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The change in aesthetic experience and empathic concern predicts theory of mind ability: Evidence from drama improvisation training

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ABSTRACT

Drama improvisation is recognized for its benefits in the Western context, particularly in enhancing performers' social awareness and interaction skills. However, there is a gap in evidence from diverse cultural backgrounds, and few studies have examined the dynamic shifts in individuals before and after brief drama improvisation training. In this study, first-year Chinese college students not majoring in arts underwent a semester-long training encompassing six modules related to drama improvisation. The participants' social anxiety, interpersonal sensitivity, intentional self-regulation, and aesthetic experience were measured pre- and post-training. Notably, the training was observed to reduce students' social anxiety and elevate their flow experience—a state marked by deep concentration, pleasure, and heightened focus. The change in the flow experience and the empathic concern, predicted one's theory of mind. These findings suggest that drama improvisation training can potentially bolster mental well-being in young adults, alter their aesthetic experiences, and enhance their socio-communicative skills, fostering creative thinking within the Chinese cultural framework.

Introduction

Drama improvisation as an effective tool for psychotherapy

Drama improvisation is an acting activity that involves creating scenes spontaneously based on a given stimulus or theme (Brett, 2022; Felsman et al., 2023). Unlike traditional scripted acting, it requires actors to deliver extemporaneous performances, drawing inspiration from scenarios or themes presented by a facilitator or the audience (Lees, 2019; Sawyer, 2000; Sowden et al., 2015). This method offers performers a dynamic platform to navigate diverse emotions, vocal techniques, and personas, thereby enhancing emotional resonance and expression (Reid-Wisdom & Perera-Delcourt, 2022; Sowden et al., 2015; Steitzer, 2011). At the heart of drama improvisation is a foundational principle: performers embrace the ideas presented by their counterparts, metaphorically signaling this acceptance with a 'yes'. They then expand upon this mutual understanding using the concept of 'and.' Within this framework, 'yes' and 'and' aren't necessarily verbalized. Instead, they represent a more profound ethos of validation and teamwork. While 'yes' serves as a symbolic gesture of agreement and acknowledgement of a partner's contribution, 'and' indicates the subsequent elaboration and enrichment of that idea, introducing fresh nuances and trajectories to the improvisational narrative (Hines, 2016; Jagodowski et al., 2015). The complexity of drama improvisation demands performers to be exceptionally receptive, promptly reactive, and adept at discerning their partner's verbal cues. Furthermore, drama improvisation calls for an elevated collaborative skill set, where performers harmoniously build upon each other's contributions, weaving them into a unified and fluid performance (Halpern et al., 1994).

Drama improvisation has been considered an effective tool for psychotherapy. Historically, improvisational drama has been employed as a means of psychological health intervention. For instance, psychodrama in the past utilized techniques such as role-playing and role reversal to dramatize personal experiences (Kedem-Tahar & Felix-Kellermann, 1996). Moreover, these psychodramatic methods gradually found applications in drama therapy, encompassing improvisational drama games and non-improvisational activities like mask-making (Kedem--Tahar & Felix-Kellermann, 1996). Drama therapy is defined by the North American Drama Therapy Association (NADTA) as "the intentional use of drama and/or drama processes to achieve therapeutic

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goals" (www.nadta.org). Nine systematic drama therapy processes have evolved with continuous practice, including dramatic projection, embodiment, personification and impersonation, interactive audience and witnessing, the life-drama connection, play, therapeutic performance, drama-therapeutic empathy and distancing, and transformation (Jones, 2007). One particular psychodramatic therapy model, the Developmental Transformations theory (DvT), emphasizes the role of embodied cognition in therapeutic change (Frydman, 2017). The practice of DvT necessitates that two or more individuals engage in an imagined or co-constructed dramatic reality, all the while using their bodies as tools of participation (Johnson, 2009). Within this interaction, the therapist and the participant continuously shift between improvised dramatic roles, fostering an ongoing interpersonal flow. The aim of this approach is to encourage the persistent transformation of dramatic roles, assisting participants in confronting their social barriers and enhancing their perceptiveness towards others' emotions (Mayor & Frydman, 2021). Through this theory, drama therapy advances the participants' dramatic skills and offers them a platform to comprehend and address their daily social challenges and emotional hurdles through dramatic activities. This amalgamation of drama and therapy provides participants with a safe environment where they can freely explore their emotional and social reactions, while also learning how to interact more effectively with others.

Effects of drama improvisation training on an individual's socio-cognitive capacity and aesthetic experience

Drama improvisation training has established a significant presence in diverse fields. In the corporate world, organizations have turned to improvisational techniques to train employees in navigating unforeseen scenarios, as evidenced by case studies and interviews. These improvisers can perceive characters' emotions through the experiences gathered from creative challenges, also known as 'flow' (Hadida et al., 2015). Drama improvisation training was also recommended for adults with autism as an effective strategy for acquiring social support and enhancing social connections (Müller et al., 2008). Felsman et al. (2019) provided evidence of the effectiveness of a 10-week school-based improvisational drama programme in reducing social anxiety symptoms by comparing quantitative self-report data between pre- and post-exposure. The social anxiety score (measured with the Social Anxiety Scale) was reduced after a drama improvisation-assisted psychology course was taken by 2nd-year non-art college students (Sarıkaya et al., 2019). Further research has shown that drama training can influence an individual's perception of emotional valence. Specifically, compared to the control group, the training group perceives emotions more positively (Celume et al., 2019). Interestingly, the mental benefits derived from drama improvisations aren't confined to Western contexts. For instance, a study by Watson-Vandiver and Wiggan (2021) analyzed the aesthetic experiences within drama improvisations of six Cantonese children aged 3–5 years in Hong Kong. The qualitative coding of video recordings of these children's performances suggests that drama improvisation training could potentially enhance children's creativity. Furthermore, a case study conducted in an under-resourced college in China showed that the teacher's use of drama-based pedagogy, including improvisational techniques, is motivated by its potential to engage the students' interest in reading activity and enhance their confidence and self-empowerment (Zhang, 2021). However, it's worth noting that much of the evidence is qualitative. Quantitative insights into the impact of drama improvisation on personal development within the Chinese context remain sparse. This includes self-confidence, self-esteem, communication, collaboration, decision-making, problem-solving, social awareness, and empathy (Rhee et al., 2003; Shafiq et al., 2020; Shoshani et al., 2021). Freshmen entering college frequently face challenges adapting to new environments, highlighting the potential benefits of drama improvisation for these developmental transitions (Alsubaie et al., 2019; Gestsdóttir & Lerner, 2007). It remains to be clarified whether drama improvisation training can address the challenges faced by first-year students within a Chinese cultural context.

Drama improvisation training has been recognized for enhancing emotional sensitivity, allowing individuals to quickly tune into others' emotional signals. This practice promotes mutual understanding and compassion among performers as they collaboratively create a unified performance (Zenk et al., 2022). The effectiveness of fostering interprofessional empathy in health professionals has been witnessed in the decreased level of personal distress in those who have received drama improvisation training, demonstrating the role of drama improvisation in altering one's interpersonal sensitivity (Zelenski et al., 2020). Moreover, focusing on building self-regulation using drama improvisation can be effective for adolescents in building interventions for trauma (Wood, 2019). Drama improvisation training can also promote 9- to 10-year-old children's theory of mind, the capacity to reason about another person's mental state, and their collaborative behavior (Celume et al., 2020). One way to gauge the influence of drama improvisation on young adults is by assessing their 'flow' during aesthetic experiences (Hadida et al., 2015). Such experiences, characterized by deep engagement with arts and culture, bring joy and satisfaction. Participants often describe being in 'flow' as a state of deep concentration, pleasure, and immersion (Gotthardt et al., 2022; Nakamura & Csikszentmihalyi, 2009; Wanzer et al., 2020). Evaluating 'flow' can illuminate the intricate connection between drama improvisation and emotional, interpersonal, and aesthetic competencies. This state of 'flow' can be experienced in various activities, from playing an instrument to drama improvisation (Hadida et al., 2015; Koster, 2014). However, whether the ability to experience flow can be altered through short-term training in drama improvisation is still unclear. More importantly, whether this change in flow would influence an individual's ability to infer the emotions of others also needs further clarification. Exploring the potential link between drama improvisation and 'flow' might offer valuable insights for therapeutic and educational strategies. Additionally, understanding how these shifts might influence emotional comprehension could be pivotal for bolstering empathy and interpersonal abilities, essentially in diverse social and professional settings (Zenk et al., 2022).

It is possible that the corresponding change in socio-cognitive function(s), such as empathic concern due to the drama improvisation activity, predicts one's theory of mind ability. Neurocognitive evidence has shown that both capacities of reasoning about another's mental state and sharing affective states can be activated when individuals are demanded to continuously infer someone else's feelings accurately (Preckel et al., 2018). Developmental studies demonstrated that young adolescents of 11 to 12 years old showed a positive association between the ability to infer another's mental state through the eyes and their empathic concern (Andrews et al., 2021). Comparing those with and without acting experience showed enhanced perspective-taking ability, further supporting the possible association between the change of empathic concern due to role-playing and theory of mind ability (Goldstein et al., 2009). Moreover, the change in aesthetic experience due to drama-improvisation training can also predict the theory of mind. Aesthetic vs. Quality appreciation can lead to differential perceptions towards artistic paintings known to be created intentionally, suggesting that extra engagement of aesthetic experience could alter the reasoning of the intent of the artist (Hawley-Dolan & Young, 2013). When individuals reason about the mental state of the characters in the photos, compared with when they evaluate non-mental characteristics, they aesthetically appreciate artistic photos more (Iosifyan, 2021).

The present study

Drama improvisation holds promise in enhancing the flow experience, empathy, and interpersonal skills. It's crucial to understand how these elements interact across different situations and cultural backgrounds. This study aims to examine 1) how receiving drama

improvisation training could affect non-art major students in socio-cognitive functions (social anxiety, interpersonal sensitivity, self-regulation) as well as in aesthetic experience and 2) how these changes could predict one's theory of mind ability. In this study, we engaged first-year non-art major students to join a six-week course, recording their responses to specific questionnaires before and after the course. The curriculum was meticulously designed and split into six modules emphasizing the essential elements of intensive drama improvisation: Relaxation and Trust, Voice and Emotion, Body and Energy, Context and Cognition, Narrative and Innovation, and concluding with Performance and Expression (Table 1). The aim was to offer students not majoring in arts a chance to hone their cognitive, expressive, empathetic, collaborative, and creative abilities. This approach diverges from traditional drama education, which often relies on unidirectional instruction from tutors. Given the existing research on drama improvisation's impact, we anticipated that students would exhibit reduced social anxiety, heightened empathy, increased self-regulation, and a richer aesthetic experience by the end of the course. Moreover, it is expected that the corresponding change in other socio-cognitive function(s), especially empathic concern due to the drama improvisation activity, could be a predictor of one's theory of mind ability. It is also likely that the change in aesthetic experience due to drama-improvisation training can predict the theory of mind.

Table 1
Themes covered in the drama improvisation training in six weeks. Each theme counts for three hours of classroom time.

Course Modules	Weeks	Description of Activities
Relaxation and Trust	1st	Students relive their psychological tension and alarms through drama games and teamwork. They are acquainted with new surroundings and fellow classmates. They feel involved, build initial trust in their teammates, and get by communicating with others in a given drama context where they can 'pretend to be others' – having the first taste of 'how the world can be otherwise'.
Voice and Emotion	2nd	Vocal expression techniques are learned and exercised, including breath, explicit articulation, stress, intonation, etc. Students are encouraged to express feelings and emotions out loud with flexible intonation for social-communicative purposes, e.g., showing how happy they are by articulating 'I am super happy today!.'
Body and Energy	3rd	Students are engaged in games, role-play, and creative drama playwriting so as to maximize their understanding of how verbal and non-verbal communication skills can integrate. For higher-level tasks, students are expected to express emotion with only movement in total silence.
Context and Cognition	4th	Students are allocated to drama scenarios simulating various real-life contexts. They are encouraged to observe themselves and others in terms of actions and communication styles, thereby forming meta-cognition. Students' empathy and interpersonal skills are developed.
Narration and Innovation	5th	Students create their own drama stories based on classic drama artworks. They are expected to think out of the box, innovatively deconstruct traditional narratives, and reconstruct their pieces of stories. They should work in groups and submit a complete, workable script.
Performance and Expression	6th	All teams prepare their scripts, rehearsing before the class. Plays are shown in the class, where students perform in a semi-professional drama room. Groups mark and comment on each other group's performance.

Methods

The intervention design of the drama improvisation project

The "Drama Improvisation Project" is a school-based intervention designed to teach social skills and expose students to social performances. Participating schools can join through a 6-week course in improvisational drama, also known as "improv acting", without incurring any costs. The project aims to assist first-year university students in continuous reflection through hands-on practice, allowing them to seamlessly transition in and out of character, both within the drama and outside of it, ultimately fostering self-awareness and honing their expressive abilities.

The instructor for this course is the author (R. Li), who has undergone rigorous and professional artistic performance training. Since 2017, the team has been conducting additional training and refining the project every semester, accumulating a participation of up to 400 individuals. To ensure the effective achievement of the intervention objectives, the author (R. Li) has structured the course around six themes, dedicating one week to each theme, spanning six weeks. Each theme lasts for 60 min, as detailed in the syllabus (see Table 1).

In the first week of the course, students delve deeply into relaxation techniques and trust-building exercises within a new environment. Through various drama activities, they not only familiarize themselves with new peers but also experience the joy of portraying different characters in the drama. The second week shifts the focus to vocal expression, where students learn to modulate their breathing, pronunciation, and intonation to vividly convey emotions such as joy and sadness. The third week emphasizes body language. Through role-playing and drama activities, students grasp the art of conveying emotions and information solely through bodily movements without relying on speech. In the fourth week, students are immersed in simulated real-life scenarios, enhancing their observational and reflective skills and better equipping them to navigate diverse social situations. The fifth week centers on creative writing and narrative techniques. Students are encouraged to craft their unique stories based on renowned drama works, showcasing their creativity and imagination. By the sixth week, students commence preparations for their drama performances. They rehearse their scripts and present their works in class, receiving feedback and suggestions from their peers.

To participate in the current Drama Improvisation Project, the following criteria must be met: 1) Participants must be first-year freshmen; 2) All participants must join voluntarily; 3) A consistent set of students must be scheduled to participate each week.

Participants

In September 2021, at the beginning of the fall semester at Shanghai International Studies University, 38 students (27 women and 11 men; Mean Age: 18.16 $\pm$ 0.55 years; Age range 17–20 years) completed pre-training surveys on the first day of the course. One student dropped the course in the second week, leaving 37 students who completed post-training surveys on the course's final week. All participants provided written consent. The study was approved by the Ethics Committee of Shanghai International Studies University. A power analysis was conducted to estimate the minimal sample size, with an effect size with Cohen's *d* of 0.5, an a priori power of 0.80, and an alpha error probability of 0.05 for two tails. The analysis yielded a minimum sample size of 34. As the number of participants exceeded this estimate, a minimal power for rejecting the false null hypothesis is ensured[2] (Faul et al., 2009).

[2] https://www.statisticsteacher.org/2017/09/15/what-is-power/

Measurement tools

Social anxiety scale (SAS)

In this study, the Social Anxiety Scale developed by Rytwinski et al. (2009) was employed to measure the level of social anxiety among participants. The scale was composed of 24 items, with two subscales of fear and avoidance, as well as four dimensions of being observed by others, social interaction, public speaking, and eating in public, each of which was calculated as the average score of certain items from each of the subscales. The four dimensions were obtained by taking the average of the two subscales. Participants responded on a 4-point scale, ranging from 0 (not afraid/ never avoid) to 3 (severely afraid/often avoid). A higher total score indicated a more severe social anxiety symptom. The Cronbach's alpha coefficients for the pre-training and post-training responses of the scale were 0.97 and 0.95, respectively, indicating high levels of internal consistency.

Interpersonal Reactivity Index (IRI)

The Interpersonal Reactivity Index (Davis (1983) was employed to measure one's interpersonal sensitivity. This inventory comprises four dimensions, namely perspective taking, personal distress, empathic concern, and fantasy, encompassing 28 items. Participants responded on a 5-point scale, where one represented 'does not apply at all' and five meant 'applies very well'. A higher score on this inventory indicated an elevated level of empathy. The Cronbach's alpha coefficients for the pre-training and post-training responses of the scale total score were 0.79 and 0.78, respectively. A recent study showed that empathy is better constructed as the aggregated measure of empathic concern and perspective-taking (Wang et al., 2020). Therefore, the empathy score is calculated by only taking items from these two subscales into account. The alpha coefficients for the aggregated measure were 0.73 for the pre-training and 0.79 for the post-training responses.

Intentional Self-Regulation (ISR)

The Intentional Self-Regulation Scale, developed by Gestsdóttir and Lerner (2007) and translated by Dai et al. (2010), was employed. This scale comprises nine items, measuring three dimensions of intentional self-regulation: selection, optimization, and compensation. For instance, an item for the "optimization" dimension was 'I will try my best to achieve my goals.' Participants rated their responses on a 7-point scale ranging from 1 (completely inconsistent) to 7 (entirely consistent). A higher total score indicated a more vital ability for intentional self-regulation. The Cronbach's alpha coefficients for the pre-training and post-training responses were 0.66 and 0.74, respectively, indicating good internal consistency of the scale.

The Aesthetic Experience Scale (AES)

The Aesthetic Experience Scale developed by Wanzer et al. (2020) was used to measure the participants' aesthetic experience. The scale comprises 22 items, encompassing five dimensions: emotion, culture, perception, knowledge, and flow. The Emotional dimension refers to a viewer's emotional responses or feelings when engaging with art. It is a personal and internal reaction to the artwork, often involving a deeper emotional connection or response, such as feelings of awe, inspiration, joy, sadness, etc. The Perceptual dimension refers to the physical or sensory experience of viewing art, such as noticing details, color, shapes, or the overall aesthetic appeal of the artwork. It defines the viewer's ability to perceive and appreciate the visual elements of the art piece. The Cultural dimension relates the significance of the artwork to the cultural or historical context. Viewers who are engaged with art at this level are interested in the historical, social, or cultural context of the artwork. The Understanding dimension is about understanding the message, theme, or concept the artist tries to convey through the artwork. It is about comprehending the artist's intention, the art piece's symbolic meanings, or interpreting its possible implications. The Flow dimension refers to the viewer's level of focus or immersion when viewing the art. It reflects the viewer's ability to become fully engaged and absorbed in the artwork, to the point where they lose track of time or can block out distractions. The concept of "flow" comes from psychology and refers to a state of total absorption in an activity where one forgets about the surroundings. The items include statements such as 'I felt deeply moved'. Participants rated their responses on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree). A higher score on the scale indicated an increased level of aesthetic experience. The Cronbach's alpha coefficients for the pre-training and post-training responses were 0.89 and 0.91, respectively. Previous literature showed that the internal consistency could be typically considered high when the Cronbach's alpha coefficients are 0.85 for SAS (Zhou et al., 2008), between 0.53 and 0.80 for IRI (Ma & Wang, 2021), between 0.68 and 0.75 for ISR (Freund & Baltes, 2002; Yu et al., 2019) and 0.88 for AES (Stamatopoulou, 2004) among the young adult Chinese population. It can be seen that the internal consistency reported in our study was generally comparable to the above literature.

Reading the Mind in the Eyes Task (RMET)

The Chinese version of the Reading the Mind in the Eyes task was used to measure one's theory of mind (Autism Research Centre at Cambridge University: https://www.autismresearchcentre.com/tests/eyes-test-adult). The materials consist of 36 human eye pictures in black and white, each 15 cm in length and 10 cm in width. Each picture covers vertically from under the bottom eyelids to right above the eyebrows and horizontally covers both eyes and eyebrows. After each picture, four options for the target's emotional expressions are provided; for instance, options (a) jealous, (b) panicked, (c) arrogant, and (d) hateful are given for "panicked" as the target. Participants were required to choose the word that best represented the emotional meaning of the gaze from the four options. The proportion of correctly identified emotional expressions was calculated as one's ability to read minds from the eye.

Procedure

The data collection was conducted using the online questionnaire platform (www.wjx.com) during the first and sixth weeks of the course project by the lecturer and a student assistant majoring in psychology. To ensure anonymity, a unique identifier was used to match pre- and post-training surveys to each student's responses. Prior to completing the surveys, students were informed that the questionnaires would be used to evaluate the course and were encouraged to respond truthfully. All scales were administered in both pre-training and post-training surveys, except for the Reading the Mind in the Eyes task, which was administered only in the post-training survey. Each survey took approximately 20 min to complete.

Data analysis

In order to evaluate the effects of drama improvisation on one's socio-cognitive capacities, paired-sample T-tests were conducted to compare the pre- and post-training responses to the SAS, IRI, ISR, and AES and their subscales (with 22 variables; Table 2) using the *t.test* function in the R environment (R4.1.3. GUI 1.70). Bayes factors (BF) were calculated by the *ttestBF* function in the *BayesFactor* package, and effect sizes were determined using the *cohens_d* function in the *rstatix* package for the T-test comparisons.

We conducted two analyses to explore the relationship between the theory of Mind (ToM) and the differential socio-cognitive capacities due to drama improvisation training. Firstly, we used the *lm* function to create a univariate predictive model with RMET scores as dependent factors and one differential score of the 22 variables between pre- and post-training as the predictor in one model. Secondly, we used the *ridge* function to create a machine-learning model. Compared to univariate linear regression, ridge regression utilizes the L2 norm as a penalty term

Table 2
Description statistics and paired-sample t-test results for the variables in the measurements.

No.	Variable	Pre-test (M ± SD)	Post-test (M ± SD)	T–value	Cohen's d	BF_{10}
1	**Social Anxiety**	1.94 ± 0.51	1.74 ± 0.43	3.279***	0.54	14.87
2	Fear	1.92 ± 0.5	1.73 ± 0.43	3.247***	0.53	13.79
3	Avoidance	1.97 ± 0.57	1.76 ± 0.48	2.934***	0.48	6.70
4	Social Interaction	1.91 ± 0.54	1.74 ± 0.47	2.517*	0.41	2.75
5	Public Speaking	2.04 ± 0.55	1.78 ± 0.45	3.771***	0.62	50.34
6	Observed by Others	1.93 ± 0.55	1.69 ± 0.51	3.222***	0.53	13.00
7	Eating in Public	1.89 ± 0.73	1.78 ± 0.65	0.938	0.15	0.27
8	**ISR**	3.96 ± 0.43	3.98 ± 0.48	-0.299	-0.05	0.18
9	selection	3.89 ± 0.76	3.81 ± 0.91	0.572	0.09	0.21
10	optimization	4.16 ± 0.53	4.17 ± 0.57	-0.088	-0.01	0.18
11	compensation	3.72 ± 0.54	3.83 ± 0.44	-1.08	-0.18	0.30
12	**IRI**	3.74 ± 0.37	3.65 ± 0.36	1.648	0.27	0.60
13	Perspective Taking + Empathic Concern	3.61 ± 0.47	3.53 ± 0.38	1.323	0.22	0.40
14	Perspective Taking	3.61 ± 0.56	3.75 ± 0.52	-1.896	-0.31	0.89
15	Personal Distress	3.62 ± 0.62	3.31 ± 0.56	3.175***	0.52	11.64
16	Empathic Concern	3.88 ± 0.49	3.86 ± 0.56	0.197	0.03	0.18
17	Fantasy	3.83 ± 0.55	3.67 ± 0.5	2.529*	0.42	2.82
18	**Aesthetic Experience Scale**	5.02 ± 0.75	5.21 ± 0.78	-2	-0.33	1.05
19	Emotion	5.67 ± 0.95	5.36 ± 0.84	2.379*	0.39	2.09
20	Culture	5.43 ± 0.93	5.68 ± 0.96	-1.6	-0.26	0.57
21	Perception	5.09 ± 1.14	5.16 ± 1.13	-0.38	-0.06	0.19
22	Knowledge	5.06 ± 0.91	5.2 ± 1.09	-0.839	-0.14	0.25
23	Flow	4.44 ± 0.96	4.81 ± 1.05	-3.032***	-0.50	8.36

Note: Bolded items represent the full questionnaire, while non-bolded items represent the subscales of the questionnaire bolded.

p <0.05: *; p <0.01: **; p<0.01: ***. ISR= Intentional Self-Regulation; IRI= Interpersonal Reactivity Index. The calculation of the T-value involves subtracting the post-test score from the pre-test score. BF_{10} indicates the ratio of evidence supporting the alternative hypothesis (H1) to evidence supporting the null hypothesis (H0), i.e., the degree to which H1 is more credible than H0. When BF_{10} was greater than 3, it was considered substantial evidence for the alternative hypothesis. However, the alternative hypothesis was rejected with substantial evidence when BF_{10} was less than 1/3 (Srimaneekarn et al., 2023).

to control the complexity of the model and has the advantage of dealing with multicollinearity (Paluszek & Thomas, 2016). Specifically, we considered the 22 variables as features altogether and used RMET score as the target variable for prediction. All features were normalized such that the normalized scores ranged between 0 to 1. Before the model training, we conducted a hyperparameter tuning for lambda. During the model training process, a hold-out method was employed to split the data such that 20% was used as the test set and 80% as the training set. This process was repeated 1000 times. The best-performing model was identified and further verified to obtain the model estimates for predicting RMET scores. The R-square and the mean squared error (MSE) were employed to determine the model with the best performance. The R-square value represents the model's goodness of fit and measures the strength and direction of the linear relationship between predicted and actual scores. The MSE quantifies the differences between the true scores and the predicted scores, where smaller values indicate a better fit of the model to the predicted values. A permutation analysis was conducted to verify the current best model further. The target variable (i.e., RMET score) was randomly permuted, and new machine learning models were performed with the optimal parameters and feature weights kept unchanged against the best model. The label was shuffled 5000 times, and the new R-square and MSE values were obtained from each model fitting. These values obtained from the models with shuffled labels were compared with those obtained from the model using the actual labels. *P*-values were calculated as total times when the new value of R-square was larger than that of the best-fit model divided by 5000 or total times when the new value of MSE value was smaller than that of the best-fit model divided by 5000. Finally, the best-trained model was interpreted to understand which factors within the training effect contributed to the prediction of the RMET score. The weight of each feature was evaluated through the *coef* function, and the top 10 features that contributed to the prediction of the RMET score were reported (see Fig. 3).

Results

Changes in socio-cognitive capacities between pre- and post-improvisation training

A significant decrease in Social Anxiety was shown in the post-training relative to the pre-training response (as shown in Fig. 1A). Additionally, all four subscales of Social Anxiety showed a significant reduction in the post-training relative to the pre-training response. Significant reductions in the Emotion subscale of the AES from the pre-training to the post-training responses were observed. The Flow subscale of the AES demonstrated a significant improvement following the Drama Improvisation Training, as shown in Fig. 1B. No significant change was shown in the Empathy score calculated from the aggregation of Empathy Concern and Perspective Taking between pre-training and post-training responses.

To investigate the associations between different effects of drama improvisation training, correlations were conducted between the differences in SAS, IRI, ISR and AES (see Table 3). The change in IRI was positively correlated with the changes in SAS and AES. The change in ISR was positively associated with the change in AES. The change in the AES flow subscale was further correlated with the SAS, IRI, and ISR. The results revealed that change in the Flow had a correlation coefficient of

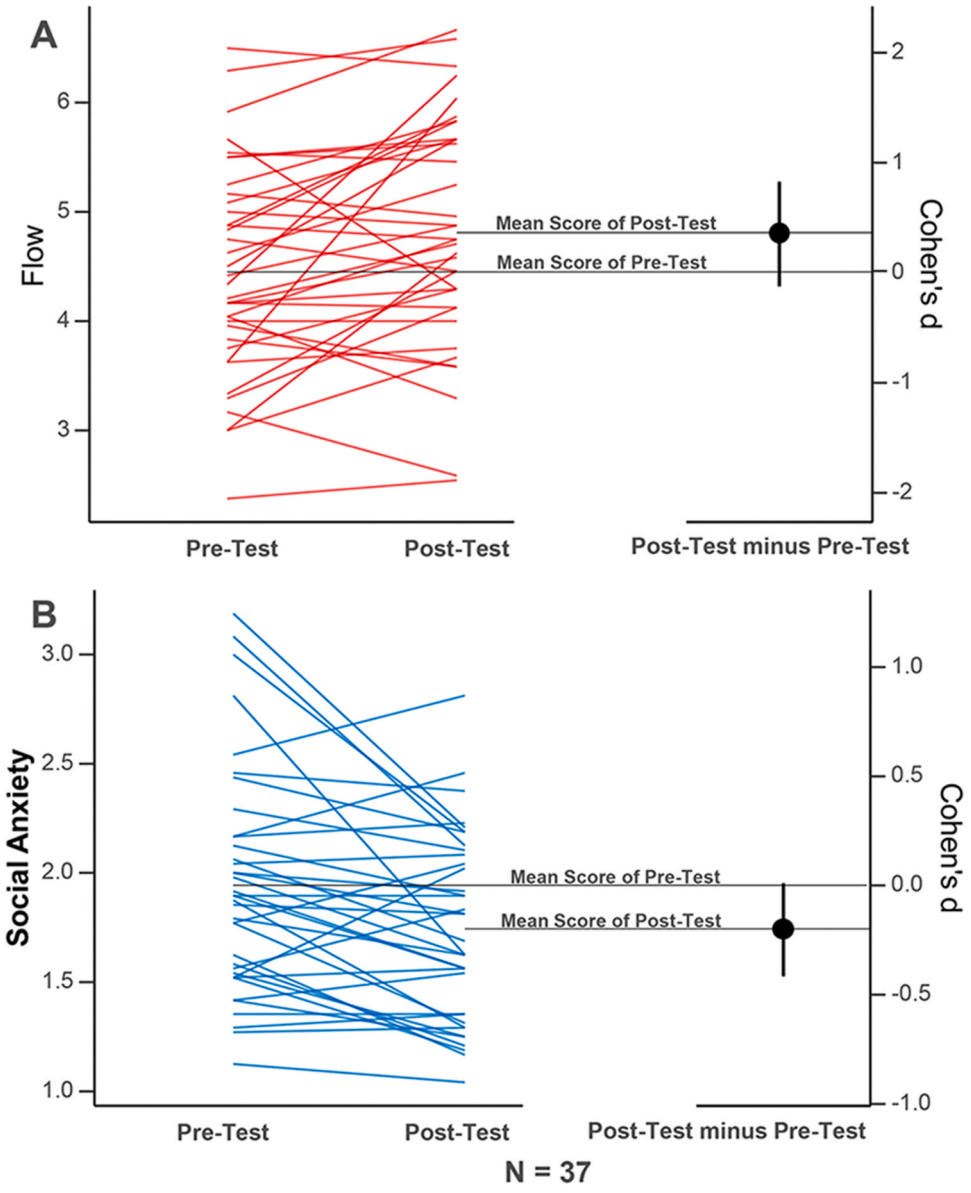

Fig. 1. Gardner-Altman estimation plot. (a) Displays the change in Social Anxiety score between pre- and post-tests. (b) Displays the change in Flow score between pre- and post-tests.

Table 3
Correlation coefficients between the difference scores of the study variables pre- and post- test.

	Social Anxiety	ISR	IRI	AES
Social Anxiety	–			
ISR	-0.11	–		
IRI	0.35*	0.00002	–	
AES	0.13	0.35*	0.38*	–

Note: $p < 0.05$
$p<0.05$:*; $p<0.01$:**; $p<0.01$:***.
ISR= Intentional Self-Regulation; IRI= Interpersonal Reactivity Index; AES= Aesthetic Experience Scale.

− 0.03 ($p > 0.05$) with SAS, 0.33 ($p < 0.05$) with ISR, and 0.05 ($p > 0.05$) with IRI.

Predicting RMET with drama training-induced changes

Predicting RMET through drama training using linear regression

As is shown in Fig. 2A, the linear regression model showed a significant effect of a differential response of Empathic Concern on the RMET score ($\beta = 2.15$, $t = 2.157$, $p < .05$, 95% CI: [0.127, 4.173], adjusted $R^2 = 0.09$, $BF_{10} = 1.86$). None of the other differential responses of other measured variables showed any significant prediction of the RMET score at a participant level (*ps* >.05). To further explore the robustness of the current results, we removed the outliers in the RMET (Fig. 2B), specifically the scores of 15 and 17 from two subjects. The regression model based on this adjustment remained significant ($\beta = 2.28$, $t = 2.989$, $p < .01$, 95% CI: [0.729, 3.838], adjusted $R^2 = 0.19$, $BF_{10} = 8.25$)..Fig. 3

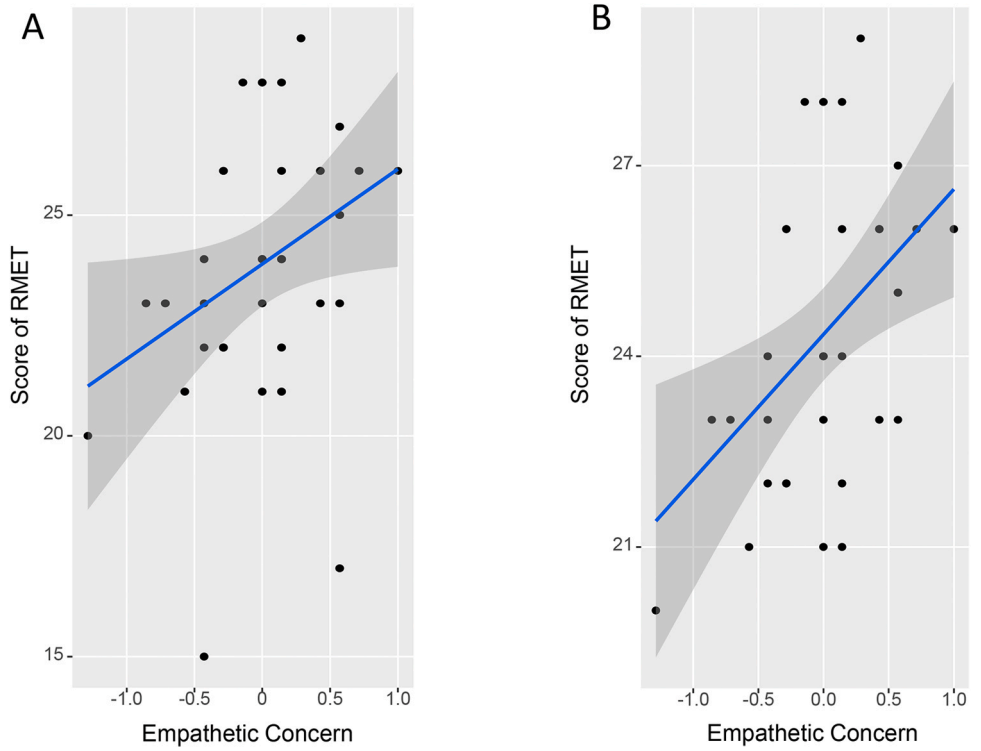

Fig. 2. Predicting the RMET score using the difference in Empathic Concern scores between pre- and post-tests. Fig. 2A shows the regression results for 37 participants. Fig. 2B represents the results after removing the outliers in the RMET score, specifically the values 15 and 17.

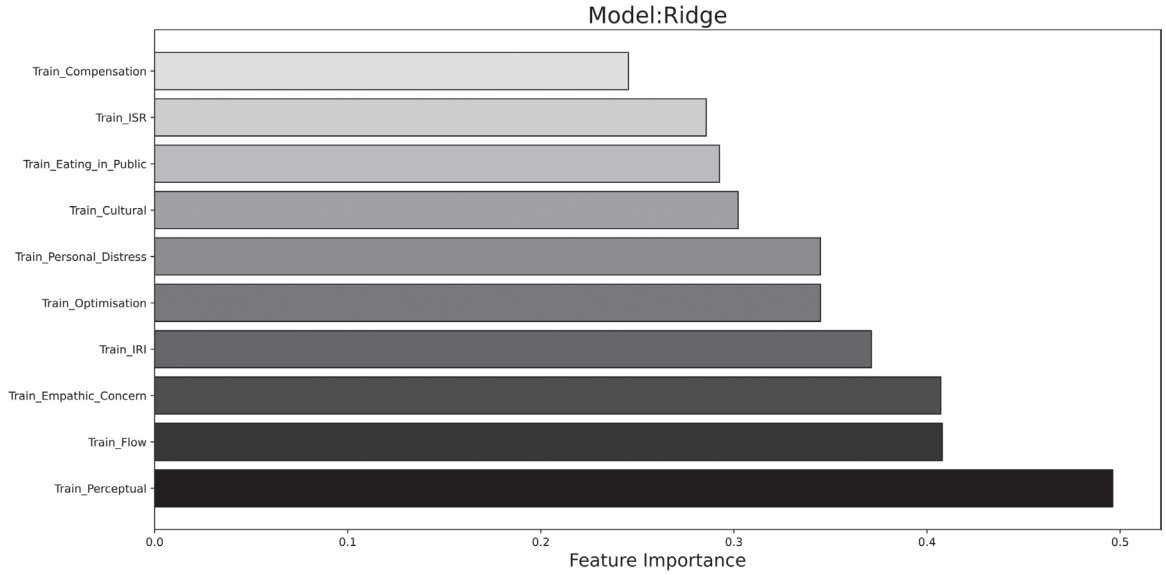

Fig. 3. This figure illustrates the top 10 features of utmost importance for the Ridge machine learning model. As the importance increases, the color transits on a gradient from grey to black.

Predicting RMET through drama training using machine learning

The model with the best performance revealed an R-square of 0.27 and an MSE of 7.70. The 5000-time permutation test indicated that the R-square values based on shuffled labels were significantly higher than that obtained from 0.27 ($p = 0.0012$), while the MSE was significantly lower than 7.70 ($p = 0.0002$) (see Fig. 4). These findings verified that the RMET scores predicted by the current model aligned well with the actual measured RMET scores (see Fig. 5).

The model showed the top 10 features contributing to the model were ranked as follows (see Fig. 3): Perceptual (0.496), Flow (0.408), Empathic concern (0.407), IRI (0.371), Optimisation (0.345), Personal Distress (0.345), Cultural (0.302), Eating in Public (0.292), ISR (0.286), and Compensation (0.245).

Discussion

The present study investigated the effects of drama improvisation training on emotion comprehension abilities, interpersonal skills, and aesthetic skills in first-year non-art major students. After a 6-week training period, we observed a notable decrease in social anxiety

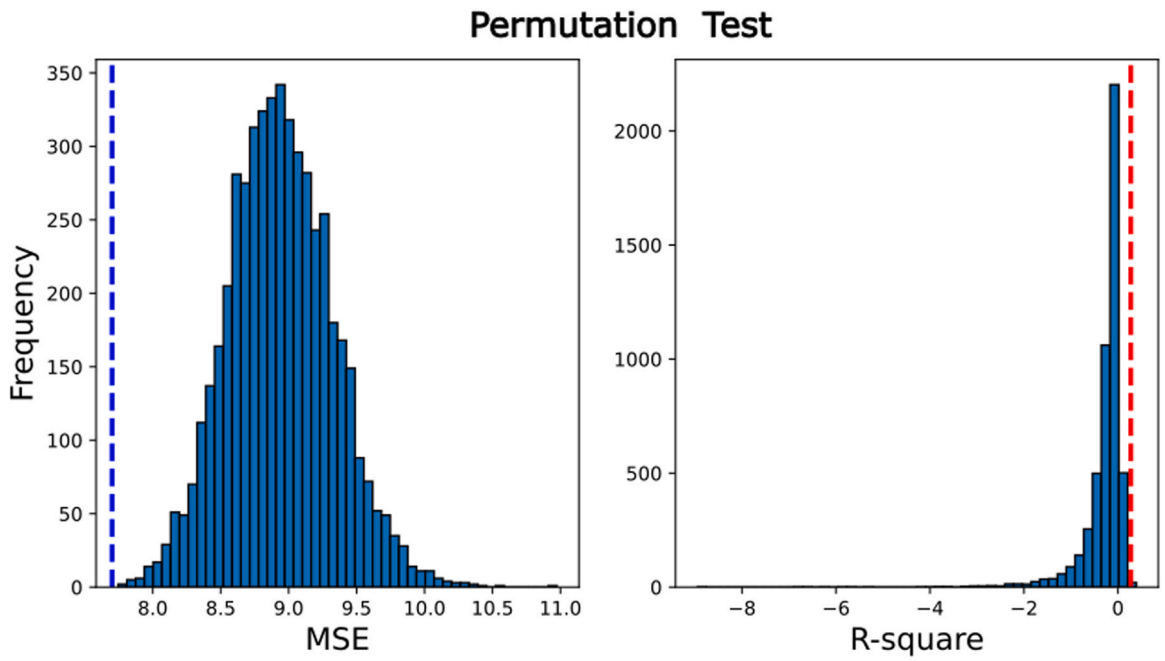

Fig. 4. This figure presents the results of permutation tests. On the left panel is the result of the MSE permutation test, with the blue dashed line representing the outcome of the optimal model's MSE. On the right panel is the result of the R-square permutation test, with the red dashed line indicating the result of the optimal model's R-square.

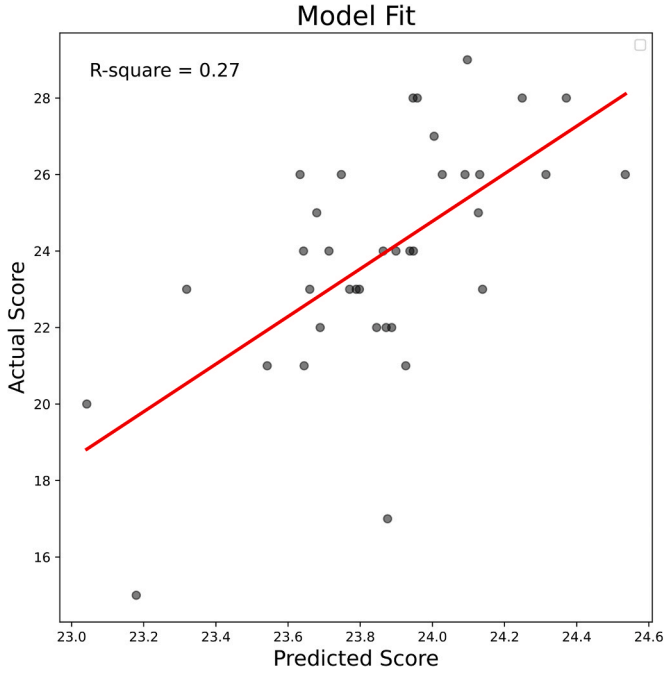

Fig. 5. This figure depicts the model fit. The black scatter points represent the correlation between the predicted scores and actual scores. The red line illustrates the linear regression fitted to the predicted and actual scores.

levels in these young adults. These findings demonstrated the utility of drama improvisation training for the socio-cognitive functions in a non-Western (i.e., Chinese) context. The observation of the positive outcomes aligns with prior studies highlighting the positive influence of drama improvisation on emotional and social well-being in Western cultures (Felsman et al., 2020; Felsman et al., 2019; Felsman et al., 2023). Drama improvisation provides a safe and supportive environment for individuals to practice interpersonal skills, such as communication and perspective-taking (Celume et al., 2019; Després et al., 2016; Lage-Gómez & Cremades-Andreu, 2019; Navarro Ramón & Chacón-López, 2021). These insights are pivotal for both educational and therapeutic contexts, suggesting drama improvisation as a potent tool to mitigate social anxiety and bolster emotional and social competencies across diverse groups, from healthy students to those grappling with social anxiety disorders (McGlade et al., 2023). Culturally specific mechanisms in the Chinese context make the validation of the data improvisation intervention essential. Individuals in Chinese culture have demonstrated a lower rate of expression and prevalence of social anxiety or related disorders, and those who did display a lower tendency to seek treatment for social anxiety as compared with those in Western culture (Hofmann et al., 2010; Hsu & Alden, 2008). The shame-prone and self-efficacy behavior has been a more critical factor that impacts social anxiety in Chinese individuals, possibly given its positive functional meaning admitted in the Chinese culture. Therefore, drama improvisation applied to the Chinese students could indirectly exert its impact on social anxiety on this sample by affecting their perception of shame in social interaction. Future research could explore the long-term effects of drama improvisation training on social and emotional well-being and investigate potential moderators of its effectiveness.

The correlation analyses further demonstrated the training-induced reduction of social anxiety can be related to a more regulated control of one's own feelings, including less experience of personal unease in a real-world interpersonal setting or a reduced tendency to transpose oneself imaginatively to the feeling of a fictive characteristic in a virtual setting. Traditional Chinese Confucian culture does not respect the individual's ability to express themselves verbally; as the saying goes, "The artful use of words is rarely benevolent" and "A gentleman is keen in action but slows in speech". Therefore, being subtle in expression and prudent in speech is itself a characteristic of Chinese culture (Ames & Rosemont, 2010), which is facilitated through drama improvisation training. Moreover, these changes can be related to the change in intentional self-regulation, in particular, the effort to maximize the engagement in behaviors that contribute towards positive future outcomes (Gestsdóttir & Lerner, 2007). In the context of Chinese culture, the increased intentional self-regulation can serve as a modulator to

lower the impact of school climate on online game addiction in adolescents (Yu et al., 2019) and can serve as a mediator to help place an adolescent with a sufficient level of resource in the family on a trajectory of happiness (Guo et al., 2023). Either way, the current study highlighted the potential of drama improvisation to serve as an innovative and engaging approach to regulate one's internal feelings or increase one's efficiency in examining their abilities and negotiating resources in the context of personal goals to attain better functioning and to enhance self-development (Yu et al., 2019), which can further promote future social and emotional adaptation by increasing goal-directed behavior (Ma et al., 2022).

Indeed, the drama improvisation training appears to reduce the self-reported emotional scores during the aesthetic experience. Such change could arise as the individual acquires the ability to suppress their emotional expressions as an emotion regulation strategy at the end of drama improvisation training (Goldstein et al., 2013). The regulation of internal mental processes is proven crucial to alleviate symptoms in children who struggle with social communication (Attwood, 2004) and adolescents with social anxiety disorders (Felsman et al., 2019; Felsman et al., 2023). These findings on Western cultures extend the positive impacts of drama improvisation training to non-Western individuals, demonstrating the validity of the drama improvisation intervention in the Chinese context, which embraces a unique communicative strategy and pedagogical philosophy.

Drama improvisation training enhances "flow" experience

The study revealed that drama improvisation training can potentially enhance the flow experience of first-year students. This result is particularly noteworthy, as it is novel to demonstrate the effectiveness of drama improvisation performance in enhancing individuals' engagement in artistic activities. The concept of "flow" is characterized by clear objectives, immediate feedback, a sense of autonomy and manifests as a fusion of action and awareness, intense focus, diminished self-awareness, and a skewed perception of time (Csikszentmihályi, 1990; Kawabata & Mallett, 2011). On one hand, the course offers a unique opportunity for students to participate in a creative and collaborative process that allows for unpredictable outcomes (Halpern et al., 1994; Sowden et al., 2015). Such unpredictability and freshness might foster the flow state by compelling participants to be deeply engrossed in the current activity (Halpern et al., 1994). On the other hand, flow experience is crucial for one engaged in exploring certain cultural experiences. Research has shown that cultural intelligence, the cognitive ability involved in appreciating cultural aspects, is crucial for developing an increased flow experience and positive emotions (Wei et al., 2021). The educational discipline and pedagogical practice in the Chinese context have formed an educational outcome in which Chinese college students go through a long period of exam-oriented education, which emphasizes the learning of book knowledge and the importance of standardized answers and lacks the freedom of independent thinking and impromptu expression in their growth process, which possibly leads to a restricted cultural intelligence (Wu, 2016). It is possible that drama improvisation training could change one's cultural intelligence, which leads to a more positive flow experience. This study highlights the potential of drama improvisation as a tool to promote students' flow experience, which is significant for their overall well-being and performance. Future works can delve further into the mechanisms that underlie the relationship between drama improvisation and flow experience, as well as potential moderating factors such as personality traits (e.g., openness) and cognitive motivation (e.g., curiosity) (Wanzer et al., 2020).

Drama improvisation training-induced changes in empathic concern and aesthetic experience predict theory of mind

To reveal the training effect and its potential impact on predicting one's theory of mind ability, the finding revealed a significant positive association between the changes in Empathic Concern and performance on the Read in Mind task. Note that the current study did not find significant results when examining the difference in Empathic Concern before and after the training (see Table 3). The direction of the difference in Empathic Concern pre- and post-training could vary between participants. Consequently, the current results could only indicate that the training effect of Empathic Concern had a predictive effect on the ability to read minds from the eye. However, this predictive effect was not particularly strong (B01 = 0.54, which was greater than 1/3). Although drama improvisation training does not produce a general benefit in improving one's interpersonal sensitivity, such training forms an effective tool for those who display different growth in empathy from this program to assess or predict their ability to understand others. Importantly, we also identified the changes in the Empathic Concern (as well as Perceptual and Flow in the AES) as essential features to predict the ability to correctly identify the emotional expression from the eye. Empathic concern represents feelings of sympathy and concern for others in distress. This aligns with prior studies underscoring the importance of empathic concern in emotional comprehension and social adeptness (Monzel et al., 2023). This insight holds clinical significance; individuals with hindered emotional comprehension and social abilities might benefit from drama improvement training, potentially enhancing their quality of life (Sheppard et al., 2023). A cross-cultural comparison demonstrates that Chinese individuals show reduced empathic concern than Western individuals, due to the higher value of interdependence than independence, which inhibits the distinction of one's own emotion from others (Wu & Keysar, 2007). The context-unique characteristics serve as important rationales that support culturally context-bound values of drama improvisation training as a specific intervention in the Chinese context. While not all participants exhibited consistent shifts in other-oriented feelings due to the training, individual variances in such changes can forecast one's capacity for understanding others (Chopik et al., 2017). It is intriguing to what extent drama improvisation training participates in individuals with different levels of empathic concern. Therefore, future research can serve to compare which component in the drama improvisation (e.g. Voice and Emotion) contributes to a larger extent to the change in emotional understanding, as well as identify optimal ways to integrate drama improvisation training into clinical practice, such as those with deficits in empathic responses (e.g. autistic individuals; Loza et al., 2023). Preliminary evidence suggests that the flow experience in aesthetic perception enables individuals to focus on a specific event (Wanzer et al., 2020). The underlying cognitive process could be closely related to the default-mode brain network, which plays a crucial role in creative thinking (Kenett et al., 2020; Zhuang et al., 2021), decoding others' emotional states (Xu et al., 2023) and appreciation of artworks (Vessela et al., 2019). Our current research has demonstrated that drama improvisation training is a practical approach to enhance individual flow experience, which could demand such neurocognitive engagement. Therefore, explaining drama improvisation training as an intervention for individuals impaired in one's theory of mind from the perspective of neural plasticity is a feasible direction for future research.

Limitations and future directions

Despite these novel results, several limitations should be acknowledged regarding the study. First, to compensate for the relatively small sample size, the machine learning study was applied with a 1000-time cross-validation to obtain the best-performing model and a permutation analysis to verify the model performance. A further study is underway to expand the participant set on the current one to a larger sample size to increase the generalizability of the current findings. Second, the current study could benefit from having an additional control group (e.g., receiving a different training but no drama improvisation), although the comparison of pre- and post-training responses has already offered a preliminary but robust change that could be

associated with anything that occurred during the course. Some studies showed flow is more likely among groups who know each other, which is more likely after six weeks of the course than at the start (Leach & Stevens, 2020). Thirdly, despite the program involving activities of writing, rehearsing and performing from scripts, not typically considered "improvisation", the course has heavily relied on drama-based pedagogy and improvisation exercises. For instance, during exercises, students are asked to make creative changes to the expression of the classic scripts and redefine their scenes and character relationships to stimulate their creativity and expression. Classic scripts are only used as materials for students to practice in the vocal and speech training sessions. Given that various cognitive mechanisms are involved in the entire training program, other mechanisms besides those involved in drama improvisation (e.g., voice imitation and role switching, among others) should be considered and evaluated in the future. Future research should address these limitations and explore the potential benefits of drama improvisation training in a larger and more diverse sample with a more rigorous experimental design.

Conclusion

The present study provides evidence for the benefits of drama improvisation training in enhancing social and emotional well-being, reducing social anxiety, and promoting flow experiences in first-year non-art major students. The findings contribute to the growing body of literature that supports the use of drama improvisation as an effective intervention in educational and clinical settings, with potential implications for individuals with social anxiety disorders and impaired emotional understanding. While the study has its limitations, it paves the way for future research to explore further the mechanisms underlying the effectiveness of drama improvisation training to identify potential moderating factors and integrate this innovative approach into clinical practice. Our data is consistent with the Developmental Transformations theory (DvT), which emphasizes the role of embodied cognition in therapeutic change (Frydman, 2017) and provides evidence for drama therapy employed as a means of psychological health intervention (Kedem-Tahar & Felix-Kellermann, 1996). The activities the drama improvisation training program has developed in the course created opportunities to encourage the participants to continuously shift between improvised dramatic roles, fostering an ongoing interpersonal flow. The persistent transformation of dramatic roles assists participants in confronting their social barriers and enhancing their perceptiveness towards others' emotions (Mayor & Frydman, 2021). By fostering greater social and emotional competence and engagement in artistic activities, drama improvisation holds promise as a powerful therapeutic tool for promoting well-being and performance in diverse populations.

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CRediT authorship contribution statement

Yanbing Hu: Writing – original draft, Formal analysis. **Ran Li**: Writing – review & editing, Validation, Resources, Methodology, Conceptualization. **Xiaoming Jiang**: Writing – review & editing, Validation, Supervision, Funding acquisition, Formal analysis, Conceptualization. **Wenjun Chen**: Writing – review & editing, Visualization, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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