Bidirectionality in Kindergarten Children's School Readiness and Emotional Regulation

Abstract

This study examined the longitudinal associations of emotional regulation and school readiness among Chinese kindergarten children. Data were collected from 523 children (mean age at time 1 = 52.42 months; 52.9% male) at two time points separated by approximately one year in Hong Kong, China. At times 1 and 2, children's school readiness was assessed by their teachers and parents while their emotional regulation was directly tested. Teachers also rated children's emotional regulation at both time points. The results from the two reciprocal path models showed that, controlling for the corresponding autoregressive effects, school readiness at time 1 was predictive of emotional regulation at time 2. However, emotional regulation at time 1 did not emerge as a significant predictor of school readiness at time 2. Theoretically, these results underscored children's school readiness as a potential contributor to their emotional regulation. Practically, these findings suggested the utility of supporting children's school readiness to foster their emotional regulation.

Keywords: bidirectionality, longitudinal, emotional regulation, school readiness, kindergarten children

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School readiness and emotional regulation are both effective indicators of children's adjustment and future academic performance (e.g., Panlilio, Harden, & Harring, 2018; Sabol & Pianta, 2012). Children's emotional regulation was suggested to influence their school readiness (e.g., Eisenberg, Valiente, & Eggum, 2010; Graziano, Reavis, Keane, & Calkins, 2007). Conversely, the psychobiological framework (Cairns, 1991) proposed that children's school readiness can reciprocally determine their emotional regulation development (Blair, 2002). Despite the plausible bidirectionality between the development of emotional regulation and school readiness, little attempt has been made to test the bidirectional associations between these two constructs by employing longitudinal investigation. Therefore, this study investigated the bidirectional links between emotional regulation and school readiness in a sample of Hong Kong Chinese kindergarten children. Findings from this study could clarify previous findings and serve as the theoretical foundation of future work. Particularly, the results could inform whether children's school readiness and emotional regulation contribute to each other across time. Additionally, given most research focuses on how emotional regulation would influence children's school readiness (Kwon, Kupzyk, & Benton, 2018), the results could shed light on intervention efforts to improve

kindergarten children's emotional regulation by supporting their school readiness.

School readiness

School readiness is a multifaceted concept which characterizes children's capacities for successfully transiting to and acquiring competencies in school (United Nations Children's Fund, 2012). School readiness covers a broad range of developmental skills including academic skills in language, literacy, numeracy, and mathematical concepts, and the cognitive skills of sustained attention, response inhibition, following instructions, and problem solving (e.g., Duncan et al., 2007; Eisenberg et al., 2010; Portilla, Ballard, Adler, Boyce, & Obradović, 2014). Nevertheless, cognitive skills such as strategic problem solving and the ability to adaptively regulate one's behaviors were perceived by first-grade teachers as more indicative of children's school readiness compared to academic skills (Gumpel, 1999). Aligned with this contention, Blair and Raver (2015) suggested a model of school readiness that considered children's capacity in regulating their cognition and behaviors and highlighted that higher-order cognitive skills (e.g., executive functions) are the chief determinants of children's school readiness. Therefore, in this study, children's school readiness was operationalized as their higher-order cognitive skills (i.e., strategic working and role-governed skills) and academic skills. Although teachers are generally recognized as the key informants in assessing children's school readiness (Gullo, 1990; Weissberg et al.,

1987), parents can also provide essential information as they can observe children's behaviors under different scenarios over a longer duration (McBryde, Ziviani, & Cuskelly, 2004) and the inclusion of both teachers' and parents' rating can provide a more comprehensive understanding of children's school readiness (Ho, Leung, & Lo, 2013). Thus, this study included both teacher's and parents' ratings on children's school readiness.

Emotional regulation

Children's emotional competence is represented by their abilities to express emotions purposefully, to understand different emotions, and to regulate emotions when needed (Campbell et al., 2016). Previous studies have examined the relationship between children's emotional regulation and their prospective academic achievement (e.g., Eisenberg et al., 2010). In general, emotional regulation in the school context refers to the processes employed in modulating how emotions are experienced and behaviorally expressed in a way that supports one's academic functioning (Eisenberg et al., 2010; Graziano et al., 2007). Emotional regulation can be measured by informant's ratings of children's proneness to have negative emotions and their strength, flexibility, and appropriateness of emotions expressed (Campbell et al., 2016). Relatedly, children's emotional regulation depends on their temperamental regulation or effortful control (Eisenberg et al., 2010; Rothbart & Bates, 2006). Effortful control represents one's temperament-based ability in regulating one's

emotional and behavioral responses including the skills to focus on stimuli, to inhibit non-adaptive responses, and to adjust behaviors according to external requirements (e.g., Fung, Chung, & Cheng, 2019; Rudasill, Hawley, LoCasale-Crouch, & Buhs, 2017). Given its fundamental role in the effective regulation of emotions, effortful control is commonly considered as a close estimate of kindergarten children's emotional regulation (Campbell et al., 2016). Children's effortful control can be assessed by the delay of gratification tasks (Eisenberg et al., 2010) that tap into their capacity in regulating emotion-driven behavioral responses (Zhou, Chen, & Main, 2012). Recent research has revealed the negative relationship between children's temptation-focused behaviors (e.g., visual attention to the temptation) in a delay of gratification task and their emotional regulation (Jahromi, Chen, Dakopolos, & Chorneau, 2019). In this study, we assessed children's emotional regulation by using a multi-method approach which included the teacher report of the child's flexibility, intensity, appropriateness, and proneness of negative emotions expressed in the classroom context as well as children's behavioral manifestation of effortful control in a delay of gratification task.

Theoretical framework of the bidirectionality between school readiness and emotional regulation

The developmental psychobiological framework of school readiness (Blair & Raver,

2015) provided the theoretical support for the bidirectional relationships between children's emotional regulation and school readiness (Posner & Rothbart, 1998; Rothbart, 2004). Under the psychobiological framework, individual differences in neural receptor sensitivity can increase one's temperamental reactivity to emotional stimuli, leading to heightened negative emotional arousal (e.g., anxiety or fear) and an additional demand on regulating such reactivity through attentional control (i.e., reactive regulation), and this additional demand on attentional control may, in turn, inhibit one's higher-order cognitive skills (e.g., executive functions) (Blair & Raver, 2015). Children showing a high tendency for reactive regulation (e.g., withdrawal and avoidance) of emotional arousal may suffer from a lower level of functioning in higher-order cognitive skills (Blair, 2002) and, therefore, reactive regulation may directly hamper school readiness. On the other hand, children showing a high propensity for emotional regulation may better regulate their reactivity to emotional stimuli through effortful cognitive processes (e.g., memory, attention, and problem solving) and put their higher-order cognitive skills to better use when needed (Blair, 2002). Therefore, emotional regulation may facilitate children's school readiness directly.

In addition to the proposed impact of children's emotional regulation on their school readiness, the developmental psychobiological framework also suggests that school readiness can influence children's neurobiological, physiological, and behavioral development (Blair, 2002). Children showing greater school readiness are more likely to develop effortful

emotional regulation than reactive regulatory skills (Blair, 2002; Blair & Raver, 2015) and there could be mediating mechanisms like expanding language skills and increasing classroom engagement that help to explain the relationship between school readiness and emotion regulation. Specifically, school readiness can support children's development in emotional regulation through their growth in language skills particularly those related to their emotional knowledge, which enables them to better understand and describe emotional states (Fung & Chung, 2019; Salmon, O'Kearney, Reese, & Fortune, 2016). Children showing greater school readiness can also build stronger positive relationships with teachers and peers as they are motivated to engage in classroom activities (Williford, Vick Whittaker, Vitiello, & Downer, 2013). Therefore, the developmental psychobiological framework of school readiness (Blair & Raver, 2015) served as the theoretical foundation supporting the bidirectionality between kindergarten children's emotional regulation and school readiness. As an initial attempt to investigate the bidirectionality based on the psychobiological framework (Blair, 2002), the present study aimed to examine the direct relationships between emotional regulation and school readiness over time without examining the possible mediating mechanisms.

The bidirectionality between emotional functioning and learning

Although there is a theoretical basis supporting the bidirectionality between children's

school readiness and emotional regulation, little is known about their reciprocal relationships across time. Nevertheless, the bidirectionality between children's emotional functioning and academic learning has received growing attention (Kwon et al., 2018). For example, a recent 5-year longitudinal study of German adolescents has demonstrated the bidirectional relationships between their achievement emotions and academic performance in mathematics (Pekrun, Lichtenfeld, Marsh, Murayama, & Goetz, 2017). Another longitudinal study of elementary students (third through six grade) from the United States has explored the bidirectional relationships between children's negative emotionality, emotional regulation, and reading achievement and the results revealed that reading achievement significantly predicted children's future negative emotionality and emotional regulation, whereas the predictive effects of negative emotionality and emotional regulation on subsequent reading achievement were indirect and mediated by children's academic engagement (Kwon et al., 2018). One study has explored the bidirectional links between positive and negative emotion expressivity and school adjustment (teacher-student conflict and closeness) in a sample of kindergarten children from the United States who were transitioning to the first grade. The findings revealed significant predictive links from school adjustment to positive and negative emotion expressivity, whereas the reverse paths were not significant (Hernández et al., 2018). However, the three studies involved participants in different developmental stages: adolescents (Pekrun et al., 2017), elementary students (Kwon et al., 2018), and

kindergarteners (Hernández et al., 2018), and the studies varied in the selected constructs particularly in the learning-related outcomes: mathematics achievement (Pekrun et al., 2017), reading achievement (Kwon et al., 2018), and school adjustment (Hernández et al., 2018). Given the theoretical basis of the psychobiological framework (Blair & Raver, 2015), a further investigation of the reciprocal relationships between kindergarten children's school readiness, which covers both academic and cognitive skills, and emotional regulation may clarify previous inconsistent findings and bring significant contribution to early intervention efforts. Therefore, this study examined the bidirectionality between emotional regulation and school readiness of Chinese kindergarten children.

The present study

In the present study, we examined the bidirectional relationships between kindergarten children's emotional regulation and school readiness before their formal schooling by using the cross-lagged panel model with two data points collected one year apart. Based on the developmental psychobiological framework of school readiness (Blair & Raver, 2015), we first hypothesized that children's emotional regulation at time 1 would positively predict their school readiness at time 2. Second, we anticipated that children's school readiness at time 1 would positively predict their emotional regulation at time 2.

Method

Participants

Participants were 523 Hong Kong children (277 boys; mean age at time 1 of 52.42 months, *SD* = 7.18 months) from nine local kindergartens as well as their teachers (18 in total) and parents (424 fathers and 463 mothers). To obtain a representative sample with different family socioeconomic backgrounds, the 18 geographic districts of Hong Kong were stratified into the high-income (US$3,718-5,128), middle-income (US$3,103-3,590), and low-income (US$2,436-2,949) geographical strata based on the district median monthly household incomes as reported by the Hong Kong Census and Statistics Department (2016) and three kindergartens from each geographical stratum were invited to participate in the study (i.e., nine kindergartens in total). Our sample consists of 149, 178, and 196 children from the low-income, middle-income, and high-income geographical stratum, respectively. Participating parents reported their educational level as a proxy of family socioeconomic status (Schmitt, Pratt, & McClelland, 2014). Children with any reported intellectual or language disability were excluded from this study. All participating children were native Cantonese speakers and they were followed up one year later with a low attrition rate of 6.1%, meaning that a sufficient number of children was obtained to test for the potential autoregressive and cross-lagged relationships among substantive variables in two successive years (Bentler & Chou, 1987). Parents reported their age and education level on a five-point scale: (1) primary, (2) secondary, (3) college, (4) university, and (5) postgraduate. Most of the

fathers (73.6%) and mothers (75.1%) were aged between 31 and 50. For education level of fathers, 36.1% of them completed secondary school, whereas 41.7% of them completed college or above. For mothers' education level, 42.1% of them completed secondary school, whereas 40.7% of them completed college or above.

Procedure

Ethical approval was obtained from the respective university before the start of the research. For participant recruitment, permission was obtained from principals of the participating kindergartens, followed by invitations to teachers. Parents of children in the participating kindergartens were then given a letter with consent form and questionnaire inviting their participation. Longitudinal data was collected at two time points separated by about 12 months, during the spring of two consecutive school years. At both time 1 and time 2, fathers and mothers reported their educational level and their child's school readiness, while teachers rated children's school readiness and emotional regulation based on their classroom observation. In addition, the same assessment task of effortful control (i.e., the delay of gratification task of wrapped gift) was individually administered at both time points by trained data collectors in a quiet area of each kindergarten.

Measures

Teacher-reported Emotional Regulation

Children's emotional regulation at both time points was assessed by the 5-item Emotional Regulation Subscale of the Chinese Preschool Socioemotional Competence Checklist (Research Team, 2019), which is a newly developed measure for assessing children's socioemotional competence. Specifically, this subscale assesses children's likeliness to experience negative emotions and their abilities to adapt to change quickly without negative emotional expression. A validation study of the Emotional Regulation Subscale was carried out on a large-scale and representative sample of 1,731 kindergarten children in Hong Kong (mean age = 55 months; 50% of them were girls) (Li, Lam, Chung, Cheung, & Leung, under review). The Subscale showed good internal consistency (Cronbach's alpha = 0.83) and criterion validity, as reflected by the positive relationship with school readiness (r = .41, p < .01) and negative relationship with problem behaviors (r = -.14, p < .01). Teachers rated each item on a 5-point scale ranging from 1 (Strongly Disagree) to 5 (Strongly agree). Reverse coding was made where appropriate, so that a higher score indicated a higher level of the construct. The five items were "Takes a long time to recover from disappointment", "Unhappy for no reason", "More sensitive to the environment compared to other children", "Becomes frustrated quickly when struggling with a task", and "Has difficulty switching from one activity to another". The Cronbach's alphas at time 1 and time 2 were 0.80 and 0.81, respectively.

Child-assessed Emotional Regulation

As a proxy of children's behavioral manifestation of emotional regulation, the wrapped gift task was used at both time 1 and time 2 for tapping their effortful control. This task has been validated and widely applied in previous studies (Brock, Rimm-Kaufmana, Nathansona, & Grimmb, 2009; Dennis, Cole, Wiggins, Cohen, & Zalewski, 2009; Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Murray & Kochanska, 2002). The child was told to wait without peeking for the experimenter to wrap a gift noisily behind her/him for 60 seconds, and s/he got the gift after the wait. The child's latency to peek (0 to 60 seconds) and peeking extent (range from 0 = peeks blatantly to 2 = no peeking) were coded. Latency and peeking extent were significantly correlated at both time points (*r*s = .78 - .82), and the scores were standardized and averaged to represent a child's effortful control at each time point.

School Readiness

Children's school readiness at both time points was assessed by the Chinese version of Gumpel Readiness Inventory (GRI), which is a validated measure of school readiness of Hong Kong kindergarten children that can be completed by parents or teachers (Ho et al., 2013). Based on the results from a local validation study (Ho et al., 2013), the GRI demonstrated good internal consistency, test-retest reliability, construct validity, concurrent validity, and unidimensionality. The GRI consists of 6 items covering children's academic (e.g., counts forwards and backwards), strategic (e.g., is able to work independently without

help from an adult), and role-governed (e.g., raises hand when s/he wants to participate) skills and the correlations among the three skills ranged from .41 to .76 (*ps* < .001). Parents and teachers rated each item on a 5-point scale ranging from 1 (Never) to 5 (Always), with a higher score representing a better endorsement of the relevant behavior. The correlations among fathers', mothers', and teachers' GRI ratings were ranged from .26 to .48 (*ps* < .001). As parents and teacher are important informants of children's school readiness (Ho et al., 2013), the ratings for academic, strategic, and role-governed skills were averaged for each rater and the three mean scores were further averaged to form a composite score to represent children's overall school readiness. The Cronbach's alphas at time 1 and time 2 were 0.85 and 0.86, respectively.

Data analysis plan

The data was examined for non-normality and missing values. Skewness and kurtosis of all study variables were within the range of +/-1.10. The percentages of missing data ranged from 0 to 19% for all study variables and the pattern of missing data was completely at random as revealed by non-significant Little's (1998) test value (χ^2 (362) = 330.48, p = .88). Given the fraction of missing data was well below 0.3, the missing data was handled by multiple imputation using the mice (i.e., multivariate imputation by Chained Equations version 3.4.0) package in R (version 3.5.0; R Core Team, 2018) with 100 between-imputation

iterations to generate 20 imputed datasets (Graham, Olchowski, & Gilreath, 2007). Children were also nested within 18 classrooms from the nine participating kindergartens and the intraclass correlations of their school readiness and emotional regulation at the classroom level ranged from 0.11 to 0.15. Being conservative, the lavaan survey package was employed to account for the nonindependence of teachers' ratings on children's school readiness and emotional regulation by using children's classroom index as the cluster identifiers (Oberski, 2014). The 20 imputed datasets were pooled to generate point and variance estimates basing on the standard Rubin (1987) formula and the maximum likelihood estimation with robust standard errors (i.e., MLM estimator) was used to estimate the model fit (Oberski, 2014).

Two series of autoregressive cross-lagged path analytic models, with either teacher-reported or child-assessed emotional regulation, were tested with the lavaan package (version 0.6-1) in R (version 3.5.0; R Core Team, 2018) to serve as triangulation of results. The autoregressive paths represented the relationship between school readiness at time 1 and time 2 as well as the relationship between emotional regulation at time 1 and time 2. The cross-lagged paths, which were of primary interest, represented the relationship between emotional regulation at time 1 and school readiness at time 2 as well as the relationship between school readiness at time 1 and emotional regulation at time 2.

In each series of analysis, four conditional models were examined to determine which

one best represented the relationships among children's school readiness and emotional regulation across the two time points (Figure 1). First, the no-coupling model (model 1) only included the autoregressive paths of school readiness and emotional regulation and their concurrent relationships. Then, the two cross-lagged paths were tested that examined whether emotional regulation at time 1 predicted school readiness at time 2 (model 2, regulation-driven model), and whether school readiness at time 1 predicted emotional regulation at time 2 (model 3, readiness-driven model), with the autoregressive paths statistically controlled. Finally, the reciprocal model (model 4) included both cross-lagged paths and examined the bidirectionality of school readiness and emotional regulation across the two time points. Model fit was compared across the four competing models by using the Satorra–Bentler Scaled Chi-square difference tests (Satorra & Bentler, 2010), and the best-fitting model was selected. A significant χ^2 difference between model 1 and model 2 or 3 would indicate that the corresponding cross-lagged path explained unique variance beyond the autoregressive paths, whereas a significant χ^2 difference between model 4 and model 2 or 3 would indicate that the bidirectional model provided a better fit to the data than the corresponding unidirectional model. Additionally, the comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) were also compared, with CFI and NNFI values above .95 and RMSEA and SRMR values below .05 indicating a good model fit (Hu & Bentler, 1999).

Results

Preliminary analyses

Table 1 shows the descriptive statistics for the study variables and the bivariate correlations among the study variables. Children's school readiness at time 1 and time 2 were positively associated with their teacher-reported (r = .27 to .38, p < .01) and child-assessed (r = .21 to .26, p < .01) emotional regulation. However, teacher-reported emotional regulation at time 1 and time 2 was positively related to child-assessed emotional regulation at time 1 (r = .16, p < .01) only. For demographic variables, child age was positively correlated to school readiness, teacher-reported emotional regulation, and child-assessed emotional regulation (r = .12 to .33, p < .01). Mother's education level was positively related to school readiness at both time points (r = .19 to .31, p < .01) but to teacher-reported (r = .12, p < .05) and child-assessed (r = .15, p < .01) emotional regulation at time 1 only, whereas father's education level was positively associated with school readiness at time 1 only (r = .19, p < .01). Since the geographical strata code (i.e., low-income = 0, middle-income = 1, and high-income = 2) was not significantly associated with the remaining variables except father's (r = .42, p < .01) and mother's (r = .40, p < .01) educational levels, only child's age, sex, and father's and mother's educational levels were added as covariates of school readiness and emotional regulation at both time points in the cross-lagged analyses.

Autoregressive cross-lagged models with teacher-reported emotional regulation

Satorra–Bentler Scaled Chi-square differences and fit indices of the four models with teacher-reported emotional regulation are shown in Table 2. The χ^2 difference between the no-coupling (model 1a) and regulation-driven (model 2a) models was non-significant ($\Delta\chi^2$ (1) = 1.84, *ns*) whereas the one between the no-coupling and readiness-driven (model 3a) models was significant ($\Delta\chi^2$ (1) = 6.00, $p < .05$), suggesting that only school readiness at time 1 predicted teacher-reported emotional regulation at time 2 beyond the stability coefficients. Moreover, the χ^2 difference between the reciprocal (model 4a) and regulation-driven models was significant ($\Delta\chi^2$ (1) = 5.74, $p < .05$) whereas the one between the reciprocal and readiness-driven models was non-significant ($\Delta\chi^2$ (1) = 1.67, *ns*), confirming that only the readiness-driven cross-lagged path was statistically significant. Therefore, the readiness-driven model was selected as the best-fitting model (χ^2 (5, $N = 523$) = 6.74, $p = .241$, CFI = 1.00, NNFI = 0.99, RMSEA = 0.03 (90% CI = .00, .07), SRMR = 0.01). Figure 2 shows that, under the readiness-driven model, teacher-reported emotional regulation was positively related to school readiness at both time 1 ($r = .35$, $p < .001$) and time 2 ($r = .15$, $p < .05$). The autoregressive paths of school readiness ($\beta = .58$, $SE = .05$, $p < .001$) and teacher-reported emotional regulation ($\beta = .30$, $SE = .07$, $p < .001$) were both significant. Furthermore, the readiness-driven cross-lagged path was significant ($\beta = .13$, $SE = .08$, $p < .05$).

Autoregressive cross-lagged models with child-assessed emotional regulation

Satorra–Bentler Scaled Chi-square differences and fit indices of the four models with child-assessed emotional regulation are shown in Table 3. The χ^2 difference between the no-coupling (model 1b) and regulation-driven (model 2b) models was non-significant ($\Delta\chi^2$ (1) = 2.65, *ns*) whereas the one between the no-coupling and readiness-driven (model 3b) models was significant ($\Delta\chi^2$ (1) = 6.37, $p < .05$), suggesting that only school readiness at time 1 significantly predicted child-assessed emotional regulation at time 2 beyond the stability coefficients. Similarly, the χ^2 difference between the reciprocal (model 4b) and regulation-driven models was significant ($\Delta\chi^2$ (1) = 6.24, $p < .05$) whereas the one between the reciprocal and readiness-driven models was non-significant ($\Delta\chi^2$ (1) = 2.57, *ns*), confirming that only the readiness-driven cross-lagged path was statistically significant. Therefore, the readiness-driven model was selected as the best-fitting model (χ^2 (5, N = 523) = 8.19, p = .146, CFI = 0.99, NNFI = 0.97, RMSEA = 0.04 (90% CI = .00, .08), SRMR = 0.01). Figure 3 shows that, under the readiness-driven model, the positive relationship between child-assessed emotional regulation and school readiness was significant at time 1 (r = .12, $p < .01$) and approached significant at time 2 (r = .09, p = .052). The autoregressive paths of school readiness (β = .58, SE = .05, $p < .001$) and child-assessed emotional regulation (β = .15, SE = .03, $p < .01$) were both significant. Furthermore, the readiness-driven cross-lagged path was significant (β = .14, SE = .10, $p < .01$).

Discussion

Based on the developmental psychobiological framework of school readiness (Blair & Raver, 2015), this study investigated the bidirectionality of school readiness and teacher-reported and child-assessed emotional regulation of a sample of Chinese kindergarten children by using the autoregressive cross-lagged models across two time points. We expected to find reciprocal relationships between children's school readiness and emotional regulation as reported by teachers or as demonstrated through children's effortful control in a delay of gratification task. The results indicated that children's school readiness was consistently predictive of their future teacher-reported and child-assessed emotional regulation, which concurred with the second hypothesis. However, contrary to previous findings (e.g., Eisenberg et al., 2010; Graziano et al., 2007) and the first hypothesis, the results revealed that neither teacher-reported nor child-assessed emotional regulation was predictive of children's prospective school readiness. The present study extended the previous research (e.g., Kwon et al., 2018; Pekrun et al., 2017) by yielding supportive evidence for the plausible directional association between early school readiness and subsequent emotional regulation.

The results showed the significant concurrent associations among school readiness, teacher-reported and child-assessed emotional regulation. Research indicated a positive link

between children's school readiness and emotional regulation (Eisenberg et al., 2010) and the emphasis on children's social and emotional strengths was also suggested as an alternative view on their problem behaviors through the lens of competence and resilience (Campbell et al., 2016). These results are consistent with teachers' views that children's emotional skills are involved in their daily learning processes through the development of harmonious student-teacher relationships and a structured and supportive classroom environment (Blair & Raver, 2015).

Although the findings did not support the bidirectionality in emotional regulation and school readiness, they suggested that children's school readiness was a significant predictor of their emotional regulation one year later. As demographic variables and prior levels of school readiness and emotional regulation were controlled, the coefficients of the readiness-driven cross-lagged paths can reasonably be regarded as the effect of school readiness on subsequent emotional regulation. Even though the effects of the cross-lagged paths were modest, they are in accordance with previous studies in relation to emotional functioning and academic learning (e.g., Kwon et al., 2018; Pekrun et al., 2017). Given that both school readiness and emotional regulation demonstrated considerable stability over time, there may exist little variance to be explained by additional variables (Pekrun et al., 2017). Nonetheless, these findings suggest that school readiness may contribute to the development of emotional regulation across time, which aligns with the contention that school readiness may exert

impact on various developmental processes (Blair, 2002).

Cross-lagged path from emotional regulation to school readiness

The present findings suggested that children's teacher-reported and child-assessed emotional regulation were not predictive of their school readiness at one year later with previous levels of school readiness controlled. The results somewhat deviated from prior studies showing the facilitative role of emotional regulation in children's school readiness (e.g., Eisenberg et al., 2010; Graziano et al., 2007). Nevertheless, the results are in line with two recent longitudinal studies examining the reciprocal relationships between emotional functioning and academic learning (Hernández et al., 2018; Kwon et al., 2018). Specifically, results from Hernández et al. (2018) demonstrated that teacher-student conflict in kindergarten was positively related to negative emotion expressivity in first grade and that school engagement in kindergarten was positively associated with positive emotion expressivity in first grade, but the reverse links did not reach the level of statistical significance. Similarly, results from Kwon et al. (2018) revealed that elementary students' reading achievement was predictive of their subsequent emotional regulation whereas the reverse link was non-significant. Taken together, it may be that the contribution from children's readiness in academic learning to their emotional functioning is relatively stronger than the reverse relation, especially among kindergarten children. However, the present

findings also revealed that the longitudinal stability of school readiness is much stronger than that of the teacher-reported or child-assessed emotional regulation. It is possible that the strong relationship between school readiness across the two time points may lead to an insufficient amount of variance left over for emotional regulation to predict. To examine the robustness of this finding, future work may investigate the bidirectionality between kindergarten children's school readiness and emotional regulation by using different operationalization of school readiness.

Another possible reason for the lack of direct association from emotional regulation to school readiness could be the involvement of a potential factor which fully mediated the relationship (Kwon et al., 2018). Emotional regulation may influence children's school readiness indirectly through the mechanism of adaptive behavioral control in the classroom (Graziano et al., 2007). For example, the relationship between preschool emotional regulation and kindergarten academic achievement was found to be mediated by children's behavioral control in the kindergarten classroom (Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003). Alternatively, emotional regulation may facilitate children's school readiness through the degree of closeness of the student-teacher relationship. In particular, children with better emotional regulation are likely to develop positive student-teacher bonding which is predictive of their attention and engagement in classroom activities (Blair & Raver, 2015). Further studies may be conducted to examine the role of emotional regulation in school

readiness by considering children's behavioral control and student-teacher bonding as potential mediators.

Cross-lagged path from school readiness to emotional regulation

Of specific importance is the finding that kindergarten children's school readiness was predictive of their later emotional regulation estimated through informant report and child assessment. Previous research has chiefly focused on the role of children's emotional functioning in their learning and achievement, while less attention has been paid to explore how children's readiness for school might influence their emotional functioning (Kwon et al., 2018). The present findings extend and contribute to our understanding of the developmental precedents of children's emotional regulation. Particularly, it seems that readiness for school can strengthen children's capacities in regulating emotion over time.

Classroom experience prior to school entry may shape children's emotional regulation, as such experience can familiarize children with the classroom setting, preparing their self-regulatory capacity toward school readiness (Blair, 2002). Based on the psychobiological framework (Blair & Raver, 2015), children who are more ready for school demonstrate better higher-order cognitive and academic skills that enable them to switch between various activities and adapt to different classroom settings successfully. These children may experience lower levels of negative emotional arousal (e.g., fear or anxiety), while they are

engaging in different activities and, therefore, they can exhibit better emotional regulation. Possibly, the positive classroom experience may reinforce children's further effort in regulating their emotion in the school context.

Alternatively, children who are ready for school engage their teachers and peers in emotionally stabilizing manners, which in turn elicits emotionally stabilizing socialization experience from these interaction partners—a reciprocal pattern that builds the foundation for longer term emotional regulation for children (Blair, 2002). Particularly, children showing higher school readiness can show higher engagement in class activities that foster their emotional regulation through the positive and supportive interactions with teachers and peers (Williford et al., 2013), which is consistent with the Vygotsky's (1978) perspective. Furthermore, consistent with Vygotsky's framework, children with advanced school readiness can develop better language skills such as vocabulary knowledge (Salmon et al., 2016), which is supportive of their understanding of personal emotional states (e.g., Beck, Kumschick, Eid, & Klann-Delius, 2012; Nelson, 2007; Salmon et al., 2013). Advanced language skills may also help kindergarten children to internalize teacher's requests and strategies in regulating emotions (Vygotsky, Hanfmann, & Vakar, 1962). As this study investigated the developmental relationships between emotional regulation and school readiness, further study is needed to examine the mediating mechanisms to expand our knowledge in the longitudinal link between school readiness and emotional regulation.

Limitations and future directions

The strength of this study is the use of longitudinal data which provides a better understanding of the development in kindergarten children's emotional regulation and school readiness. However, several limitations should be taken into account when interpreting the findings and these limitations can be used to suggest directions for future studies.

First, although it used longitudinal data in examining the relationships between children's emotional regulation and school readiness across time and controlled for multiple covariates and autoregressive effects, this study was correlational in nature and no causal inference could be drawn from its findings. Moreover, the present findings may be due to other variables that are not included. Therefore, future research using multi-wave longitudinal or experimental design should be conducted to verify the results.

Second, as participants are Chinese kindergarten children in Hong Kong, the generalizability of the findings to children in other cultures remains an open question. Further studies are needed to examine whether such a pattern of relationships can be obtained in other Asian and Western countries and to explore if a predictive relationship exists between school readiness and other aspects of emotional competence such as emotional expressivity and emotion understanding.

Third, this study assessed children's emotional regulation with an informant-report

measure (i.e., teacher) and a child-assessed task (i.e., effortful control). Although comparable patterns of relationships were obtained from the two models, the effortful control measure may not be a "direct enough" assessment of children's behavioral manifestation of emotional regulation (Campbell et al., 2016), as reflected by its low to non-significant correlations with teacher-reported emotional regulation. However, in view of the lack of a valid observation tool for tapping kindergarten children's emotional regulation (Campbell et al., 2016), the utilization of the effortful control measure as an estimate is, at least, justified. Nevertheless, it pointed to the need to develop effective tools in measuring children's behavioral indicators of emotional regulation. Furthermore, replication studies with multiple measures of emotional regulation are needed to test the robustness of the findings.

Fourth, this study operationalized children's school readiness as their academic skills and cognitive skills (i.e., GRI's academic, strategic, and role-governed skills). Different patterns of relationships might be obtained by tapping children's school readiness with other measures (e.g., performance on standardized assessments of language, literacy, and mathematics) and further study is needed to verify the present findings.

Finally, as noted in the discussion, the main purpose of this study is to test the bidirectionality between emotional regulation and school readiness and we did not examine the mediating mechanisms underlying the observed links. Emotional regulation may promote

school readiness through improved behavioral control (Howse et al., 2003) and student-teacher relationship (Blair & Raver, 2015) whereas school readiness can foster emotional regulation via positive motivation (Vygotsky et al., 1962) and engagement (Williford et al., 2013). Additional research is needed to understand how the cognitive and motivational processes could mediate the links between school readiness and emotional regulation.

Conclusions and implications

Despite these limitations, the present study provides theoretical insights by showing the predictive link between school readiness and emotional regulation of Hong Kong kindergarten children. Specifically, the results provide strong empirical support for school readiness as a preceding indicator of emotional regulation. Practically speaking, the results suggest the utility of supporting kindergarten children's readiness for school to foster their future emotional regulation. Given the importance of higher-order cognitive skills (e.g., executive functions) in kindergarten children's school readiness (Blair & Raver, 2015) and the malleability of executive functions (Diamond, 2013), parents and teachers may use games like "Simon Says" and "Red Light, Purple Light" to support children's readiness for school (Tominey & McClelland, 2011). Intervention targeting children's emotional regulation may incorporate some games that train up children's higher-order cognitive skills in their daily class activities.

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

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

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

Data Availability Statement: Research data are not shared.

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Table 1

Descriptive statistics and bivariate correlations among study variables

			Correlations								
Variables	*M*	*SD*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. T1 School Readiness	3.56	.47	--								
2. T2 School Readiness	3.75	.51	.62**	--							
3. T1 Teacher-reported Emotional Regulation	3.60	.68	.38**	.31**	--						
4. T2 Teacher-reported Emotional Regulation	3.91	.69	.27**	.30**	.37**	--					
5. T1 Child-assessed Emotional Regulation	.02	.94	.22**	.26**	.16**	.16**	--				
6. T2 Child-assessed Emotional Regulation	.00	.94	.21**	.23**	.08	.08	.21**	--			
7. Child Age in Months	52.42	7.18	.33**	.31**	.12**	.14**	.18**	.13**	--		
8. Mother's Education Level	2.81	1.10	.31**	.19**	.12*	.01	.15**	.03	-.04	--	
9. Father's Education Level	2.94	1.15	.19**	.09	.01	-.03	.06	-.02	-.06	.66**	--
10. Geographical Strata Code	--	--	.09	.08	.00	.04	.05	.02	.02	.40**	.42**

Note. *M* = mean; *SD* = standard deviation;

* $p < .05$; ** $p < .01$.

Table 2

Model Fit Results with Teacher-reported Emotional Regulation

Model	χ^2 (*df*)	CFI	NNFI	RMSEA (90% CI)	SRMR	Satorra–Bentler Scaled $\Delta\chi^2$ (*df*)
1a. No-coupling	13.59 (6)	0.99	0.95	0.05 (.01, .08)	0.02	
2a. Regulation-driven (TER => SR)	7.90 (5)	0.99	0.98	0.03 (.00, .08)	0.01	
Model 1a vs Model 2a						1.84 (1)
3a. Readiness-driven (SR => TER)	6.74 (5)	1.00	0.99	0.03 (.00, .07)	0.01	
Model 1a vs Model 3a						6.00 (1)*
4a. Reciprocal	1.67 (4)	1.00	1.02	0.00 (.00, .04)	0.00	
Model 4a vs Model 2a						5.74 (1)*
Model 4a vs Model 3a						1.67 (1)

Note. These models controlled for child age, sex, and father's and mother's educational levels. CFI = comparative fit index; NNFI = non-normed fit index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual; TER = teacher-reported emotional regulation; SR = school readiness.

* $p < .05$.

Table 3

Model Fit Results with Child-assessed Emotional Regulation

Model	χ^2 (*df*)	CFI	NNFI	RMSEA (90% CI)	SRMR	Satorra–Bentler Scaled $\Delta\chi^2$ (*df*)
1b. No-coupling	16.48 (6)	0.98	0.91	0.06 (.03, .09)	0.02	
2b. Regulation-driven (CER => SR)	10.68 (5)	0.99	0.94	0.05 (.00, .09)	0.02	
Model 1b vs Model 2b						2.65 (1)
3b. Readiness-driven (SR => CER)	8.19 (5)	0.99	0.97	0.04 (.00, .08)	0.01	
Model 1b vs Model 3b						6.37 (1)*
4b. Reciprocal	2.55 (4)	1.00	1.02	0.00 (.00, .05)	0.00	
Model 4b vs Model 2b						6.24 (1)*
Model 4b vs Model 3b						2.57 (1)

Note. These models controlled for child age, sex, and father's and mother's educational levels. CFI = comparative fit index; NNFI = non-normed fit index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual; CER = child-assessed emotional regulation; SR = school readiness.

* $p < .05$.

Figure Legends

Figure 1. Four conditional models tested in the autoregressive cross-lagged path analyses: (a) no-coupling model, (b) regulation-driven model, (c) readiness-driven model, and (d) reciprocal model. T1 = time 1; T2 = time 2.

Figure 2. School readiness-driven model with teacher-reported emotional regulation controlling for child age, sex, and father's and mother's educational levels at each time points. Standardized coefficients are reported. T1 = time 1; T2 = time 2.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Figure 3. School readiness-driven model with child-assessed emotional regulation controlling for child age, sex, and father's and mother's educational levels at each time points. Standardized coefficients are reported. T1 = time 1; T2 = time 2.

† $p = .052$; * $p < .05$; ** $p < .01$; *** $p < .001$.