.25 ± 1.03 and 5.22 ± 1.11 for pleasant stimuli, 6.33 ± 1.06 and 4.25 ± 1.07 for neutral stimuli, and 4.11 ± 1.22 and 5.17 ± 1.21 for unpleasant stimuli. The valence ratings of pleasant and unpleasant images differed significantly from those of neutral images ($P < 0.001$). Similarly, neutral images elicited significantly lower arousal levels compared to both pleasant and unpleasant images ($P < 0.001$). All images depicted human faces or figures. Positive slides illustrated expressions of contentment and elation, whereas negative slides featured sorrowful and melancholic imagery. Slides with high arousal potential were excluded due to their distressing, alarming, or sexually provocative content. The appendix provides the identification numbers of the IAPS slides along with normative ratings of valence and arousal for each image. A total of 120 slides were displayed in a randomised sequence. Participants were instructed to view the images and experience their emotions without interpreting the symbolic meaning of the visuals.

Neuroimaging data were analysed using Statistical Parametric Mapping software. Functional images were realigned to the first image in the time series after slice timing correction. They were then rescaled to the Montreal Neurological Institute's standard template (2 × 2 × 2 mm resolution) and spatially smoothed using an 8 mm full-width-at-half-maximum Gaussian kernel. A high-pass filter removed low-frequency noise from the fMRI time series. A general linear model with a canonical haemodynamic response function identified significant haemodynamic changes within each group. Two T-contrasts were computed per participant: one comparing responses to positive versus neutral stimuli and another for negative versus neutral stimuli. A random-effects analysis using a mixed-design two-way ANOVA assessed the impact of dance training on neural responses. Statistically significant voxel values indicated that street dance training may influence haemodynamic activity in response to emotional stimuli.

As this represents the first attempt to utilise event-related fMRI to examine the effects of exercise training on neural responsiveness, exploratory whole-brain analyses were conducted. To control for false positives, clusters comprising fewer than 10 contiguous voxels were excluded, and anatomical labelling was performed using Anatomic Automatic Labelling. To confirm the improvement in emotional states following street dancing training, the training group completed self-reported questionnaires during the first and twelfth sessions. Emotional states were assessed before and five minutes after each dance session using a mood-check questionnaire.

The MCL-S was developed to evaluate emotional states during or following physical activity. This survey measures levels of enjoyment, calmness, and unease experienced by individuals. It comprises 15 questions, with five items allocated to each component. Participants provide ratings using a 7-point Likert scale, with scores for each dimension ranging from -12 to 12. An increase in enjoyment and calmness, alongside a reduction in unease, indicates a positive shift in emotional state. Additionally, depressive symptoms were assessed using the CES-D following each fMRI scan conducted before and after the training sessions.

Results

Table 1 shows that 20 participants (66.67%) were male, while 10 (33.33%) were female. The majority (66.67%) were aged between 21 and 23 years, followed by 20% under 20 years old, and 13.33% in another age category. The mean age of the participants was 21.41 ± 2.52 (Figure 1).

Table 1

Gender and Age of the Participants

Gender	Number	Percentage	P Value
Male	20	66.67	0.21
Female	10	33.33	
Age in Years			0.12
Below 20	6	20	
21-23	20	66.67	
24-26	4	13.33	
Mean Age	21.41±2.52		

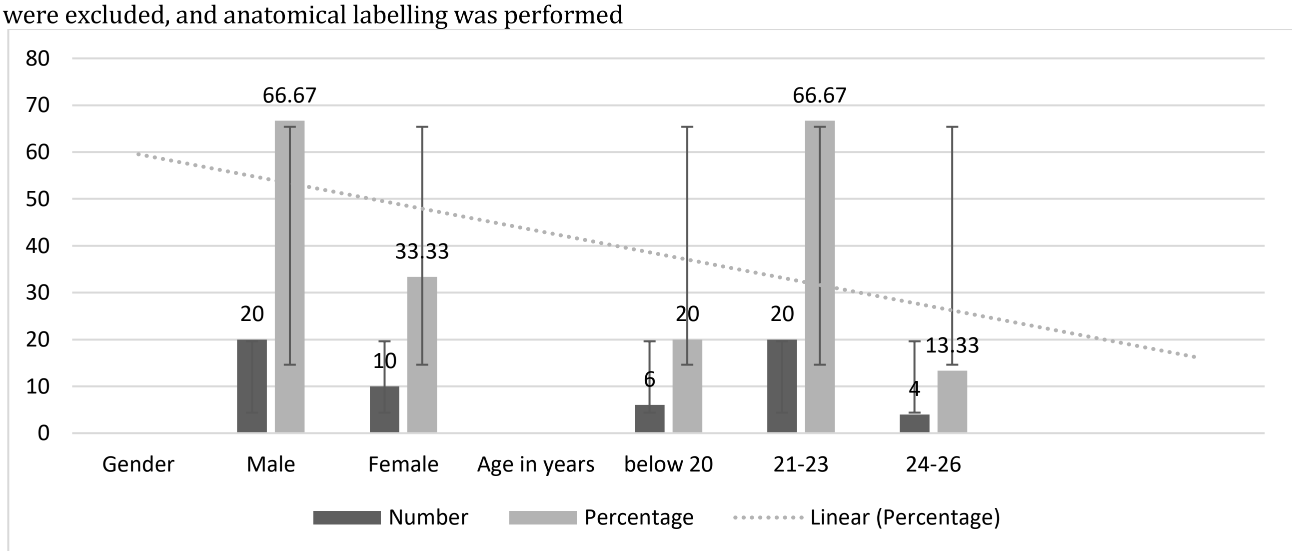

Figure 1: Gender and Age of the Participants.

Table 2 presents the emotional states before and after the first and twelfth exercise sessions. Enjoyment significantly increased from 17.99 ± 2.58 to 23.06 ± 3.47 (P = 0.02) after the first session and from 17.02 ± 2.06 to 24.11 ± 3.14 (P = 0.003) after the twelfth session. Additionally, anxiety levels significantly decreased from 13.21 ± 2.22 to 8.99 ± 1.57 (P = 0.03) immediately after the first session and from 13.04 ± 1.89 to 8.01 ± 1.63 (P = 0.04) following the twelfth session. The CES-D scores in the training group increased from 11.99 ± 1.63 before training to 14.03 ± 2.04 after training, while in the control group, they changed from 10.96 ± 1.21 before training to 12.69 ± 2.55 after training. These results are illustrated in Table 2 and Figure. 2.

Table 2

The Affective States Before and After Training

Pleasure	Before Training	After Training	P Value
1st Session	17.99 ± 2.58	23.06 ± 3.47	0.02
12th Session	17.02 ± 2.06	24.11 ± 3.14	0.003
Anxiety			
1st Session	13.21 ± 2.22	8.99 ± 1.57	0.03
12th Session	13.04 ± 1.89	8.01 ± 1.63	0.04
CES-D Scores			
1st Session	11.99 ± 1.63	14.03 ± 2.04	0.14
12th Session	10.87 ± 1.41	13.21 ± 1.37	0.13

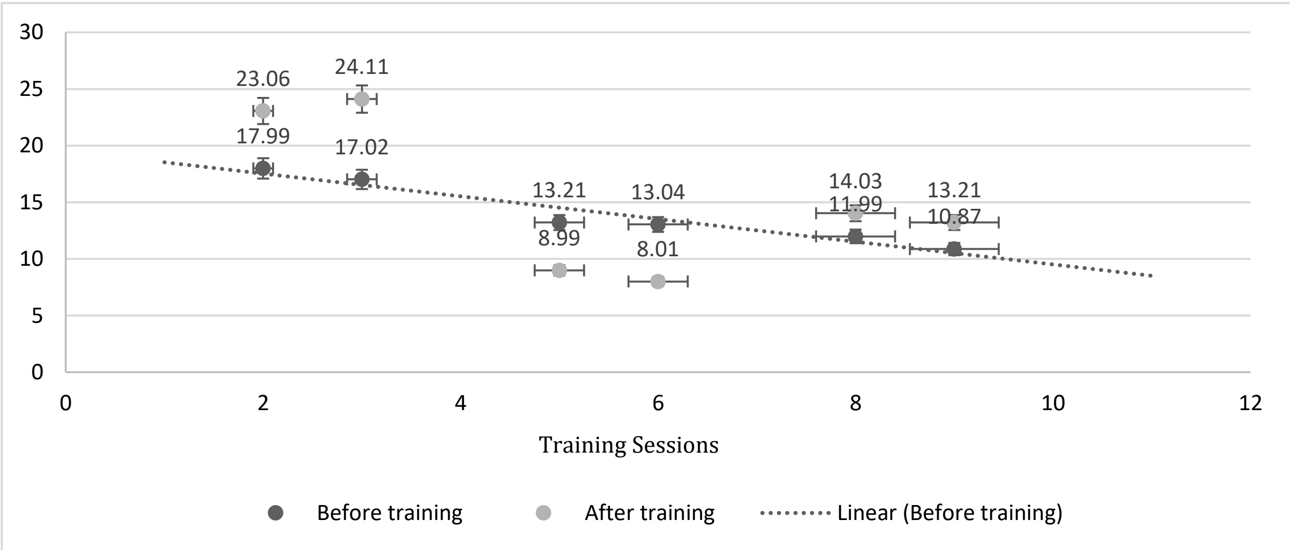

Figure 2: The Affective States Before and After Training.

Table 3 presents an analysis of the impact of street dancing instruction on the brain's response to positive and negative emotions. The training group demonstrated significantly greater activation than the control group in several brain regions associated with emotional processing. The precuneus, cuneus, angular gyrus, insula, putamen, temporal pole, and pMCC were among the regions associated with processing positive emotional stimuli. Additionally, in response to negative emotional stimuli, the training group exhibited increased activation in the cuneus, somatosensory region, IPL, SPL, and the whole brain. Following FWE correction for multiple comparisons, the increased activity observed in the cuneus [x, y, z = -12, -77, 29] in response to positive emotional stimuli remained statistically significant (P < 0.05). Notably, no brain regions displayed reduced neuronal responsiveness in the training group compared to the control group. These findings are summarised in Tables 3 and 4 and illustrated in Figure. 3.

Table 3

Effects of Exercise Training on Neural Response Significant Group-by-Time Interaction to Pleasant Emotional Stimuli

Regions	Coordinate					
	Regions Showing Increased Activity					
	L/R	X	Y	Z	Z Value	Size
Cuneus/SOG	L	-12	-77	29	6.25	238
Insula/Putamen	L	-28	15	-7	4.15	9
Lingual/PHG/Precuneus	R	19	-39	-3	4.75	22
TP/Insula	R	49	12	-12	4.25	53
Lingual/Cerebellum	L	-7	-71	-3	4.62	16
Insula	R	41	17	-5	4.15	42
Angular Gyrus	R	39	-71	46	4.25	32

Precuneus/Cuneus	R, L	7	-74	46	4.63	147
pMCC	R	14	-19	45	4.32	31

Table 4

Impact of Exercise Training on Neuronal Responsiveness

	Coordinate					
	Regions Showing Increased Activity					
	L/R	X	Y	Z	Z Value	Size
SPL/IPL	L	-31	-58	47	5.52	87
Postcentral Gyrus/PCL	R	16	41	72	4.69	36
Precuneus	R	7	69	46	4.74	16

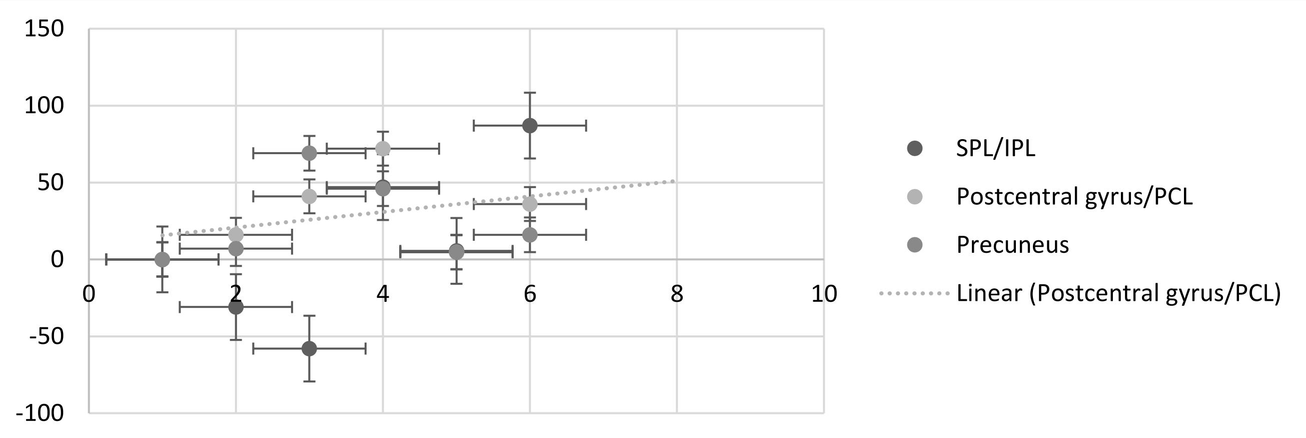

Figure 3: Impact of Exercise Training on Neuronal Responsiveness.

The findings in Table 5 suggest that the influence of music is linked to the changes in VAS ratings. Ratings in the joyful music condition (M = 61.58) were significantly more favourable, whilst those in the sad music condition (M = 42.63) were distinctly more unfavourable, in comparison to the no-music condition (M = 52.96). These data substantiate the existence of a cross-modal bias. The primary influence of dance valence endorses the choice of dance stimuli, demonstrating that movements correlated with pleasure garnered substantially higher favourable evaluations (M = 65.74) compared to those associated with melancholy (M = 43.15). To investigate the characteristics of this interaction, paired t-tests were performed, comparing participants' assessments across various musical settings for each dance emotion (joyful versus sad). The findings demonstrated that sad dancing stimuli were regarded as markedly more positive when combined with happy music (incongruent condition) and as significantly more negative when accompanied by sad music (congruent condition), in comparison to the no-music control.
Nonetheless, positive dance stimuli did not obtain substantially higher favourable ratings in the joyful music condition relative to the no-music condition. Nonetheless, they received significantly lower ratings under the sad music condition. The rating difference in the upbeat music condition was not statistically significant. The cross-modal bias was apparent for both happy and sad music in the presence of negative dance stimuli, but only for sad music with positive dance stimuli. An analogous examination of GSR data (Table 5, Figure 4) revealed diminished responses in the absence of music (M = 0.91) relative to joyous (M = 1.11) and melancholic music (M = 1.07). The ANOVA (3 Music × 2 Dance Valence) revealed no significant main effects or interactions, suggesting that the cross-modal bias and dance valence effects on VAS ratings did not manifest in physiological responses.

Table 5

VAS Ratings for the Positive and Negative Dance Stimuli were Analysed based on the Dancing Condition

	Happy Dance	Sad Dance	F Value	P Value
VSA Score			5.25	0.001
Happy	61.58	65.74		
Sad	42.63	43.15		
No dance	52.96	42.85		
GSR			4.69	0.01
Happy	1.11	0.98		
Sad	1.07	1.21		
No Dance	0.91	0.82		

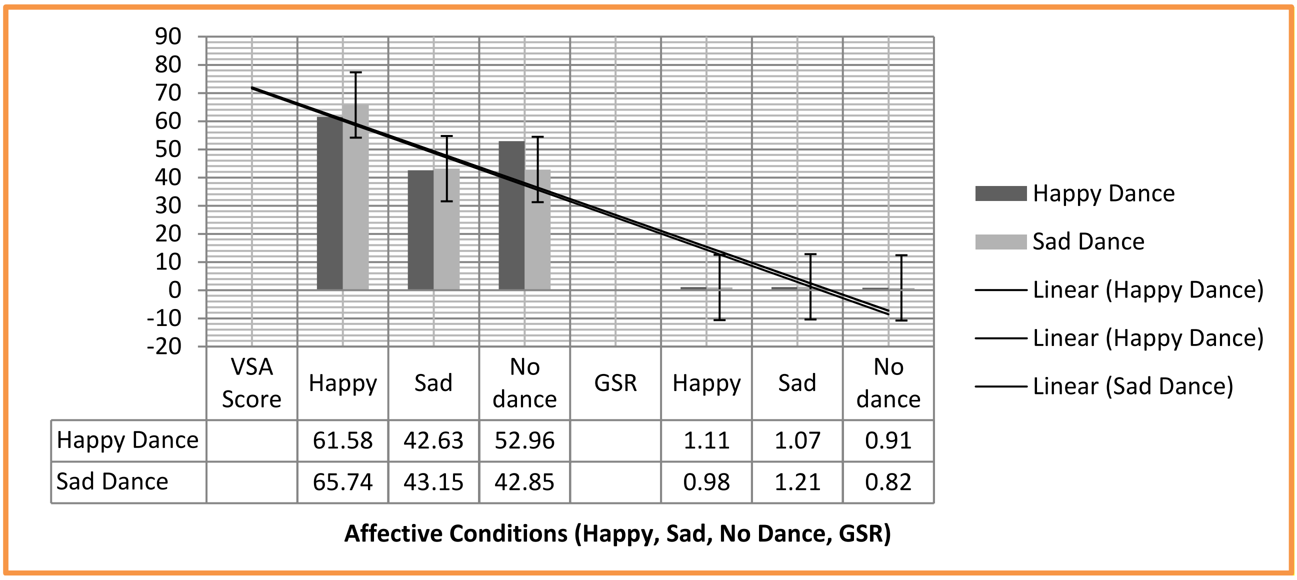

Figure 4: VAS Ratings for Positive and Negative Dance stimuli were Analysed based on the Dancing Condition.

The Role of Arousal

To investigate the effect of arousal on cross-modal bias, the experiment was repeated with varying arousal levels as a within-subject variable. A 3 × 2 repeated measures ANOVA was conducted on VAS ratings, considering music condition (Happy-None-Sad) and dance arousal (High-Low). The Shapiro-Wilk test confirmed normal distribution. The results reinforced the significant influence of the music condition. However, the interaction between components was not statistically significant, suggesting cross-modal bias similarly affected both arousal levels. The impact of dance-induced arousal on participants' GSR data was examined, with normal distribution confirmed via the Shapiro-Wilk test. A 3 × 2 ANOVA revealed a significant interaction between factors, though no main effects. As shown in Table 6, and consistent with cross-modal bias, GSR levels significantly increased when low-arousal dance videos were paired with sad music compared to no music. A slight increase was also observed for high-arousal dance videos with happy music. This suggests that music aligning with the excitement level of dance movements enhances physiological responses. The results are presented in Table 6 and Figure 5.

Table 6

The VAS Scores for the Low-Arousal and High-Arousal

	Low	High	F Value	P Value
VSA Score			3.22	0.001
Happy	61.58	65.74		
Sad	42.63	43.15		
No Dance	65.66	38.25		
GSR			4.29	0.01
Happy	1.17	0.98		
Sad	1.16	1.25		
No Dance	0.08	0.82		

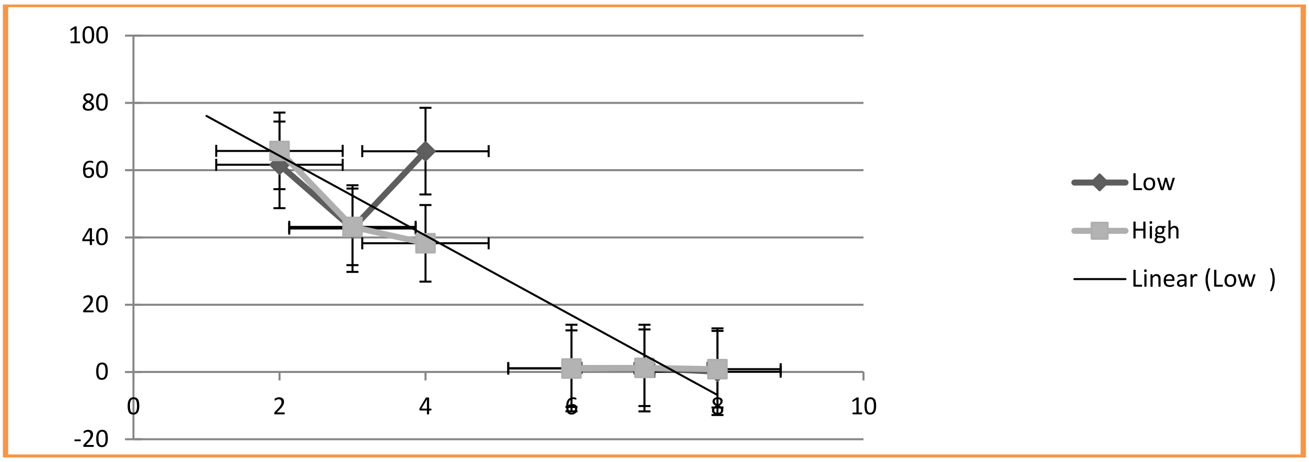

Figure 5: The VAS Scores for the Low-Arousal and High-Arousal.

Discussion

Engaging in street dance training, like other forms of physical exercise, can influence neural responses and contribute to overall well-being, including emotional regulation. While research specifically on street dance training is limited, extensive studies have explored the broader effects of physical activity on brain function [15]. Street dance or other physical activities may positively affect neural responses to emotional stimuli through several mechanisms:

Neurotransmitter Release: Physical activity, including dance, stimulates the release of neurotransmitters such as endorphins, which are associated with improved mood and reduced pain perception, thereby enhancing emotional well-being.

Stress Reduction: Regular physical activity lowers stress hormone levels, such as cortisol. Consistent engagement in street dance may improve stress management and influence the brain's response to emotional stimuli.

Neuroplasticity: Exercise is linked to enhanced neuroplasticity, enabling the brain to reorganise and form new neural connections. Street dance training may induce such changes, affecting emotional processing. Additionally, improved cognitive functions, such as attention, memory, and executive function, may contribute to more adaptive emotional responses.

Social Interaction: Street dance often involves group participation, fostering cooperation and a sense of community. Positive social engagement can influence emotional well-being and promote a more favourable neural response to emotional stimuli (Bernardet et al., 2019; Fu et al., 2007).

This study examined the effects of street dance training on neural responses to emotional stimuli in healthy young individuals. The findings revealed that such training enhanced brain activity in multiple regions associated with emotional regulation. However, no significant improvement in depressive symptoms was observed. Participants consistently reported improved emotional states during each session, marked by increased enjoyment and reduced anxiety (Gondoh et al., 2009), suggesting that street dance serves as an effective stimulus for mental well-being.

Despite completing 12 training sessions, no changes were detected in CES-D scores. Previous research indicated that a more extended intervention, involving 30 sessions, led to improvements in CES-D scores among physically active young adults. This suggests that a longer training period may be required to alleviate depressive symptoms. Alternatively, neural changes in response to emotional stimuli may occur before measurable improvements in depressive symptoms. Increased neural activity was detected in several clusters, particularly within the posterior parietal cortex—including the precuneus, superior parietal lobule, inferior parietal lobule, and angular gyrus—as well as in the cuneus and superior occipital gyrus of the occipital lobe (Bonny, Lindberg, & Pacampara, 2017; Gvirts & Perlmutter, 2020). These responses were observed for both positive and negative emotional stimuli. The posterior parietal cortex, situated within the occipital lobe between the postcentral gyrus and the visual cortex, plays a key role in integrating visual and somatosensory inputs. It contributes to sensory regulation by transmitting signals to the frontal premotor area, facilitating motor control. These regions likely support the processing of visual information from stimuli, enhancing visual attention towards emotionally salient cues.

The angular gyrus, which exhibited increased activation exclusively in response to positive emotional stimuli, forms part of the TPJ. The TPJ is involved in the cognitive function known as the "Theory of Mind," which enables individuals to attribute mental states—such as thoughts and beliefs—to themselves and others. It is also crucial for distinguishing between self-initiated and externally generated actions, a fundamental aspect of empathy. Changes in TPJ activity in response to positive emotional stimuli may influence the perception of such stimuli, potentially contributing to the psychological benefits associated with physical exercise (Kosmat & Vranic, 2017). Additional clusters within the posterior parietal cortex appear to be involved in processing emotional visual input. Increased activity in these areas is thought to enhance the processing of emotional signals conveyed through bodily expressions. Notably, this region demonstrates greater activation in response to bodily expressions of emotion compared to facial expressions (Amin, 2016; Cebolla & Cheron, 2019).

Mirror systems are essential for understanding others' perspectives, as observing emotions activates motor and somatosensory components. This study found increased activity in the posterior midcingulate cortex and somatosensory area in response to negative emotional stimuli. The pMCC regulates skeletal muscle movement via spinal cord signalling and interacts with the posterior parietal cortex. Mirror systems demonstrate plasticity, evident in heightened activity when trained dancers observe learned movements (An et al., 2018; Aronov, Nevers, & Tank, 2017). The cortex generates all subjective experiences and emotions, reflecting the body's overall physiological state. Additionally, this region plays a key role in translating perceived emotions into subjective experiences. In this study, only positive emotional stimuli influenced activity in the insular cortex (Gallotto et al., 2017; Harvey, 2020).

The findings suggest that street dance training enhances the subjective experience of positive emotions. Additionally, the anterior insular cortex exhibits lateralised asymmetry in function. Activation of the right AIC is associated with heightened physiological arousal, whereas the left AIC responds primarily to pleasant and affiliative emotions, reflecting increased sympathetic and parasympathetic activity towards positive stimuli. Neuroimaging studies have linked the insular cortex to various neuropsychiatric disorders, including mood and panic disorders and PTSD. Thus, its role in maintaining mental well-being suggests that changes in insular activity in response to positive emotions may underlie the psychological benefits of physical exercise (Goldstein et al., 2018). This study examined the overall impact of street dance training. However, to accurately assess the effects of physical and physiological exercise stimuli, it is essential to account for the influences of social interaction and music. Moreover, the subjective experience during physical activity appears to play a crucial role in enhancing psychological well-being.

Conclusion

This study examined how street dance training influenced neural responses to emotional stimuli in young, healthy individuals. Both positive and negative emotional cues activated the occipital and posterior parietal cortex. As anticipated, the TPJ and insular cortex exhibited distinct neural responses to pleasurable emotional stimuli. These neural adaptations may be linked to the psychological benefits of physical exercise.

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