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Observing Playfulness in Physical Games: Implications for AI-Enhanced Teaching and Child Development

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Abstract

This study, grounded in the Child Playfulness Scale (CPS), examined age- and gender-related differences in playfulness among young children during physical games. Using a revised CPS (assessing physical/social/cognitive spontaneity, manifest joy, sense of humor), we analyzed 30 children (10 each from junior/middle/senior kindergarten classes, 1:1 gender ratio) from two Hangzhou kindergartens.

Results showed children scored highly in physical spontaneity and manifest joy but lower in sense of humor. Boys exhibited greater physical spontaneity, while girls outperformed in social and cognitive spontaneity. Senior class children had significantly higher humor scores than younger peers, though total playfulness did not increase linearly with age.

Potential influencing factors included uneven game time, kindergarten environment variations, and scale limitations. This research provides empirical support for physical game design and playfulness assessment, and offers insights into enhancing teachers' activity design/adaptive instruction competencies via AI tools, aligning with AI-empowered education trends.

Key words: Young children; Physical games; Playfulness manifestation; Age differences; Gender differences; AI in education; Teacher competency

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1. INTRODUCTION

1.1 Research Origin

Physical games are a crucial component of kindergarten education, significantly impacting children's physical and mental development. However, current research on young children's playfulness manifestations during physical games and their age-related differences is relatively limited. Playfulness, as an important reflection of children's personality traits and characteristics, may change with age, but the specific differences remain unclear. Furthermore, existing studies often focus on single game types or small-sample observations, lacking support from systematic assessment tools.

To address this gap, this study aims to utilize a revised *Child Playfulness Scale* (CPS) to conduct a multidimensional quantitative analysis of the behavioral performances of children in junior, middle, and senior kindergarten classes during physical games, exploring the differential characteristics of playfulness across age groups. The findings are intended to deepen the theoretical understanding of playfulness development in young children and provide practical guidance for teachers designing age-appropriate physical games to promote holistic child development. The study also considers potential influences such as gender differences and environmental factors to inform future research. In the context of AI-enhanced educational practices, this study also implicitly touches upon the role of teacher competency in designing, adapting, and evaluating play-based activities—a dimension that can be further augmented through intelligent systems.

1.2 Conceptual Definitions

1.2.1 Young Children's Physical Games

Play is inherent to human nature. Young children's physical games are a vital means of physical education in kindergartens and a primary form of physical activity for children. Designed according to the objectives, tasks, and requirements stipulated by curriculum standards, these games are conducted under the guidance of physical education teachers using playful methods. They are rule-based games focused on developing fundamental movements and skills, aiming to promote physical and mental health. Young children's physical games possess three basic characteristics: Firstly, they are "interest-oriented" activities, representing a highly enjoyable form of physical activity. Secondly, they exhibit spontaneity driven by children's interests; physical games should be autonomous activities for children. Thirdly, they have a clear purpose, primarily developing children's basic motor skills by integrating skill practice into highly engaging physical activities—the game itself is an effective form of basic movement education. Additionally, young children's physical games emphasize process over outcome; although games have defined results, children focus less on the outcome itself and more on the participatory process and the enjoyment derived from the physical games.

1.2.2 Children's Playfulness

Currently, foreign scholars' interpretations of playfulness encompass two meanings： firstly, viewing playfulness as an objective characteristic of an activity or a criterion for judging the nature of an activity, with Johan Huizinga as a key figure. Secondly, considering playfulness as a proactive developmental state centered on subjectivity, a personality trait and characteristic of the child, primarily represented by Lieberman. Furthermore, Lieberman proposed five aspects of the structure of playfulness:

(1) Physical Spontaneity: Manifested as children being energetic during play, focusing on physical coordination and movement level.

(2) Social Spontaneity: Refers to qualities of interacting friendly with others, including initiative, cooperation, sharing, and responsiveness.

(3) Cognitive Spontaneity: Emphasizes characteristics like imagination, creativity, and cognitive flexibility.

(4) Manifest Joy: The expression of enthusiasm, happiness, enjoyment, and uninhibited vocalizations during play.

(5) Sense of Humor: Capturing common joking, teasing, and clowning during activities, as well as laughter in response to humorous stories or when telling funny stories themselves.

Barnett further refined Lieberman's perspective, developing the *Child Playfulness Scale*(CPS), which has been validated as a feasible and highly reliable tool for measuring children's playfulness. (Barnett, 1991)

This study aims to observe and explore playfulness manifestations in children during physical games, defining playfulness as the concrete expression of children's personality traits and characteristics within physical games. It adopts the five dimensions of Lieberman's (1965) playfulness concept (physical spontaneity, social spontaneity, cognitive spontaneity, manifest joy, sense of humor) as indicators for evaluating playfulness in physical activities. (**Lieberman,** 1965) The study utilizes Barnett's CPS as the primary assessment tool, with revisions, to ultimately evaluate playfulness manifestations in children's physical games.

2. METHOD

2.1 Evaluation Content

(1) To quantitatively analyze the overall level of playfulness manifestations in kindergarten physical games across different age groups and evaluate the differences.

(2) To explore whether children of different ages exhibit prominent manifestations in "physical spontaneity," "cognitive spontaneity," "social spontaneity," "manifest joy," and "sense of humor" within the context of physical games, and to identify their characteristics.

(3) To analyze whether significant differences exist in children's playfulness manifestations across different types of physical games and to compare them.

2.2 Participants

This study selected two kindergartens in Hangzhou for observing children's physical games. From these kindergartens, 30 children with high attendance rates were randomly selected (10 each from junior, middle, and senior classes, with a gender ratio of 1:1). Each child's playfulness manifestations during different physical games were observed and rated. Each physical activity session lasted no less than 10 minutes, and each type of physical game was observed for no less than 40 minutes.

2.3 Assessment Tool

This study employed a revised version of the *Child Playfulness Scale* (CPS) developed by Barnett (1991). International research indicates good reliability and validity for this scale, which comprises five dimensions and 23 items. Factors within the scale are positively correlated (correlation coefficients ranging from 0.63 to 0.71), and it exhibits high internal consistency (Cronbach's alpha = 0.88).

As this study focuses on physical games, revisions were made based on Jing Xiaomeng's related research on "playfulness in physical activities." The item "Child does much running, jumping, sliding" was changed to "Child engages in many basic movements like running, jumping, sliding." "Child is willing to share toys with others" was changed to "Child is willing to cooperate in games and share equipment with others." "Child uses unconventional objects in play" was changed to "Child uses equipment in unconventional ways." Items from the humor dimension, "Child tells funny stories" and "Child enjoys making silly jokes with people around," were deleted. Ultimately, the five dimensions of the original scale were retained, resulting in 21 items.

3. RESULTS

3.1 Reliability and Validity Testing

3.1.1 Reliability Analysis

The scale used in this study contained 21 items. The calculated Cronbach's alpha coefficient was 0.900, indicating extremely high reliability and good internal consistency, making it suitable for subsequent data analysis.

Table 1
Reliability Statistics

Cronbach's Alpha	N of Items
.900	21

3.1.2 Validity Analysis

The KMO value was 0.580, slightly below 0.6 but near the threshold, indicating some suitability for factor analysis. Bartlett's test of sphericity was significant ($\chi^2 = 469.754$, df = 210, $p < .001$), suggesting correlations among the data suitable for factor analysis. The rotated component matrix shows that the composition of the five factors is basically reasonable and well reflects the potential structure of the five dimensions.

Table 2
KMO and Bartlett's Test

KMO Measure of Sampling Adequacy		.580
	Approx. Chi-Square	469.754
Bartlett's Test of Sphericity	df	210
	Sig.	.000

3.2 Overall Characteristics of Playfulness Manifestations

Table 3
Descriptive Statistics for the Five Dimensions and Total Score of Playfulness in Physical Games

	Physical Spontaneity	Cognitive Spontaneity	Manifest Joy	Sense of Humor	Social Spontaneity
Mean	3.78	2.86	3.47	2.31	3.41
Mode	4	2a	3	3	3
Std. Deviation	.649	.770	.758	.892	.659
Minimum	2	2	2	1	2
Maximum	5	4	5	5	5
Sum	114	86	104	69	102

a. Multiple modes exist. The smallest value is shown.

3.2.1 Data Analysis of Score Modes

This study analyzed the performances of 30 children during game activities across five dimensions (physical spontaneity, social spontaneity, cognitive spontaneity, manifest joy, sense of humor), collecting 150 data points. Frequency distribution showed that most children exhibited relatively prominent performance in physical spontaneity and manifest joy, with modes of 4 and 3 respectively. The mode for sense of humor was 2, indicating relatively lower performance. This preliminarily suggests that the participating children showed high levels of movement participation and positive emotional experience across playfulness dimensions but still need improvement in humorous expression.

3.2.2 Data Analysis of Mean Scores

Descriptive statistics revealed the mean scores for the five dimensions, from highest to lowest: Physical Spontaneity ($M = 3.78$), Manifest Joy ($M = 3.47$), Social Spontaneity ($M = 3.41$), Cognitive Spontaneity ($M = 2.86$), Sense of Humor ($M = 2.31$). The total playfulness mean score was 3.23, at a medium to high level. This indicates that children showed good willingness to participate and emotional expression in games but still have room for improvement in cognitive innovation and humorous interaction.

3.3 Gender Difference Analysis

Independent samples t-tests revealed significant gender differences in three dimensions: physical spontaneity, social spontaneity, and cognitive spontaneity.

(1) Physical Spontaneity: Boys' mean score (M = 4.02) was significantly higher than girls' (M = 3.55), p < .05.

(2) Social Spontaneity: Girls' mean score (M = 3.65) was significantly higher than boys' (M = 3.16), p < .05.

(3) Cognitive Spontaneity: Girls' mean score (M = 3.18) was significantly higher than boys' (M = 2.53), p < .05.

(4) Manifest Joy and Sense of Humor: No significant differences were found between boys and girls in these two dimensions, indicating relatively similar performance in emotional experience and humorous expression, with no pronounced gender differences.

Table 4
Group Statistics

Dimension	Gender	N	Mean	Std. Deviation	Std. Error Mean
Physical Spontanity	M	15	4.02	.495	.128
	F	15	3.55	.715	.185
Social Spontaneity	M	15	3.16	.364	.094
	F	15	3.65	.798	.206
Cognitive Spontanity	M	15	2.53	.619	.160
	F	15	3.18	.788	.203
Manifest Joy	M	15	3.49	.580	.150
	F	15	3.45	.924	.239
Sense of Humor	M	15	2.13	.615	.159
	F	15	2.49	1.097	.283
Total Playfulness	M	15	3.1365	.39345	.10159
	F	15	3.3302	.69578	.17965

Note: M=Male, F=Female.

Table 5
Independent Samples T-Test

		Levi's variance equality test		*t*-test for equality of means				
		F	Significance	*t*	*df*	Significance (two-tailed)	Difference 95% confidence interval	
							Lower limit	Upper limit
Physical Spontanity	Assumption of equal variance	.561	.460	2.079	28	.047	.007	.927
	No assumption of equal variance			2.079	24.926	.048	.004	.929
Social Spontaneity	Assumption of equal variance	7.067	.013	-2.178	28	.038	-.957	-.029
	No assumption of equal variance			-2.178	19.586	.042	-.966	-.020
Cognitive Spontanity	Assumption of equal variance	1.050	.314	-2.514	28	.018	-1.180	-.120
	No assumption of equal variance			-2.514	26.513	.018	-1.181	-.119
Manifest Joy	Assumption of equal variance	3.844	.060	.142	28	.888	-.537	.617
	No assumption of equal variance			.142	23.547	.888	-.542	.622
Sense of Humor	Assumption of equal variance	4.144	.051	-1.095	28	.283	-1.021	.310
	No assumption of equal variance			-1.095	21.997	.285	-1.029	.318
Total Playfulness	Assumption of equal variance	5.215	.030	-.938	28	.356	-.61641	.22911
	No assumption of equal variance			-.938	22.123	.358	-.62153	.23423

3.4 Age Difference Analysis

A one-way ANOVA compared the three age groups (Junior, Middle, Senior class).

(1) Sense of Humor: Significant difference existed ($F(2,27) = 22.756$, $p < .001$). LSD post-hoc tests showed senior class scores were significantly higher than both junior and middle classes.

(2) Manifest Joy: Significant difference existed ($F(2,27) = 4.641$, $p < .05$). LSD post-hoc tests showed

middle class scores were significantly higher than junior class scores, but differences between senior and junior classes were not significant.

(3) Total Playfulness Score: Significant difference existed ($F(2,27) = 6.303$, $p < .01$). LSD post-hoc tests showed senior class scores were significantly higher than middle class scores, but the difference between senior and junior classes was not significant.

(4) Physical Spontaneity, Social Spontaneity, Cognitive Spontaneity: No significant differences were found among age groups for these three dimensions, indicating relatively balanced development across ages.

Table 6
ANOVA Results Summary Table

		Sum of Squares	*df*	Mean Square	F	Sig.
Physical Spontanity	between groups	.529	2	.265	.611	.550
	within the group	11.688	27	.433		
	Total	12.217	29			
Social Spontaneity	between groups	1.395	2	.697	1.680	.205
	within the group	11.204	27	.415		
	Total	12.599	29			
Cognitive Spontanity	between groups	2.504	2	1.252	2.299	.120
	within the group	14.706	27	.545		
	Total	17.210	29			
Manifest Joy	between groups	4.267	2	2.133	4.641	.019
	within the group	12.412	27	.460		
	Total	16.679	29			
Sense of Humor	between groups	14.496	2	7.248	22.756	.000
	within the group	8.600	27	.319		
	Total	23.096	29			
Total Playfulness	between groups	2.937	2	1.468	6.303	.006
	within the group	6.290	27	.233		
	Total	9.226	29			

Table 7
Multiple Comparisons (LSD)

Dependent variable		(I) Age Group	(J) Age Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Physical Spontanity	LSD	junior class	middle class	.150	.294	.614	-.45	.75
			Senior class	-.175	.294	.557	-.78	.43
		middle class	small class	-.150	.294	.614	-.75	.45
			Senior class	-.325	.294	.279	-.93	.28
		Senior class	small class	.175	.294	.557	-.43	.78
			middle class	.325	.294	.279	-.28	.93
Social Spontaneity	LSD	junior class	middle class	.340	.288	.248	-.25	.93
			Senior class	-.180	.288	.537	-.77	.41
		middle class	small class	-.340	.288	.248	-.93	.25
			Senior class	-.520	.288	.082	-1.11	.07
		Senior class	small class	.180	.288	.537	-.41	.77
			middle class	.520	.288	.082	-.07	1.11

Dependent variable		(I) Age Group	(J) Age Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Cognitive Spontanity	LSD	junior class	middle class	.600	.330	.080	-.08	1.28
			Senior class	-.025	.330	.940	-.70	.65
		middle class	small class	-.600	.330	.080	-1.28	.08
			Senior class	-.625	.330	.069	-1.30	.05
		Senior class	small class	.025	.330	.940	-.65	.70
			middle class	.625	.330	.069	-.05	1.30
Manifest Joy	LSD	junior class	middle class	.800*	.303	.014	.18	1.42
			Senior class	.000	.303	1.000	-.62	.62
		middle class	small class	-.800*	.303	.014	-1.42	-.18
			Senior class	-.800*	.303	.014	-1.42	-.18
		Senior class	small class	.000	.303	1.000	-.62	.62
			middle class	.800*	.303	.014	.18	1.42
Sense of Humor	LSD	junior class	middle class	.933*	.252	.001	.42	1.45
			Senior class	-.767*	.252	.005	-1.28	-.25
		middle class	small class	-.933*	.252	.001	-1.45	-.42
			Senior class	-1.700*	.252	.000	-2.22	-1.18
		Senior class	small class	.767*	.252	.005	.25	1.28
			middle class	1.700*	.252	.000	1.18	2.22
Total Playfulness	LSD	junior class	middle class	.54762*	.21585	.017	.1047	.9905
			Senior class	-.19048	.21585	.385	-.6334	.2524
		middle class	small class	-.54762*	.21585	.017	-.9905	-.1047
			Senior class	-.73810*	.21585	.002	-1.1810	-.2952
		Senior class	small class	.19048	.21585	.385	-.2524	.6334
			middle class	.73810*	.21585	.002	.2952	1.1810

3.5 Causal Relationship Analysis

Multiple linear regression analysis was conducted with the total playfulness score as the dependent variable and the factor scores of the five dimensions as independent variables. The overall regression model was significant ($F(5, 24) = 1254.917$, $p < .001$, $R^2 = .996$ [calculated from Sum of Squares Regression/Total]), rejecting the null hypothesis. All five dimensions significantly positively predicted the total playfulness score ($p < .001$). Emotional expression (Manifest Joy) and physical activity level (Physical Spontaneity) had the greatest impact on total playfulness. For each unit increase in these factor scores, the total playfulness score increased by 0.300 and 0.354 units, respectively. This indicates that positive emotional experiences and active physical participation in games are key drivers for enhancing overall playfulness. Although the Sense of Humor dimension had the smallest impact, it was still significant ($B = 0.043$, $p < .001$), suggesting its role as an auxiliary component of playfulness that should not be overlooked and contributes to its development.

Table 8
ANOVA for Regression Model^a^

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.191	5	1.838	1254.917	.000b
	Residual	.035	24	.001		
	Total	9.226	29			

Table 9
Coefficients for Regression Model^a^

Model		Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.233	.007		462.726	.000
	REGR factor score 1 for analysis 2	.354	.007	.627	49.751	.000
	REGR factor score 2 for analysis 2	.300	.007	.533	42.278	.000
	REGR factor score 3 for analysis 2	.287	.007	.508	40.348	.000
	REGR factor score 4 for analysis 2	.132	.007	.235	18.641	.000
	REGR factor score 5 for analysis 2	.043	.007	.076	6.048	.000

a. Dependent Variable: Total Playfulness Score.

4. DISCUSSION AND IMPLICATIONS FOR TEACHING PRACTICE

This study employed the revised CPS to assess and compare the playfulness manifestations of children in junior, middle, and senior kindergarten classes during physical games across five dimensions, aiming to explore developmental characteristics and differences across ages.

4.1 Gender Differences in Playfulness Manifestations

(1) Differences in Physical, Social, and Cognitive Spontaneity

Significant gender differences were found in three dimensions. Boys scored higher in physical spontaneity, indicating greater physical activity and participation enthusiasm during games. Girls scored higher in both social and cognitive spontaneity, suggesting they are more proactive and engaged in game interactions and social exchanges, and exhibit more planning, strategic thinking, and creativity during play.

Children's play behaviors are often influenced by gender expectations from family, school, and culture. Boys are typically encouraged to engage in gross motor activities like running and competition, aligning with their higher physical spontaneity scores. Girls receive more guidance in social interaction and verbal expression, reflected in their better performance in social and cognitive spontaneity. Vygotsky emphasized the key role of social interaction in developing higher mental functions. Girls' greater skill in communicating and cooperating during games likely enhances their social behaviors and cognitive development, corroborated by their higher scores in these two dimensions. (**Vygotsky,** 1978)

(2) No Significant Differences in Manifest Joy and Sense of Humor

Although no significant gender differences were found in manifest joy and sense of humor, scores for both were at medium to high levels (M ≈ 3.47 and M ≈ 2.31 respectively). According to the data, children of both genders in this age stage can derive joyful experiences and possess a certain degree of humorous interaction ability from games, possibly attributable to the gradual maturation of emotion regulation and expression abilities during this period.

4.2 Age Difference Analysis

(1) Differences in Sense of Humor, Manifest Joy, and Total Playfulness

Significant age differences were found. Sense of humor showed a highly significant increase with age, with senior children outperforming both younger groups, indicating a developmental trend. Manifest joy showed a significant difference, with middle class children scoring higher than junior class children, suggesting the middle class period might be a key stage for emotional expression development. The total playfulness score was significantly higher for seniors compared to middles, indicating more mature overall playfulness, though the difference between seniors and juniors was not significant.

According to Erikson's psychosocial development theory, the "Initiative vs. Guilt" stage (3-6 years) is when children begin developing initiative and goal-directed behaviors. (**Erikson,** 1963) Senior children's significantly higher scores in humor and total playfulness suggest greater ability to actively participate, express emotions, and create scenarios, displaying more mature playfulness. Furthermore, senior children's highest humor scores support McGhee's (1979) theory that children's humor ability undergoes a qualitative leap around ages 5-6, indicating humor expression develops with age. (McGhee & Pistolesi, 1979) Regarding manifest joy, middle children's highest scores might be because ages 4-5 are a particularly sensitive period for reactions to emotions like happiness and excitement. Children at this stage have active emotional expressions and particularly strong reactions to game situations.

(2) No Significant Dimension Differences in Physical, Social, and Cognitive Spontaneity

No significant differences were found among age groups for physical, social, and cognitive spontaneity. Our quantitative data did not show the expected age-related advantages in these areas for the senior class; indeed, the average score for physical spontaneity was slightly higher for the middle class than the senior class (see Table 6).

However, existing domestic research generally agrees that as children age, they demonstrate higher strategy use, social coordination, and plot construction abilities in games. For instance, a Ningbo University study found significant enhancement in prosocial behaviors (e.g., sharing, cooperation, helping) among middle and senior class children after a one-year "social dramatic play" intervention. This suggests that while existing research supports the notion of upgraded play performance with age, our study data did not reflect this trend as anticipated.

4.3 Manifest Joy and Physical Spontaneity Dimensions Have the Greatest Impact on Total Playfulness

Regression analysis showed physical spontaneity had the highest weight (Beta ≈ 0.627), indicating physical activity level is a key factor influencing playfulness. From a physical development perspective, physical games enhance muscle strength, balance, coordination, and motor control through activities like running, jumping, and throwing, which are fundamental physical requirements for play development. Only with sufficient physical capacity can children smoothly engage in role-playing scenarios and sustain the "action-plot-symbol" chain; otherwise, maintaining high-level play structures becomes difficult.

Simultaneously, the standardized coefficient for manifest joy (Beta ≈ 0.533) was second only to physical spontaneity, contributing significantly to the total playfulness score. As noted by the China Association of Early Childhood Education, joyful experiences in games promote emotion recognition, regulation, stress relief, and empathy development. Dynamical systems theory suggests that playfulness pleasure stimulates children's exploratory interest, enhances participation depth and persistence, and benefits situational learning potential release. Positive emotions also promote "flow" experiences in play, enhancing physical coordination and cognitive integration abilities.

Moreover, the findings of this study highlight the importance of teacher competency in designing and facilitating physical games that are responsive to children's developmental and gender-specific needs. In the era of artificial intelligence in education, AI tools can support teachers in assessing playfulness more accurately, designing personalized games, and tracking developmental trajectories over time. For instance, AI-powered observation systems could automate behavioral coding, reduce rater subjectivity, and provide real-time feedback to teachers. This not only enhances the efficiency of assessment but also empowers teachers to refine their instructional strategies based on data-driven insights. Thus, the ability to integrate AI tools into activity design and evaluation represents an emerging dimension of teacher professional attainment in early childhood education.

5. CAUSES OF PLAYFULNESS MANIFESTATIONS

The data showed significant age-related trends only in some dimensions, deviating from expectations overall. Based on observation records and the research process, several potential reasons for this deviation are summarized:

5.1 Limited Discriminatory Power of Scale Indicators for Ability Levels

For example, in the physical spontaneity dimension, score differences between age groups were not significant, even showing slightly higher scores for the middle class in some indicators. In-depth analysis revealed that scale scoring for this dimension primarily quantified based on the frequency and variety of actions (e.g., running, jumping, spinning), paying less attention to age-related improvements in movement refinement, control, and sustained attention.

This allows younger children with basic motor skills and active participation to achieve high scores, while the advantages of older children in movement coordination, strategic action, and movement complexity are not fully captured. For instance, a junior child performing 10 jumps in 10 minutes might receive a similar score to a senior child performing complex movements involving spinning, rhythm, and scenario creation, thereby weakening the observed age-related differences in quantitative data.

5.2 Uneven Distribution of Game Time Across Age Groups

During data collection, senior children, due to impending graduation, were frequently scheduled for graduation performance rehearsals, significantly compressing their game time, while junior and middle classes had more ample and regular game time. This "time investment difference" directly affected playfulness manifestations during observation, potentially making senior children appear less active than younger children and weakening the potential age-driven enhancement effect on playfulness levels.

5.3 Impact of Kindergarten Environment Differences on Playfulness Expression

The three age groups came from different campuses within the kindergartens. The senior and middle class campus had smaller grounds and relatively scarce equipment resources, limiting activity space. The junior class campus had larger activity areas and richer equipment (e.g., swings, climbing frames, slides, ropes). This provided junior children with more ample space and material support for game expression during observation, enabling them to display more game behaviors and creative expression. Juniors' average scores on dimensions like physical spontaneity and creative expression were not much different from middles and seniors, and behavioral records showed more cross-domain integrative behaviors (e.g., using slides as backdrops for role-playing), indicating the positive role of equipment resources on game expression, thereby increasing their playfulness scores across multiple dimensions. Campus resource differences likely constituted an important external variable influencing the observations.

5.4 Limited Sample Size and Difficulty Controlling Variables

This study used natural observation. Limited by manpower and time resources, only 10 children per age group were observed, resulting in a small sample size that made effective variable control and stratified sampling difficult. Furthermore, the actual sample selection criteria were not fully uniform. For example, the junior class sample covered individuals of different ability levels, while the senior class sample primarily consisted of average individuals, potentially introducing selection bias unintentionally and weakening the representativeness and comparability of the results. This sample structure difference may have led to uneven distribution of behavioral variance, absence of extreme behaviors, and mean score masking. For instance, in social spontaneity ratings, a few high-performing junior children increased the overall score variance, making their performance on some indicators similar to that of middle and senior classes.

5.5 Observer Subjectivity and Applicability Issues of Scoring Criteria

Although the scale provided behavioral descriptors and frequency guidelines, observational scoring still involved some subjectivity, particularly for ambiguous or unstructured indicators. The personal judgment, observation perspective, and interpretation of raters influenced the results. Additionally, differences among raters in observational sensitivity and behavioral judgment criteria might affect scoring consistency and reliability.

5.6 Developmental Pace Factors in Gender Differences

Although the study controlled gender ratio (1:1) during sample selection, observations revealed that in some classes, girls' developmental pace in language expression, rule understanding, and emotion regulation was noticeably faster than boys', especially in the middle class. This difference in developmental progress may have affected individual scores on cognitive and social spontaneity dimensions, manifesting as gender differences in the overall analysis, even though this difference did not stem from sample size structure imbalance.

In conclusion, as a multi-dimensional and highly contextual psychological and behavioral characteristic, the expression and observation of playfulness are highly dependent on the context setting, assessment tools, sample structure and implementation environment. Some of the "underperformance" phenomena that emerged in this study do not imply that children's playability does not develop with age. Instead, they suggest that there are multiple potential interfering factors in the design and implementation of the research, which are worthy of further control and optimization in subsequent studies.

6. CONCLUSION

This study explored differences in playfulness manifestations among children aged 3-6 during physical games from gender and age perspectives. Using the revised CPS, it systematically evaluated children's play behaviors across five core dimensions, yielding several enlightening findings:

6.1 Gender Differences

Boys and girls exhibited strengths in different dimensions. Boys showed greater prominence in physical activity participation, with higher liveliness and persistence in bodily movements. Girls demonstrated stronger abilities in game interaction and cognitive strategies, displaying more proactive social behaviors and richer creative thinking. Notably, performance in emotional experience and humorous expression was similar between genders, both achieving good game enjoyment.

From a developmental psychology perspective, these differences may stem from multiple factors. Cognitive development stage theory can partially explain girls' advantage in thinking strategies, while gender socialization theory helps understand the differentiation in behavioral tendencies. Sociocultural theory further suggests that girls' earlier developed social interaction skills promote their cognitive development.

6.2 Age Differences:

Playfulness development showed non-uniform characteristics. Humor comprehension and expression ability increased significantly with age, with seniors significantly outperforming younger children. Emotional expression development showed stage characteristics, with the middle class period potentially being a key stage for the most active emotional responses. However, no significant differences were found among age groups for physical activity, social interaction, and cognitive strategy dimensions, possibly suggesting relatively stable development of these abilities during the preschool period.

The study also found some results inconsistent with expectations, particularly the lack of expected advantages for older children in some dimensions. In-depth analysis suggests this might be related to: insufficient sensitivity of the assessment tool to higher-order abilities, differences in environmental resources between campuses, uneven distribution of game time during observation periods, and sample selection limitations. These factors indicate that playfulness manifestations are influenced by multi-level factors, requiring comprehensive consideration of assessment methods, environmental support, and individual differences in both research and practice.

The findings provide empirical evidence for understanding the developmental patterns of play behavior in young children and offer implications for educational practice: physical game design and guidance should respect gender characteristics and provide diverse activity choices; appropriate humorous elements and emotional expression opportunities should be introduced timely based on developmental characteristics of different ages; the impact of environment creation and resource guarantee on children's play behavior needs emphasis. Future research should further optimize assessment tools, expand sample sizes, and control environmental variables to more comprehensively reveal the inherent patterns of playfulness development in young children.

The results also underscore the potential of AI technologies to support teachers in creating more developmentally appropriate and inclusive physical games. By leveraging AI for behavioral analysis, activity adaptation, and individualized feedback, teachers can enhance their professional practice and better support each child's playful learning journey. Future research should explore the integration of AI tools into play-based assessments and teacher training programs to further promote high-quality early childhood education.

7. RESEARCH REFLECTION AND ADJUSTMENT STRATEGIES

7.1 Optimization of Preliminary Preparation

Scale Indicator Refinement and Age-Adaptability Improvement: The current scale might overemphasize action frequency and variety, neglecting action quality, strategic performance, and age-related refined control. Future research should refine scale indicators, adding assessments for movement quality, strategic action performance, and complexity. Scale revision must fully consider developmental characteristics across ages. Video analysis with independent coding by two researchers can ensure objectivity and consistency, maintaining universality while better capturing key features of playfulness.

Sample Size Expansion and Stratified Sampling Strategy:The small sample size may affect representativeness and comparability. Future studies should determine minimum sample size based on effect size pilot studies, aiming for at least 30 children per group. Three-stage stratified sampling is recommended: select 6 kindergartens based on urban development level, recruit 10 children each aged 2-5 from each kindergarten, balancing gender. Longitudinal tracking cohorts with reassessment every 3 months could analyze individual developmental trends.

Environmental Standardization and Dynamic Resource Allocation: Differences in site conditions and equipment between kindergartens can influence results. To minimize environmental interference, prioritize kindergartens with similar hardware conditions or statistically control for environmental variables. Establish basic game environment standards (e.g., same type/quantity of blocks, role-play props), check safety, lighting, and layout beforehand. Maintain environmental consistency during observation to avoid affecting natural behavior, enhancing reliability.

7.2 Scoring Standardization System and Observer Consistency Enhancement

Scoring exhibited some subjectivity due to varying interpreter understanding and unclear behavioral definitions. A standardized system needs construction:

Scoring Process: Implement double-blind independent scoring. Two trained observers score the same game video; if differences exceed a threshold (e.g., ≥2 points), third-party arbitration is needed. Calculate inter-rater reliability, ensuring consistency ≥0.8.

Scoring Standards: Develop a detailed *Playfulness Behavior Scoring Manual* including clear dimension definitions, typical behavior examples, and specific anchors for 5-point ratings, particularly concretizing ambiguous concepts.

Rater Training: Adopt a progressive "theoretical learning + practical assessment" scheme: watch standard scoring videos with discussion; complete 20 practice ratings with consistency ≥90%; pass a final certification test.

7.3 Research Interference Factor Control and Optimization Strategies

Game Time Management and Research Schedule Optimization: Senior children's play time was compressed due to graduation rehearsals. Mitigation strategies: Understand class schedules during design, avoid important activity periods; establish flexible observation mechanisms (extend period or increase frequency if needed); record detailed context (time, location, child state) for post-hoc correction; maintain close communication with kindergartens for stable observation windows.

Systematic Control Plan for Research Variables:Establish a multi-level variable control system: standardize physical environment (equipment); record and analyze potential factors (teacher style, student-teacher ratio); collect background info via questionnaire (parenting style, outdoor time). For uncontrollable variables: use statistical correction; report potential influences; consider control groups or repeated measures designs. Standardize observation procedures and recording protocols ensure data comparability across observers.Furthermore, in light of the growing interest in AI-enabled education, future studies could incorporate AI-assisted observation and data analysis tools to improve the objectivity and scalability of playfulness assessments. For example, computer vision algorithms could be trained to recognize and code play behaviors in real time, reducing the burden on human raters and minimizing subjectivity. Such tools could also help teachers identify children who may need additional support in specific playfulness dimensions, thereby facilitating early intervention. This aligns with the broader movement toward smart education environments where teacher expertise is augmented—not replaced—by technology.

7.4 Leveraging AI for Objective Playfulness Assessment and Teacher Support

The limitations of this study—including rater subjectivity, insufficient observation time, and environmental variability—point to broader challenges in traditional observation methodologies. These very constraints, however, indicate compelling opportunities for applying artificial intelligence to support both research and practice. Future efforts could integrate AI technologies to establish an augmented assessment system that enhances—rather than replaces—teachers' expertise.

One promising direction is AI-augmented objective assessment. Computer vision and action recognition algorithms can be trained to automatically identify and quantify key behavioral indicators outlined in the playfulness scale. For instance, an AI system could measure the frequency and duration of motions like running and jumping (physical spontaneity), detect moments of cooperation and equipment sharing (social spontaneity), and even analyze facial expressions to estimate joy intensity (manifest joy). This would significantly improve inter-rater reliability and provide consistent, reproducible metrics needed for tracking developmental progress.Furthermore, AI can function as an intelligent teaching assistant, mitigating constraints related to time and human resources. A well-designed system can simultaneously observe multiple children, automate tedious coding and logging tasks, and generate intuitive visual reports (e.g., daily playfulness dashboards). By delegating routine documentation to AI, teachers can devote more attention to higher-value responsibilities such as emotional support, individualized interaction, and designing responsive learning environments. In this way, AI serves as a supportive tool that elevates teachers' roles rather than diminishing them.Finally, AI can foster personalized education and teacher training. Longitudinal data collected by AI systems can help identify individual developmental patterns in playfulness dimensions, flag potential delays, and suggest tailored interventions. For example, the system might recommend: "Child A shows consistently low scores in social spontaneity; consider assigning cooperative roles in the next activity." Moreover, a repository of AI-annotated video examples can become a valuable resource for training novice teachers, accelerating their ability to observe and understand child behavior.

In conclusion, integrating AI into the assessment of playfulness is not aimed at replacing human judgment but at establishing a new collaborative paradigm of human-machine partnership. In this model, AI handles data processing while teachers interpret meaning; AI offers alerts while teachers provide care; AI reveals patterns while teachers create learning experiences. Together, they can form a powerful synergy that advances early childhood education into a more precise, scientific, and empathetic future.

REFERENCES

Barnett, L. A. (1991). The playful child: Measurement of a disposition to play. *Play and Culture, 4*(1), 51-74.

Erikson, E. H. (1963). *Childhood and society*(2nd ed.). Norton.

Lieberman, J. N. (1965). Playfulness and divergent thinking: An investigation of their relationship at the kindergarten level. *The Journal of Genetic Psychology, 107*(2), 219-224. https://doi.org/10.1080/00221325.1965.10533661

McGhee, P. E., & Pistolesi, E. (1979). *Humor: Its origin and development*. W. H. Freeman.

Piaget, J. (1962). *Play, dreams and imitation in childhood*. Norton.

Rubin, K. H., Fein, G. G., & Vandenberg, B. (1983). Play. In P. H. Mussen (Ed.), *Handbook of child psychology: Vol. 4. Socialization, personality, and social development*(4th ed., pp. 693-774). Wiley.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.