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Playfulness and Longitudinal Development in Creative Thinking Processes and Academic Skills Among Kindergarten Children

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ABSTRACT

This study examined the longitudinal relationships between children's playfulness, creative thinking processes, and academic skills. Participants were 150 Chinese kindergarten children (52.7% boys; Time 1 age range = 4–5 years) and their parents. At Time 1, the parents reported demographic information and rated children's playfulness (social and cognitive spontaneity) by completing the questionnaire. Children were administered behavioral measurements of creative thinking processes (convergent and divergent thinking), Chinese word reading, and mathematics skills (forward counting, backward counting, number word comparison, arithmetic addition, and arithmetic subtraction). One year later, at Time 2, children completed the same behavioral assessments again. Results from a path analytic model revealed that the indirect relationship between playfulness at Time 1 and mathematics at Time 2, mediated through convergent thinking at Time 1, was positive and significant. Moreover, children's convergent thinking and mathematics skills reciprocally predicted each other. These findings suggest that playful kindergarten children might display better creative thinking and academic skills over time. Furthermore, the results highlight how encouraging children's playfulness and implementing play-based mathematics activities may nurture their creativity and academic skills.

1 | Introduction

In early childhood, playfulness represents children's qualities or styles of play displayed across different contexts (Barnett 1991; Lieberman 1977). As play has long been suggested as an important context in which children learn and grow (e.g., Piaget 1976; Vygotsky 1967), playfulness offers us a unique lens to understand how individual differences (in play) may influence their future development. A growing body of evidence has revealed how playfulness predicts kindergarten children's creativity development, conceptualized as creative personality traits (e.g., Fung and Chung 2021, 2022a, 2023b; Fung et al. 2021) or creative thinking processes (e.g., Fung and Chung 2024b, 2025). Considering the importance of creative thinking processes (i.e., convergent and divergent thinking; Vries and Lubart 2019) in academic learning, recent evidence has also demonstrated the interlinks between creative thinking processes and academic achievements (e.g., Abdulla Alabbasi et al. 2023; Akpur 2020; Gajda 2016; Gajda et al. 2017; Zhang et al. 2020). Nonetheless, research examining the relationships between creative thinking processes and academic skills in early childhood is very limited (Denervaud et al. 2019; Fung and Chung 2024b), and those investigating their reciprocal links across time with playfulness considered are even rarer. The present study filled the gaps by

examining the longitudinal relationships among kindergarten children's playfulness, creative thinking processes, and academic skills in mathematics and word reading. Given that convergent and divergent thinking skills are intricately embedded in academic learning (Cheng et al. 2023), this study also investigated whether and how early academic skills would reciprocally predict children's subsequent creative thinking processes.

1.1 | Playfulness and Creative Thinking Processes

Creativity indicates the production of novel and functional ideas in diverse settings (Amabile 1996). In early childhood, children tend to show creativity in daily situations, such as play, for entertainment and gratification (Chávez-Eakle et al. 2012; Runco 2014). Therefore, their creative ideas are often novel and appropriate (Richards 2007, 2019) but not essentially functional (Runco and Jaeger 2012). Grounded on Rhodes's (1961) conceptualization, children's potential for creative ideations (i.e., creative potential; Runco 2014) can be displayed in different domains, including creative personality traits (i.e., person), creative outcomes (i.e., product), and creative thinking processes (i.e., process).

Convergent and divergent thinking are vital processes underlying creative problem solving (Vries and Lubart 2019). Divergent thinking reflects one's ability to generate multiple possibilities for addressing a reference question (Vries and Lubart 2019), whereas convergent thinking indicates one's competency to reason the best answer to a problem quickly, precisely, and rationally (Cropley 2006). In the process of creative problem solving, divergent thinking expands the number of possible ideas, while convergent thinking appraises the alternatives and prunes the less feasible/appropriate ones (Zhu et al. 2019). The cyclic employment of convergent and divergent thinking processes leads to the best solution (Cropley 2006). Therefore, convergent and divergent thinking are fundamental processes contributing to creative ideation.

As play is an important context in which children show their creativity (e.g., pretense and sociodramatic play; Vygotsky 2004), recent research has explored how children's playfulness links with their creativity development. Children's playfulness captures their patterns or qualities of play demonstrated across different contexts (Barnett 1991; Lieberman 1977), consisting of five indicators: physical spontaneity (qualities of motor dexterity and activity level), social spontaneity (qualities of peer interaction and leadership), cognitive spontaneity (qualities of imaginative, associative, and innovative ideas), manifest joy (qualities of positive emotional expression), and sense of humor (qualities of teasing, joking, and clowning). Individual differences in children's playfulness govern their daily play behaviors and play participation and, thus, may determine their early development. Aligning with Vygotsky's (1967, 2004) proposition highlighting the importance of pretense or make-believe, emerging evidence has demonstrated the specific roles of social and cognitive spontaneity in early creativity development (e.g., Fung and Chung 2021, 2022a, 2023b, 2024b; Fung et al. 2021).

Make-believe play is characterized by its "as if" nature (Vygotsky 1967), and children employ various cognitive skills in this form of play, including object substitution, symbolic representation, free association, board scanning, and affect-laden thinking (Russ 2003; Russ and Wallace 2013). Therefore, children with higher cognitive spontaneity are likelier to engage in make-believe and develop their creativity. In group pretense, such as sociodramatic play, children also need to communicate their innovative and interesting play ideas with peers effectively and prosocially so that the play ideas can be accepted and actualized (Fung and Chung 2023b). Thus, children with better social spontaneity tend more to engage effectively in group pretense, benefiting their creativity development. Concurring with these contentions, kindergarten children's social and cognitive spontaneity were positively associated with their creative personality traits, as reported by parents (Fung et al. 2021) and teachers (Fung and Chung 2022a). Fung and Chung (2023b) further demonstrated the bidirectional relationships between kindergarten children's playfulness (social and cognitive spontaneity) and creative personality traits, suggesting their co-development across time. Nevertheless, prior research examining the relationship between children's playfulness and creative thinking processes is minimal, except for two studies revealing the cross-sectional relationships of social and cognitive spontaneity with convergent and divergent thinking skills (Fung and Chung 2024b, 2025). The present study not only further examined the relationship between kindergarten children's playfulness and creative thinking processes but also explored how playfulness and creative thinking processes collectively predict their prospective academic skills.

1.2 | Creative Thinking Processes and Academic Skills

The roles of creative thinking processes in supporting children's academic skills have received growing attention. Conceptually, convergent thinking requires children to analyze logically, maintain a narrow focus, combine similar concepts, and pursue accuracy (Cropley 2006). Equally important, divergent thinking requires children to change perspectives, combine remote concepts, transform existing ideas, and generate alternative strategies (Cropley 2006). Thus, convergent and divergent thinking are inherent in acquiring academic skills (Cheng et al. 2023) and academic problem-solving (Zhu et al. 2019). Prior evidence has illustrated the positive relationships between creative thinking processes and academic achievement in various age groups (e.g., Akpur 2020; Gajda 2016; Gajda et al. 2017). For example, convergent and divergent thinking processes positively predicted the academic achievement of primary school children (Zhang et al. 2020) and university students (Abdulla Alabbasi et al. 2023). Convergent and divergent thinking processes were also positively associated with children's academic skills in mathematics and reading in their early years (Denervaud et al. 2019; Fung and Chung 2024b). Nevertheless, these two recent studies involving children in their early years were cross-sectional, precluding any claims for directionality. Given that playfulness is a robust predictor of early creativity development (e.g., Fung and Chung 2021, 2022a, 2023b), this study extended to investigate the indirect links between kindergarten children's playfulness, creative thinking processes, and academic skills using longitudinal data.

Apart from a unidirectional prediction, the relationship between creative thinking processes and academic skills may also be bidirectional. A recent review of children's academic achievement and cognitive abilities has concluded that these two domains may co-develop over time (Peng and Kievit 2020). Children with higher levels of academic skills are possibly motivated to engage in future academic activities due to intrinsic (e.g., sense of achievement, mastery of advanced concepts) or extrinsic (e.g., reinforcement from teachers, tangible rewards) reasons. The increased engagement in academic activities provides additional opportunities for these children to apply and improve their creative thinking processes, leading to bidirectional development. Indeed, a recent study examining the relationship between undergraduate students' meta-creativity (i.e., creative motivation, creative leadership, and divergent thinking) and academic performance has concluded a bidirectional relationship between these two variables (Villalustre et al. 2024). Despite the sound theoretical and empirical bases (Peng and Kievit 2020; Villalustre et al. 2024), to the best of our knowledge, no prior research has investigated the bidirectional development between creative thinking processes and academic skills in early childhood. The present study filled this gap by examining the bidirectionality of kindergarten children's creative thinking processes and academic skills in mathematics and word reading over 1 year.

1.3 | The Present Study

This study investigated the longitudinal relationships between playfulness (social and cognitive spontaneity), creative thinking processes (convergent and divergent thinking), and academic skills (mathematics and word reading) among kindergarten children. It also examined the reciprocal association between children's creative thinking processes and academic skills across two time points separated by 1 year. Based on the literature review and studies (e.g., Cheng et al. 2023; Denervaud et al. 2019; Fung and Chung 2024b; Villalustre et al. 2024; Vries and Lubart 2019), it was hypothesized that children's playfulness at Time 1 would be indirectly related to their academic skills in mathematics and word reading at Time 2 via creative thinking processes at Time 1. It was also expected that creative thinking processes and academic skills would predict each other across Times 1 and 2. Considering previous evidence that playfulness was not directly related to kindergarten children's school readiness (Fung and Chung 2023a) or academic skills (Fung and Chung 2024b), we anticipated nonsignificant direct relations between playfulness and academic skills.

2 | Method

2.1 | Participants

The participants were 150 Chinese kindergarten children (52.7% boys; Time 1 age range = 4–5 years; Time 2 age range = 5–6 years) and their parents recruited from nine kindergartens in three low to middle socioeconomic areas in Hong Kong. Parents reported their age and education levels: (1) primary, (2) lower secondary, (3) upper secondary, (4) college, (5) undergraduate, (6) master, and (7) doctoral. 48% of the parents completed upper secondary level, 19% attained lower secondary level, 16% finished college, and 16% completed an undergraduate degree or above. Mothers completed about 80% of the questionnaires.

2.2 | Procedure

Ethical approval was granted by the university's ethics board (approval reference number: A2018- 2019-0175-01). The principals of the nine kindergartens also consented to take part. At Time 1, informed consent and questionnaire forms were sent to the parents of second-year children (kindergarten K2) as an invitation. Consenting parents reported demographic information and rated children's playfulness by completing the questionnaire, which took around 10 min. Participating children were administered behavioral measurements of convergent thinking, divergent thinking, Chinese word reading, and mathematics skills by experienced research assistants in a quiet area of the schools. Verbal consent was obtained from the participating children before the start of the behavioral measurements. The assessment tasks took around 30 min, with a short break in between. One year later, at Time 2, participating children (in kindergarten K3) completed the same set of behavioral measurements again.

2.3 | Measures

2.3.1 | Playfulness at Time 1

Children's playfulness was measured with the social spontaneity and cognitive spontaneity subscales of the Children's Playfulness Scale (CPS; Barnett 1991). The CPS was widely employed in research on kindergarten children's playfulness (e.g., Fung and Chung 2021, 2022a, 2022b, 2024a; Trevlas et al. 2003), with satisfactory reliability of its test scores (internal consistency above 0.80) and factorial validity of its test score interpretations (Barnett 2018). The social spontaneity subscale has five items (e.g., "The child assumes a leadership role when playing with others"), whereas the cognitive spontaneity subscale contains four items (e.g., "The child uses unconventional objects in play"). Parents rated the items on a 5-point Likert scale ranging from 1 (*not like my child*) to 5 (*exactly like my child*). The mean score of the two subscales represented children's playfulness. The Cronbach's alpha of the test scores under the social spontaneity and cognitive spontaneity subscales was 0.75.

2.3.2 | Mathematics at Times 1 and 2

To ascertain age-appropriateness and minimize ceiling or floor effects, children's mathematics skills were measured with a battery of mathematics tasks: forward counting, backward counting, number word comparison, arithmetic addition, and arithmetic subtraction. Both forward counting (e.g., "Can you count forward from 12 to 17?") and backward counting (e.g., "Can you count backward from 26 to 20?") tasks consist of four items, with satisfactory reliability of their test scores (internal consistency above 0.80) and construct validity of their test scores interpretation (Chung and McBride-Chang 2011). Each correct counting sequence scored two marks, whereas one mark was awarded if the child made one mistake in a sequence. If the child made two or more mistakes in

a sequence, zero marks were given. The maximum scores for forward counting and backward counting were both eight.

Number word comparison was assessed by the verbal number comparison task (Honore and Noel 2016; Yang et al. 2020), with adequate reliability of its test scores (internal consistency above 0.80; Yang et al. 2020) and construct validity of its test scores interpretation (Honore and Noel 2016). This task contains eight items, with four of them focusing on larger quantities (e.g., "Among 38 and 26, which is the larger number?") and the remaining four focusing on smaller quantities (e.g., "Among 17 and 24, which is the smaller number?"). Children were presented with the items verbally and asked to decide which number was larger or smaller. Each correct response scored one mark, whereas a wrong response scored zero marks. The maximum score for this task was eight.

For arithmetic, both addition (e.g., "Can you tell me the answer of 3 + 7?") and subtraction (e.g., "Can you tell me the answer of 9 − 6?") tasks contain five items, with adequate reliability of their test scores (internal consistency above 0.80) and construct validity of their test scores interpretation (Liu et al. 2020). The items were printed on A4 paper and verbally presented to the children. Children were allowed to use a draft paper, a pencil, and a rubber to work out the answer and then verbally present their answer to the research assistant. Each correct answer scored one mark, whereas a wrong answer scored zero marks. The maximum scores for arithmetic addition and arithmetic subtraction were both five.

The total aggregated scores from all five tasks represented children's mathematics skills, with a maximum of 34. The Cronbach's alphas of the test scores under the forward counting, backward counting, number word comparison, arithmetic addition, and arithmetic subtraction tasks at Time 1 and Time 2 were 0.87 and 0.90, respectively.

2.3.3 | Word Reading at Times 1 and 2

Children's word reading skill was measured with the Chinese word reading subset from The Hong Kong Reading Ability Screening Test for Preschool Children (RAST-K; Ho et al. 2011), which is a locally validated assessment with satisfactory reliability of its test scores (internal consistency and test–retest reliability above 0.80) and content validity of its test score interpretations (Ho et al. 2011; Zheng et al. 2022). The RAST-K contains 55 one- and two-character words arranged in increasing difficulty. Children were asked to read the words aloud. A correct answer scored one mark. A flawed pronunciation or a mistakenly recognized word scored zero marks. The total score represented children's word reading skills, with a maximum of 55. The Cronbach's alphas of the test scores under the word reading task at Time 1 and Time 2 were 0.97 and 0.98, respectively.

2.3.4 | Creative Thinking Processes at Times 1 and 2

Children's creative thinking processes were operationalized as their convergent thinking and divergent thinking skills (Cropley 2006; Vries and Lubart 2019). Convergent thinking was measured with the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn and Dunn 1981), with adequate reliability of its test scores (internal consistency above 0.80) and construct validity of its test score interpretations (Fung and Chung 2024b, 2025; Lloyd and Howe 2003). The PPVT-R includes 125 items with four pictures each (a target object, a phonological distractor, a semantic distractor, and an irrelevant distractor). This task required the children to infer the single correct answer speedily and logically, concurring with the definition of convergent thinking (Cropley 2006). The research assistant read a vocabulary word for each item, and the children were asked to indicate the corresponding picture. The task was discontinued if a child gave six consecutive wrong answers on eight items. A correct answer (i.e., point to the target object) scored one mark, whereas an incorrect answer (i.e., point to any distractor) scored zero marks. The total score represented children's convergent thinking.

Divergent thinking was measured with the Torrance Tests of Creative Thinking figural circle task (TTCT; Torrance 1974). TTCT was employed in prior research examining early divergent thinking (e.g., Dziedziewicz et al. 2013; Lubart et al. 2010), with satisfactory predictive, criterion, and discriminant validity of its test score interpretations (Torrance 1972; Wechsler 2006). Children were given an A4-sized paper with 15 equal circles, and they had 4 min to add elements in each circle to generate an interesting drawing (e.g., a sun, a ball, and a tire). After the 4 min, the experimenter reviewed all drawings generated and clarified the meaning of any unclear drawings with the child. A distinctive and interpretable drawing scored one mark. In the case that drawings were highly comparable (e.g., a man's face and a woman's face) or repetitive, only one mark was given. An uninterpretable drawing scored zero marks. The total number of distinctive drawings representing children's fluency in creative ideations (Torrance 1974) was used to indicate children's divergent thinking. The Cronbach's alphas of the test scores under the PPVT-R task at Time 1 and Time 2 were 0.80 and 0.96, respectively. The interrater reliabilities of the test scores under the TTCT task at Time 1 and Time 2 were 0.84 and 0.94, respectively.

2.4 | Data Analysis Plan

Descriptive statistics and correlational analyses were conducted to examine the characteristics of the concerned variables. The variables were then subjected to a path analytic model to examine their interrelationships over time. The path model was estimated using the lavaan package in R (version 4.2.0; R Core Team 2024). Model fit was assessed by referring to Hu and Bentler's recommendations (1999): nonsignificant chi-square index (χ^2), comparative fit index (CFI) beyond 0.95, Tucker–Lewis index (TLI) beyond 0.95, root mean square error of approximation (RMSEA) under 0.06, and standardized root mean square residual (SRMR) under 0.08. The bias-corrected bootstrapping with 5000 resampling (Hayes 2009) was employed to estimate the significance of the indirect relationships.

3 | Results

3.1 | Preliminary Analyses

Table 1 shows the descriptive statistics, reliabilities, and bivariate correlations of the study variables at Times 1 and 2.

Playfulness at Time 1 was positively associated with creative thinking processes at Time 1 ($r = 0.18–0.20$, $p < 0.05$) and convergent thinking at Time 2 ($r = 0.20$, $p = 0.02$), but its relationships with academic skills were nonsignificant. The concurrent and longitudinal correlations among mathematics, word reading, and creative thinking processes were positive and significant ($r = 0.16–0.49$, $p < 0.05$), except those with divergent thinking at Time 2. The percentages of missing data for the study variables ranged from 0.7 (divergent thinking at Time 2) to 9.3% (mathematics at Time 2). The Little's (1998) test value was nonsignificant (χ^2 (33) = 31.96, $p = 0.52$), indicating that the data were missing completely at random. Therefore, path analysis was conducted using full information maximum likelihood estimation with robust standard errors (i.e., estimator MLR), which is robust to non-normality.

3.2 | Path Analytic Model Predicting Mathematics, Word Reading, and Creative Thinking Processes

Figure 1 shows the parameter estimates and model fit statistics of the path analytic model of mathematics, word reading, and creative thinking processes across Time 1 and Time 2, with children's playfulness at Time 1 as an antecedent. The path model reveals a good fit to the data χ^2 (df = 22, $N = 150$) = 40.59, $p = 0.12$, CFI = 0.98, TLI = 0.95, RMSEA = 0.05 (90% CI: 0.00, 0.08), SRMR = 0.05, $R^2_{Time\ 2\ Mathematics} = 0.49$, $R^2_{Time\ 2\ Word\ Reading} = 0.61$, $R^2_{Time\ 2\ Convergent\ Thinking} = 0.35$, $R^2_{Time\ 2\ Divergent\ Thinking} = 0.11$.

Children's playfulness was positively associated with convergent (β = 0.20, SE = 1.78, $p = 0.01$) and divergent thinking (β = 0.17, SE = 0.29, $p = 0.02$) at Time 1. In contrast, the links between playfulness and academic skills at Time 1 were nonsignificant. The autoregressive paths of mathematics (β = 0.47, SE = 0.08, $p < 0.001$), word reading (β = 0.71, SE = 0.07, $p < 0.001$), convergent thinking (β = 0.40, SE = 0.10, $p < 0.001$), and divergent thinking (β = 0.32, SE = 0.12, $p = 0.01$) across time were all positive and significant. The path from convergent thinking at Time 1 to mathematics at Time 2 was significant (β = 0.24, SE = 0.04, $p = 0.01$), whereas the one from convergent thinking at Time 1 to word reading at Time 2 emerged at trend level (β = 0.11, SE = 0.07, $p = 0.09$). In contrast, the paths from divergent thinking at Time 1 to academic skills at Time 2 were nonsignificant. Conversely, the path from mathematics at Time 1 to convergent thinking at Time 2 was significant (β = 0.19, SE = 0.21, $p = 0.03$), but the path from word reading at Time 1 to convergent thinking at Time 2 was nonsignificant. The paths from both academic skills at Time 1 to divergent thinking at Time 2 were also nonsignificant. The indirect relationship between playfulness at Time 1 and mathematics at Time 2 mediating through convergent thinking at Time 1 was positive and significant (indirect effect: β = 0.05, SE = 0.31, $p = 0.03$, 90% CI: 0.07, 1.28), but the one between playfulness, convergent thinking at Time 1, and word reading at Time 2 was nonsignificant.

TABLE 1 | Descriptive statistics, reliabilities, and bivariate correlations of study variables.

		Correlations								
Variables		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. T1 playfulness		—								
2. T1 mathematics		0.08	—							
3. T1 word reading		0.04	0.51***	—						
4. T1 convergent thinking		0.20*	0.49***	0.37***	—					
5. T1 divergent thinking		0.18*	0.24**	0.18*	0.37***	—				
6. T2 mathematics		0.07	0.63***	0.33***	0.49***	0.26**	—			
7. T2 word reading		0.13	0.51***	0.75***	0.38***	0.20*	0.40***	—		
8. T2 convergent thinking		0.20*	0.43***	0.36***	0.52***	0.24**	0.39***	0.34***	—	
9. T2 divergent thinking		0.05	0.15	0.12	0.34***	0.33***	0.16*	0.05	0.13	—
Descriptive statistics	Mean	3.77	10.85	10.46	33.31	2.74	21.27	23.38	43.66	3.21
	Standard deviation	0.58	7.20	12.19	14.81	2.32	8.14	16.15	17.87	2.66
	Skewness	0.13	0.83	2.21	0.87	0.77	−0.64	0.55	0.57	1.14
	Kurtosis	−0.06	0.38	4.88	1.24	0.25	−0.31	−0.94	−0.24	1.49
	Minimum	2.07	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00
	Maximum	5.00	34.00	55.00	88.00	10.00	34.00	55.00	91.00	14.00
	Cronbach's alpha	0.75	0.87	0.97	0.80	0.84[a]	0.90	0.98	0.96	0.94[a]

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
[a]Divergent thinking was assessed with the TTCT figural circle task and the interrater reliability is shown.

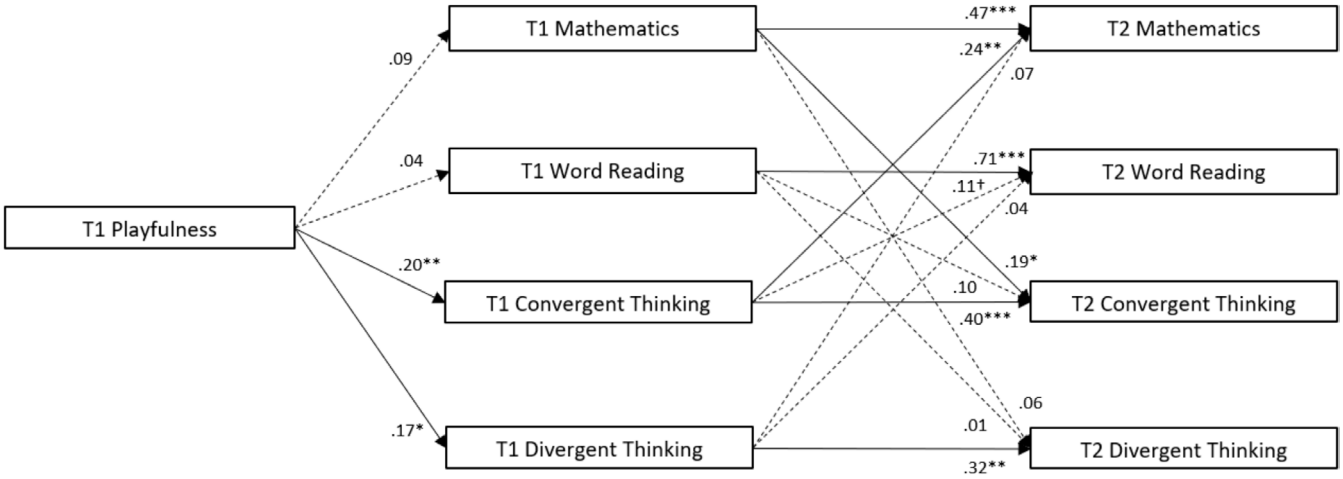

FIGURE 1 | A path analytic model of mathematics, word reading, and creative thinking processes (convergent and divergent thinking) across Time 1 and Time 2 with children's playfulness (social spontaneity and cognitive spontaneity) at Time 1 as an antecedent. Control variables include children's gender and parental education level. Covariances among mathematics, word reading, convergent thinking, and divergent thinking at Time 1 and those at Time 2 were modeled but not shown for clarity. Standardized coefficients are reported. Solid paths are statistically significant. Dashed paths are nonsignificant. T1 = time 1 and T2 = time 2. $^{\dagger}p = 0.09$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$. Fit indices: χ^2 (df = 22, $N = 150$) = 40.59, $p = 0.12$, CFI = 0.98, TLI = 0.95, RMSEA = 0.05 (90% CI: 0.00, 0.08), SRMR = 0.05, $R^2_{\text{Time 2 Mathematics}} = 0.49$, $R^2_{\text{Time 2 Word Reading}} = 0.61$, $R^2_{\text{Time 2 Convergent Thinking}} = 0.35$, $R^2_{\text{Time 2 Divergent Thinking}} = 0.11$.

4 | Discussion

This study investigated the longitudinal links between children's playfulness, creative thinking processes, and academic skills, and it also explored whether the latter two predicted each other across time. The findings highlighted the mediating role of convergent thinking in the indirect relationship between children's playfulness and mathematics skills. The results also revealed the plausible co-development of children's convergent thinking and mathematics skills in the early years. These findings have expanded the existing evidence (e.g., Fung and Chung 2022a, 2022b, 2023a, 2024a, 2024b; Fung et al. 2021) by demonstrating how playfulness might predict children's creativity development and future academic skills.

4.1 | Indirect Relationships Between Playfulness, Creative Thinking Processes, and Academic Skills

As expected, children's playfulness was unrelated to their concurrent academic skills. Instead, playfulness was positively associated with their creative thinking processes, further predicting subsequent mathematics skills. Aligning with emerging evidence suggesting the facilitative role of playfulness in early creativity development (e.g., Fung and Chung 2022a, 2023b; Fung et al. 2021), the present results extended recent work (i.e., Fung and Chung 2024b) to show how these two factors were associated with children's academic skills using longitudinal data. Playful children, particularly those with higher levels of social and cognitive spontaneity, are keen on engaging peers and transforming ideas in their play (Barnett 2018; Fung and Chung 2021). Perhaps, these characteristics motivate them to employ their convergent (e.g., filter out inappropriate ideas that are less relevant to the play theme or partners) and divergent (e.g., figure out alternative uses of play materials, link up remote concepts or experiences) thinking skills repetitively to sustain fun and enjoyable play, exercising their creative thinking processes (Fung and Chung 2024b).

Concurring with prior evidence revealing the supportive role of creativity in academic competence (e.g., Cheng et al. 2023; Denervaud et al. 2019; Fung and Chung 2024b), the present results further illustrate how creative thinking longitudinally predicted academic skills development in the early years. Specifically, children's convergent thinking positively predicted their mathematics skills 1 year later, although the prediction on their word reading emerged at a trend level. This pattern of relationships is in line with previous findings showing that the links of creative thinking processes with mathematics skills are relatively stronger than those with literacy skills (i.e., Cheng et al. 2023; Fung and Chung 2024b), possibly owing to the fluid and intangible nature of mathematics (Nusbaum and Silvia 2011). Although divergent thinking was not predictive of children's academic skills in the present results, this study relied exclusively on children's drawing to indicate their abilities to create alternative ideas, which may or may not align with children's interests and competence. A different measure tapping into children's creative ideation in another domain, such as their creative movement (Torrance 1981), can be used to further examine the interlinks between divergent thinking and academic skills. Considering the current sample size (i.e., 150), future research with more participants can also be conducted to further validate how creative thinking processes predict word reading development in early childhood.

Importantly, the indirect relationship between playfulness and mathematics skills mediated through convergent thinking was positive and significant. This finding supports the contention that play is an important context allowing children to learn and develop naturally and joyfully (Bodrova and Leong 2018;

Vygotsky 1967). Playful children might not only develop their social–emotional competence and school readiness (e.g., Fung and Chung 2022b, 2023a, 2024a) through increased peer play but also acquire convergent thinking (Fung and Chung 2024b), which is fundamental to their academic learning. Future studies may explore whether and how playfulness and creativity may collectively predict children's long-term academic learning and social–emotional wellbeing during their formal school transition (e.g., from preschool to early primary years).

4.2 | Reciprocal Links Between Academic Skills and Creative Thinking Processes

Notably, the path model (Figure 1) revealed that mathematics at Time 1 reciprocally predicted convergent thinking at Time 2, above and beyond the autoregressive pathway. A recent study has illustrated the bidirectionality between kindergarten children's playfulness and creative potential (Fung and Chung 2023b). The current results highlighted that, apart from daily peer play experiences like sociodramatic play (Fung and Chung 2023b), children might exercise their creative thinking when engaging in mathematics activities. The nonsignificant relations from word reading at Time 1 to creative thinking processes at Time 2 also underscored the uniqueness of mathematics as a subject actively engaging children's creativity. Taken together, the current findings pointed to a possible co-development of kindergarten children's creative thinking and mathematics skills over time. However, the current study used a correlational design, which limited its ability to inform causality. Thus, caution should be taken in this interpretation.

4.3 | Limitations

The present study has at least three limitations. First, although children's word reading, mathematics, and creative thinking processes were directly measured, playfulness was assessed using a parent-reported survey (i.e., Children's Playfulness Scale; Barnett 1991), which may be biased due to social desirability (Krumpal 2013). Although the Children's Playfulness Scale is a validated measure commonly employed in research on kindergarten children, there are observational measures of children's playfulness based on their play behaviors (e.g., the Test of Playfulness scale; Bundy et al. 2001). Collecting data from multiple informants (e.g., father, mother, and teacher) may also help to triangulate participants' ratings and improve the objectivity of results. Future research should engage a wider range of playfulness assessments and multiple informants to validate the present findings. Relatedly, additional creativity assessments (e.g., the Test for Creative Thinking—Drawing Production; Urban and Jellen 1996) allow the employment of a more sophisticated approach, such as structural equation modeling (which requires at least three observed measurements to construct a latent variable), to examine the interrelationships among children's playfulness, creative thinking processes, and academic skills robustly.

Second, the current sample size was adequate but small (post hoc analysis of power = 0.81; Moshagen and Erdfelder 2016), and all participants were recruited from the same cultural context (i.e., Hong Kong). Further research with a large and diverse sample (e.g., cross-cultural study) can verify the robustness and generalisability of the present findings. Lastly, this longitudinal study was correlational and, thus, cannot claim causal inference. Due to limited resources, the current study can only support two data collection points, with children's playfulness reported at Time 1 to predict their directly assessed creativity thinking processes and academic skills at Time 1 and Time 2. However, a proper longitudinal mediation should be tested with playfulness, creative thinking processes, and academic skills measured repeatedly at three time points to ascertain their temporal order and control for autoregressive effects (Cole and Maxwell 2003; MacKinnon et al. 2007). The present results do not reflect a legitimate longitudinal mediation model, and future work using a longitudinal design with multiple data collection points or experimental design is needed to inform the direction of effects.

4.4 | Conclusions and Implications

Despite its limitations, this study contributed to the literature by showing the reciprocal relations of children's creative thinking and academic skills and how these factors were longitudinally related to their playfulness. Theoretically, the findings demonstrated that playful children might develop better creative thinking that supports their academic pursuit in mathematics and, possibly, literacy. Practically, the results emphasized the utility of promoting kindergarten children's playfulness and further employing a play-based approach in mathematics learning. Teachers may incorporate more group play time in the daily schedule, endorse children's play ideas, and offer unstructured play materials to encourage children's playfulness (Canning 2010; Fung and Chung 2022a, 2022b). Moreover, teacher training or professional development programs may include components for raising practitioners' playfulness (Pinchover 2017; Proyer et al. 2021) and improving their competence in designing and executing play-based mathematics activities to nurture children's early creativity and academic skills.

Disclosure

Compliance with ethical standards: This manuscript was prepared in accord with the ethical standards of the American Psychological Association.

Ethics Statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institution and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent

Informed consent was obtained from all participants included in the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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