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Department of Education
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M.Sc. Dissertation

Examining the characteristics of behavioural, cognitive and emotional aspects of self-regulation and their associations with academic achievement among Chinese preschool children

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Abstract

Self-regulation is an important determinant of children's concurrent and long-term developmental outcomes. In recent decades, research has consistently provided robust evidence regarding its associations with academic achievements. However, less or even no research has attempted to explore different aspects of self-regulation (including behavioural, cognitive and emotional) in a single study. The current study aimed to provide a comprehensive profile of a sample of Chinese children's behavioural, cognitive and emotional self-regulation by investigating their characteristics in relation to gender and age, examining their associations with numeracy and literacy outcomes, and testing the moderating effects of age and gender on these associations. Results showed that girls outperformed boys in behavioural and emotional self-regulation, while these advantages only emerged at later stages during preschool. Although K2 children were older than K1 children, they failed to show any advantages on behavioural and emotional self-regulation. A closer inspection revealed different developmental trajectories of girls' and boys' self-regulation. Moreover, all aspects of self-regulation uniquely and significantly contributed to Chinese children's numeracy and literacy scores. Neither age nor gender moderated these associations. Chinese children's characteristics of self-regulation in terms of gender differences and developmental patterns were discussed in the context of the wider literature. The findings also emphasised the significance of self-regulation in preschoolers' academic outcomes. Implications and limitations of the current study were discussed.

List of Abbreviations

EF	*Executive function*
HTKS	*Head-Toes-Knees-Shoulders task*
Tools	*Tools of the Mind (Bodrova & Leong, 1996)*
CSBQ	*Child Self-Regulation and Behavioural Questionnaire (Howard & Melhuish,2017)*
IDELA	*International Development Early Learning Assessment (Save the Children, 2011)*
K-S	*Kolmogorov-Smirnov test*
S-W	*Shapiro-Wilk*
ANOVA	*Analysis of Variance*
BehSR	*Behavioural Self-Regulation*
CogSR	*Cognitive Self-Regulation*
EmoSR	*Emotional Self-Regulation*

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1. Introduction

Parents and educators have constantly endeavoured to foster children's development and maximise their developmental outcomes effectively. It is widely evidenced that physical and mental health, educational and occupational attainment, and social functioning are largely rooted in one's early stages of life (Robson et al., 2020). In other words, later personal, social and cognitive functioning are rooted as early as in childhood (Howard & Melhuish, 2017; Wolf & McCoy, 2019), suggesting that early childhood is a critical stage for children's both concurrent and long-term development. Therefore, it provides parents and educators a great opportunity to effectively foster children's developmental outcomes. Particularly, children's self-regulation that refers to the capacity to control their behaviours, thoughts and emotions, has been consistently considered to be a foundational determinant of early childhood outcomes with the great potential to affect children's life-long trajectories (Blair & Raver, 2015; Howard & Melhuish, 2017; Pandey et al., 2018).

Self-regulation has a rapid development during the first five years of children (Blair, 2002; Howard & Melhuish, 2017; Slot et al., 2017) and is predictive of a broad range of developmental outcomes, such as academic achievement (Allan et al., 2014; Horn & Packard, 1985; Lenes et al., 2020; McClelland et al., 2007; Ponitz et al., 2009; Robson et al., 2020), educational achievement (Blair & Diamond, 2008) and social competencies (Kochanska et al., 2000; Robson et al., 2020). Although the significance of self-regulation is widely accepted, most studies have failed to provide a comprehensive profile of it. In other words, self-regulation can take place in several forms including behavioural, cognitive and emotional, while the majority of research fails to incorporate all of the three forms. This argument will be elaborated in the following Section 2.1. Therefore, given the absence of empirical research exploring different

forms of self-regulation, there is still ambiguity regarding the characteristics and roles of these forms of self-regulation. For example, it remains possible that one particular aspect of self-regulation is highly predictive of later outcomes while another aspect has less or even no predictive power.

By recruiting children from mainland China, the current study aims to provide a comprehensive profile of Chinese children's self-regulation. Given that fewer studies have explored Chinese children's either a single construct or multiple constructs of self-regulation, China may serve as an interesting research country. Furthermore, due to the unique Chinese cultural values and norms (for a detailed discussion, see the following Section 2.4.), there might also be a different picture of Chinese children's self-regulation compared with Western children. Therefore, the study will attempt to investigate gender differences in and developmental patterns of Chinese preschoolers' behavioural, cognitive and emotional self-regulation, and examine their associations with numeracy as well as literacy performance.

This dissertation is structured as follows:

- The second chapter reviews the literature regarding self-regulation. Specifically, it critically discusses the definitions and theoretical frameworks of self-regulation. The associations between self-regulation and academic achievement are highlighted. It also discusses how self-regulation is placed under the Chinese society with a comparison between the Western and Chinese early childhood curriculum fostering self-regulation. Gaps in the extant literature and the current research questions are presented at the end of this chapter.
- The third chapter presents the methodological approach of the current study. As a secondary data analysis, this chapter describes the original database and inclusion

criteria for the sample. The advantages and drawbacks of secondary data analysis are discussed. It also critically reviews existing tools of measuring children's self-regulation, leading to the description of the measure adopted by the current study. Ethical considerations and an analysis plan are presented at the end of this chapter.

- The fourth chapter describes the results of this study based on different statistical tests.
- The fifth chapter discusses the interpretations of the results in the context of the wider discussion regarding the characteristics of different types of self-regulation and their associations with academic performance.
- Limitations of the current study are outlined in the concluding chapter. Implications as and suggestions for future research are demonstrated.

2. Literature Review

This chapter reviews the literature regarding self-regulation and outlines the rationale as well as research questions. Specifically, it will discuss the definitions and theoretical framework of self-regulation and summarise empirical evidence regarding the associations between self-regulation and academic outcomes. It will then discuss self-regulation in the Chinese cultural context. Research gaps in the extant literature and the aims and research questions of this study will be presented at the end of this chapter.

2.1. Definition of Self-Regulation

The study of children's self-regulation has a long history and it is a popular research area (Burman et al., 2015; Hofmann et al., 2012; Howard et al., 2020). However, researchers have attempted to conceptualise and understanding self-regulation from varied perspectives. Burman et al.'s (2015) network map analysis of the literature regarding self-regulation reveals more than 400 different uses of this term which could be integrated into 88 closely related concepts and six broad conceptual clusters. When reviewing the definitions of self-regulation, it is generally accepted that self-regulation is a complex and multidimensional construct regarding one's ability to regulate his or her behaviours, thoughts and emotions (Baumeister & Heatherton, 1996; Blair, 2002; Dan, 2016; Hubert et al., 2017; Jahromi & Stifter, 2008; McClelland et al., 2007, 2010; Montroy et al., 2016; Schunk & Zimmerman, 1997; von Suchodoletz et al., 2013).

Although the characteristic of multidimensionality is generally accepted, there is still less agreement on the constructs of self-regulation, making it difficult to conceptualise and therefore, leading to discrepant results (Burman et al., 2015; Edossa et al., 2017; Hubert et al., 2017). Several researchers have defined self-regulation as a kind of goal-directed behaviours (Hofmann et al., 2012) or as an attempt to regulate the quality and sequence of behaviours in task settings

(Howse et al., 2003) from a behavioural or consequentialist perspective. They argue that the ability to control behaviours is of utmost importance, while both cognitive and emotional regulation abilities are served for regulating behaviours (Dan, 2016; Hofmann et al., 2012). Moreover, it seems that several researchers fail to dissociate the behavioural and cognitive processes involved in self-regulated attempts, e.g., Day et al. (2015), McClelland et al. (2007), Ponitz et al. (2008, 2009), von Suchodoletz et al. (2013) and Weis et al. (2013). They have attempted to define behavioural self-regulation as the execution and manifestation of cognitive self-regulation (including working memory, inhibitory control and cognitive flexibility) in overt behaviour (McClelland et al., 2007; Morrison et al., 2010; Wanless et al., 2011b). Measures tapping into behavioural and cognitive dimensions of self-regulation are also often interchangeable (e.g., the Head-Toes-Knees-Shoulders task; for a detailed discussion, see Section 3.3.1 Background of Self-Regulation Measures). Arguably, such approaches to understanding self-regulation are somewhat narrow and overlook the unique cognitive and emotional contributions to the self-regulation process. For example, cognitive self-regulation allows individuals to eliminate task-irrelevant information in mind, resist distraction and impulses during goal attainment, and flexibly switch between different tasks and mental operations (Howard et al., 2020; Howard & Melhuish, 2017). These cognitive abilities can be bundled as executive functions (EFs). Hofmann et al. (2012) highlight that self-regulation and EFs are closely linked by stating that the major aspects of EFs may support the mechanisms through which an individual pursues self-regulatory goals. Further, EFs, which are typically considered to be a cold cognitive concept, may be influenced by the regulation of hot processes, such as, redundant emotional experiences (Morasch & Bell, 2011; Sheese et al., 2008; Willoughby et al., 2011). Moreover, based on Blair and Ursache's (2011) bidirectional model of EFs and self-

regulation, Hubert et al. (2017) and Zelazo and Carlson (2012) propose that self-regulation has two interconnected levels: EFs play a top-down role; from a bottom-up perspective, EFs depend on the ability to control emotional reactivity. They and other researchers, for example, Kerr and Zelazo (2004) and Willoughby et al. (2011), further refer to cognitive regulation as cold self-regulation and emotional regulation as hot self-regulation for EFs.

Although it seems that what the present study has argued for is the independence of the dimensions of self-regulation, we have only tried to dissociate them on a conceptual level, while their functions are reciprocally interrelated to a larger extent (Calkins, 2007; Calkins & Howse, 2004; Carver & Scheier, 1982; Montroy et al., 2016; Powers, 1973). Brain research has provided evidence that dysfunctions of the frontal lobe are associated with inhibitory deficits in action, cognition and emotion, indicating that there seems to be a common structure governing these processes (Jahromi & Stifter, 2008). Therefore, children who are predisposed to anger (i.e., poor emotional self-regulation) would be expected to be prone to adjustment and cognitive problems, and therefore classroom behaviours and academic performance, although the degree to which this is true depends on the cooperation of multiple self-regulated processes across levels of function (Blair, 2002; Kopp, 1989; Montroy et al., 2016). For a detailed discussion of the interplay between different dimensions of self-regulation see Section 2.3. Self-Regulation and Academic Achievement.

In addition to the ability to control behaviours, thoughts and emotions, several researchers (e.g., Howard et al., 2020; Howard & Melhuish, 2017) attempt to complement this definition by adding that “the ability to override impulses and urges even when they run contrary to proximal or distal goals”. Such ability is commonly used to define the term self-control (Hofmann et al., 2012). Although these two terms are often used interchangeably in literature

(Duckworth & Kern, 2011), it is more accurate to consider self-control as a subdimensions of self-regulation. Since the conception of self-control overlaps somewhat with the conception of cognitive self-regulation that refers to the ability to inhibit distraction and impulses when pursuing a goal. However, Robson et al. (2020) suggest that a control-focused conceptualisation of self-regulation is the one that most commonly adopted by parents and educators. Accordingly, the present study considers self-regulation as the ability to control dominant impulses to regulate behaviours, thoughts and emotions. This definition has reflected behavioural, cognitive and emotional contributions to the self-regulation process.

2.2. Theoretical Framework of Self-Regulation

2.2.1. The Control Theory and the Feedback Loop Model

Carver and colleagues' (1979, 1982) control theory is a prominent approach to understanding self-regulating systems from the perspective of self-control (Baumeister & Heatherton, 1996; Robson et al., 2020). The basic unit of this theory is the negative feedback loop in which individuals compare current with reference states to negate and reduce sensed deviations (Carver & Scheier, 1982). The underlying mechanism of this self-regulation model is reducing perceived discrepancies between the existing and desired states. According to Carver and Scheier (1982), when a discrepancy is perceived, behaviours are initiated to reduce the discrepancy. While the behaviour does not address the discrepancy directly, it impacts the system's environment. Such impact creates a change in the present state, which in turn is compared again with the desired state. If the discrepancy remains, the loop will continue; while if the discrepancy has been successfully solved, the loop will be exited (Robson et al., 2020). These processes thus constitute a closed-loop of test-operate-test until the present condition is matched with the desired condition. Carver and Scheier (1982) also emphasised that the central

function of this feedback-loop model is not to create behaviours but to create and keep the perception of the desired state.

Based on this model, Baumeister and Heatherton (1996) suggested three possible underlying mechanisms for a failed self-regulatory attempt. Firstly, without having a clear and consistent standard of the desired states, self-regulation will be hindered. In other words, a lack of standards or a dilemma of conflicting and inappropriate standards can impede self-regulation. The second mechanism regards monitoring. As the central stage of the feedback-loop model is to compare the present with desired states, individuals must keep close track of their actions and states. Therefore, monitoring is essential for people to self-regulate successfully. When they stop monitoring themselves, they are more likely to lose control. Baumeister and Heatherton (1996) illustrated that alcohol assumption tends to result in a self-regulatory failure, as it reduces attentional abilities and therefore, people will be less able or willing to monitor themselves (Hull, 1981). The third mechanism is quite simple. Although individuals have clear and appropriate standards and are able to monitor their states, they may just be unable to bring about the desired change. Baumeister and Heatherton (1996) proposed that the process in which individuals actually function or do not function to bring about the desired change depends on whether one internal process is overriding another. Considering the process of self-regulation in which a response or an impulse is stimulated by latent motivations and activating stimuli, the aim of self-regulation is to interrupt that impulse and prevent it from running to its typical outcomes. As impulses are often automatically generated and beyond one's volitional control, the focus of self-regulation is to override the usual consequence of an impulse instead of preventing the impulse from occurring. Typical failed self-regulatory attempts can be identified in two distinct forms: under-regulation and misregulation. Under-regulation represents that individuals fail to change

the response to that which brings the best outcomes and misregulation means individuals have made an effort but that does not bring about the best outcomes (Lakes & Hoyt, 2004). Consequently, in order to achieve successful self-regulation, Baumeister and Heatherton (1996) suggested that individuals must have a clear and appropriate standard, a sufficient capacity to overcome impulses, and sustained motivation to reduce the discrepancy between the present and desired states.

2.2.2. The Strength Model of Self-Regulation

An expansion of the feedback-loop model is the strength model of self-regulation (Baumeister et al., 2018; Baumeister & Heatherton, 1996; Baumeister & Vohs, 2016). Essentially, the strength model proposes that impulses vary with strength, in which weaker impulses are easier to control and stifle, while greater efforts are necessary to stifle stronger impulses. Therefore, unsuccessful self-regulation or under-regulation probably results from the inadequacy of one's strength to override impulses. A more promising implication of the strength model is that the model considers self-regulation as a limited resource or energy that depletes with use and replenishes with rest or glucose intake (Barutchu et al., 2013; Baumeister & Heatherton, 1996; Robson et al., 2020). Baumeister et al. (2018) have attempted to distinguish the concept of energy and motivation involved in the strength model of self-regulation. Energy refers to resources consuming in effortful activities, while motivation is the willingness to participate in effortful activities. Although the model recognised both conceptions, the focus is on the consumption of limited energy in the self-regulatory process. Individuals may become exhausted from many simultaneous demands (e.g., dieting while quitting smoking) and will sometimes fail at all of these tasks (Baumeister et al., 2018). Based on the strength model, such failure is attributed to the temporarily depleted strength of self-regulation (i.e., energy depletion;

Baumeister & Heatherton, 1996). It has also been evidenced that the performance on a self-regulation task will be repaired if it is preceded by another task demanding self-regulatory ability, even these tasks are not associated (Baumeister et al., 2006; Hofmann et al., 2012; Muraven et al., 1998; Muraven & Baumeister, 2000; Vohs & Heatherton, 2000). Moreover, the capacity for self-regulation is more likely to be momentarily impaired when people are under stress (Glass et al., 1969; Muraven & Baumeister, 2000) and late in the evening (Baumeister & Heatherton, 1996). Energy depletion might be beneficial for explaining these facts, in which energy operates as brain fuel and therefore, after consuming some, there will be insufficient energy left to do any more causing the ego depletion effect (Baumeister et al., 2018; Muraven & Baumeister, 2000). However, this explanation has been widely criticised by studies. According to the idea of conservation, Muraven et al. (2006) suggest that the body tends to preserve the remaining energy after some has been consumed, and individuals can still perform well when they get sufficiently motivated. Also, Inzlicht and Schmeichel (2012) argue that ego depletion can be explained by the changes in motivational priorities when performing several consecutive self-control tasks. However, these arguments have been less evidenced (Baumeister & Vohs, 2016). Despite these plausible challenges, the feedback-loop model and strength model have provided robust evidence that self-regulation operates across a broad range of domains and researchers should focus on the behavioural, cognitive and emotional dimensions of self-regulation (Howard et al., 2020).

2.3. Self-Regulation and Academic Achievement

A large body of empirical research has demonstrated that self-regulation is associated with both concurrent and long-term academic outcomes under different educational systems, such as behavioural regulation and control in Hammer et al. (2017, 2018), McClelland et al.

(2007), Ponitz et al. (2009) and von Suchodoletz et al. (2013), and cognitive regulation in Allan et al. (2014), Blair and Razza (2007), Howse et al. (2013), Raver et al. (2011) and Sawyer et al. (2014). One possible explanation of the consistent relationship between behavioural and cognitive dimensions of self-regulation and academic achievement may be attributed to the characteristics of measures. For example, one can assume that if a child performs well on a task-based self-regulation measure (e.g., the Head-Toes-Knees-Shoulders task), the child may own strong executive functioning skills which are closely associated with academic performance (Morrison et al., 2010). Further, teachers' or parents' report-based self-regulation measures are largely influenced by the child's behaviours and performance at home and in classrooms, which are likely to affect the child's learning process and academic outcomes. Arguably, it remains possible that parents and teachers may rate children's self-regulatory ability in a similar direction as their current academic outcomes due to the stereotype.

Emotional self-regulation's association with academic achievement is quite complex. It is generally expected and documented that higher emotional-regulated ability is associated with better academic outcomes (Graziano et al., 2007; Howse et al., 2003; Raver et al., 2011; Sawyer et al., 2014). However, Belsky et al. (2001) argued that toddlers with intense negative emotionality achieved greater school readiness (including letter knowledge, shape and colour identification, and counting), but only when they owned adequate attention skills. Morrison et al. (2010) suggest that higher levels of behavioural and cognitive regulation, especially attentional flexibility, may mediate the influences of poor and unstable emotionality. Since strong attentional skills might be beneficial for children to choose where to direct their attention and overt behaviours (Morrison et al., 2010). Moreover, Trentacosta and Izard (2007) found that children's emotional regulation in kindergarten predicted their attention skills in first grade

which predicted their first-grade achievement. Similarly, Howse et al. (2003) showed that preschool behavioural self-regulation mediated the contribution of emotional self-regulation to maths and literacy outcomes in kindergarten. Therefore, children with extreme emotional lability might not be disadvantaged if they are able to deal with their extreme reactions in an adaptative way. Although it has been hypothesised that children may exhibit unregulated problematic behaviours, even if they are not particularly prone to negative emotions (Elsenberg et al., 2007), research has not provided robust evidence. Therefore, behavioural and cognitive self-regulation might be the more important determinants of academic success than emotional self-regulation.

Several meta-analyses have also provided robust evidence regarding the relationship between self-regulation and academic outcomes. For example, Horn & Packard's (1985) meta-analysis of 58 studies suggests that the ability to focus and keep their attention predicts later reading achievement. Allan et al.'s (2014) meta-analysis of 75 studies shows that inhibitory control is a main component of cognitive self-regulation, is positively associated with academic outcomes. However, their cognitively-focused meta-analysis failed to exclude poor-quality studies and did not explore the potential for small study effects (Debray et al., 2018). Smithers et al.'s (2018) meta-analysis has addressed these limitations by including higher-quality cross-sectional as well as longitudinal studies and employing a comprehensive battery of self-regulation skills (including temperament, effortful control, persistence, working memory, inhibitory control, cognitive flexibility, emotional reactivity and emotional regulation). In addition, their meta-analysis of 554 studies shows that self-regulation is associated with a broad range of academic, cognitive and psychosocial outcomes. Similarly, Robson et al.'s (2020) meta-analysis also reveals that self-regulation is positively associated with concurrent and subsequent academic achievement as well as social competence, and is negatively related to internalising

problems. In terms of the associations between self-regulation and academic achievement, Robson et al.'s (2020) meta-analysis suggests self-regulation is more strongly associated with mathematics than literacy outcomes. This pattern is in accordance with Allan et al.'s (2014) meta-analysis finding that inhibitory control seems to be more important for maths than literacy outcomes, however, Smithers et al. (2018) failed to identify such a pattern. A possible explanation of the preference for maths rather than literacy might be that solving mathematical problems requires intensive cognitive control resources (Zhou et al., 2012), and the prefrontal brain regions, which are considered critical areas for self-regulation, have been implicated (Blair & Raver, 2015; Bull et al., 2008). Literacy, on the other hand, is generally considered to be a secondary ability (Lan et al., 2011), might receive greater instructional efforts both at home and in school, limiting the influence of self-regulation in literacy outcomes (Siraj et al., 2016).

In summary, there has been strong evidence that self-regulation is closely associated with both concurrent and long-term academic outcomes. However, empirical evidence does not suggest that academic achievement completely depends on self-regulation skills, which typically depends on a broad range of factors, such as socio-economic background, gender, parenting style, home learning environment, school environment and social-emotional skills, etc. Therefore, it remains possible that a child with lower self-regulation skills has achieved better academic outcomes. Nevertheless, we can infer from these findings that self-regulation might be a strong predictor of academic achievement. Accordingly, improving children's self-regulation skills is likely to improve their capacity to control behaviours, attention, thoughts and emotions. Such improvements will benefit their daily learning and study, including attentional regulation in class (Posner & Rothbart, 2007), higher-quality interaction with peers and teachers (Eisenberg et

al., 2010; Fabes et al., 2003), and long-term planning as well as goal-setting (Zhou et al., 2012) and therefore, academic outcomes.

2.4. Researching Chinese Children's Self-Regulation

Early childhood education curriculum in China is a confluence of diverse and varied early childhood educational ideals and practices as a result of the political and policy changes in the 20th century (Bullough & Palaiologou, 2019). It is hard to name any specific Chinese early childhood education curriculum since most institutions attempt to integrate Western educational philosophy into the traditional Chinese values and national curriculum for classroom practices (Qi & Melhuish, 2017). For example, several kindergartens attempt to hold a play-based and child-centred approach as part of their curriculum, which is a key element of Western curriculum such as the Tools of the Mind and the Montessori curriculum. During such activities, however, children are expected to behave in a socially acceptable manner in accordance with the Chinese cultural norms. Therefore, although the early childhood education curriculum in China has been historically influenced by Western theories, the traditional Chinese philosophy and values are often reflected in daily practices in classrooms.

The development and implications of self-regulation may be affected by cultural context. Vygotsky (1962) has suggested that culture exerts an influence on higher-order thinking and self-regulated behaviours since each culture has distinct ways of solving problems and specific views on appropriate self-regulated behaviours (Bronson, 2000). Several researchers have highlighted that the value and standard of self-regulation may vary with the cultural context in which the individual is embedded (Chen, 2012; Jaramillo et al., 2017; Trommsdroff, 2009; Zimmerman et al., 1995).

Chinese culture historically emphasises rigorous adherence to group norms and dedication to familial and social responsibilities (Chen & French, 2008). It is heavily influenced by the Chinese philosopher Confucius' theories that promote interdependence, collectivistic pursuits and filial piety (Chen et al., 2011). As a result, the class size is relatively large (Qi & Melhuish, 2017; Wanless et al., 2011a) and there are more group activities than individual activities (Pang & Richey, 2007). In class, children are required to follow the behaviours of the group, even if these behaviours are in contradiction to the more dominant responses (Wanless et al., 2011a). Given these characteristics, self-regulation may have different implied standards in Chinese culture. In terms of emotions, for example, although being emotional is a universal ability, culture defines how individuals evaluate situations, whether they communicate particular emotions and when certain emotions are evoked (Davis, et al., 2012; Mesquita & Frijda, 1992). In individualistic societies that emphasise individuality and autonomy, people are encouraged to express their emotions. In contrast, people in collectivistic societies such as China are socialised to control emotional expressions to maintain group harmony (Cole et al., 2006; Zhou et al., 2009). For example, experiences and expressions of high-arousal positive emotions are relatively less preferred than low-arousal positive emotions (Davis et al., 2012; Tsai et al., 2007). Since the open expression of positive emotions such as excitement may promote pride which is a less acceptable emotion among Chinese culture (Zhou et al., 2009).

Self-regulation is also associated with a broad range of both academic and non-academic outcomes among Eastern children (Eisenberg et al., 2007; Liu et al., 2018; Zhou et al., 2009, 2012). However, the developmental patterns of self-regulation skills are different. For example, Korean (Oh & Lewis, 2008) and Chinese children (Sabbagh et al., 2006) showed better

performance on inhibitory control tasks than their British and US counterparts with the same age. This pattern has also been found to be present in early adolescence (Ellefson et al., 2017).

Although Western early childhood education curriculum has also been designed to foster the development of self-regulation, Chinese children's advantages can be attributed to the strategy and underlying rationale between Asian and Western curriculum. Pandey et al.'s (2018) meta-analysis of Western curriculum-based programs indicates that self-regulation was consistently improved in 16 of the 21 programs. Typical examples include the Tools of the Mind (Tools; Bodrova & Leong, 1996) and the Montessori curriculum (Montessori & Claremont, 1967). Guiding by Vygotsky's (1962) thoughts, the Tools is a comprehensive curriculum that assumes children should be fostered in an interactive and constructivist environment (Baron et al., 2017; Bodrova & Leong, 1996). According to Barnett et al. (2008), basic principles of the Tools include: children construct their own knowledge; children's development should not be separated from the social context; and language plays an important role in mental development. The Tools integrates self-regulatory challenges with regular classroom activities (Baron et al., 2017; Diamond et al., 2007), in which play is the prominent element of these activities. Therefore, the central focus of the Tools is social pretend play or make-believe play, in which children are expected to remember their own and other's roles, inhibit acting out of the characters and flexibly adjust as their classmates improvise (Baron et al., 2017). These processes train children's working memory, inhibition control and cognitive flexibility abilities, which are the three major aspects of EFs (Diamond et al., 2007; Diamond & Lee, 2011). Although the Tools is child-centred, it also emphasises teachers' daily practices to guide and support children's learning (Barnett et al., 2008). In accordance with Vygotsky's (1962) idea of the act of scaffolding, the Tools helps teachers scaffold children's higher levels of thinking in planning,

social learning and play. Bodrova and Leong (2007) proposed that the three processes underlying the Tools activities are: teachers regulate students, students regulate students and students self-regulate. Thus, a child's self-regulation tends to begin with someone outside of the child who first regulates the child's behaviour. To do this, teachers may help children write play plans, teach children to plan their dramatic play and help them think about the next steps during their play (Barnett et al., 2008).

Similar to the Tools, the Montessori curriculum (Montessori & Claremont, 1967) is also a comprehensive program that integrates self-regulatory challenges into the daily routine (Diamond & Lee, 2011; Lillard & Else-Quest, 2006). Although EFs are not explicitly reflected by the curriculum, what Montessorians mean by normalisation includes having good EFs. Normalisation describes the process in the Montessori classrooms where young children learn to focus and concentrate for sustained periods (Ervin et al., 2010). In order to achieve normalisation, Montessori practices emphasise several principles: 1) children can freely choose their activities to pursue, move freely around the classroom to work and perceive control over their learning results; 2) children are provided with an appropriate and optimal level of challenge to capture their attention, leading to sustained and deep concentration; 3) teachers do not prepare extrinsic rewards which arguably disrupt children's engagement with their work by shifting focus from the activity to the reward; 4) and children deliberately practice cognitively challenging activities to increase self-regulation capacity (Ervin et al., 2010).

In contrast, Chinese children's self-regulation is likely to be fostered more directly than Western children. As previously discussed, although Chinese kindergartens tend to adopt the elements of Western early childhood education curriculum, the traditional Chinese norms and values still highly influence the implementation. For example, Chinese children often receive

intensive authoritative instructions in normal classroom practices, such as inhibiting behaviours and controlling attention (Kwon, 2004; Lan et al., 2011). Lan et al. (2009) has documented that teacher in China tend to give substantially more proactive instructions (e.g., “do something properly”, “avoid doing something” and “sit quietly”), compared with American teachers who value free choice and self-expression, and are more likely to give reactive instructions when students misbehave (Chen et al., 2011; Lan et al., 2011).

Although the original intention of such instructions might be teaching children to obey the classroom rules defined by the culture and society, these instructions are also considered to be an unintentional training of inhibition and attention skills, thus leading to higher performance on these tasks. Extending on Sabbagh et al.’s (2006) study, which compares the performance on inhibitory control tasks, Lan et al. (2011) adopted a comprehensive battery of EF tasks, including attentional and inhibitory control and working memory. Consistent with the previous finding that Chinese preschoolers performed better on inhibitory control tasks than American preschoolers, however, there was no advantage on working memory tasks (Lan et al., 2011). Such finding is not surprised, given that although self-control is highly valued in Chinese culture and classrooms, working memory has not been emphasised. It also remains possible that working memory is culture-free and relatively less affected by cross-cultural differences (Lan et al., 2011).

To sum, the development and implications of self-regulation have been widely explored but are mostly limited to Western samples (Jaramillo et al., 2017). Given the significance of self-regulation for children’s academic, social and developmental outcomes, it is necessary to conceptualise self-regulation under each cultural context with enough attention to cultural variations, and therefore, to effectively support children’s development of self-regulation.

2.5. Gaps in the Extant Literature and the Current Study

The above sections have demonstrated that there are diverse approaches to conceptualising and understanding self-regulation. These approaches have provided robust frameworks for self-regulation studies by acknowledging the multidimensionality of self-regulation. However, the present literature review has revealed a lack of consensus on the constructs of self-regulation. For example, several researchers hold a behavioural or consequentialist perspective that emphasises behavioural outcomes of self-regulated attempts, and they appear to integrate the behavioural and cognitive processes underlying self-regulation. Given the adopted definition of self-regulation that the ability to control dominant impulses to regulate behaviours, thoughts and emotions, the present study assumes that self-regulation includes three distinct but interdependent constructs: behavioural, cognitive and emotional self-regulation. Therefore, a comprehensive profile of self-regulation should include characteristics of these aspects of self-regulation.

To our knowledge, however, there has been limited research exploring the three aspects of self-regulation in a single research. Although Howard et al. (2020) have assessed children's behavioural, cognitive and emotional self-regulation using the same measure that the current study has adopted (i.e., the Child Self-Regulation and Behaviour Questionnaire), the scores for each subscale have been averaged to achieve a single self-regulation index in order to reduce the number of analyses performed. Further, although research has documented gender differences in self-regulation with girls typically outperforming boys among Western samples (Duckworth & Seligman, 2006; Gestsdottir et al., 2014; Hubert et al., 2015; Matthews et al., 2009; Ponitz et al., 2009), there have been fewer studies investigating such differences among Chinese children. Moreover, it has been expected and evidenced that children's self-regulation skills increase as

they grow up (Demetriou, 2000), but again, fewer studies have attempted to explore whether this association emerges in all aspects of self-regulation and failed to provide a developmental picture of children's self-regulation. Therefore, the current study may be the first to explore the characteristics of behavioural, cognitive and emotional aspects of self-regulation. These findings may point to the importance of investigating gender differences in and developmental patterns of these aspects of self-regulation.

In addition, although research has provided evidence regarding the association between self-regulation and academic achievement among Chinese samples, fewer studies have emphasised a younger sample, such as preschoolers and kindergarteners. Also, research has revealed girls' advantages of both self-regulation and academic outcomes, however, the moderating effects of age and gender have often been overlooked when investigating the associations between self-regulation and academic outcomes. Thus, the present study aims to address these gaps by investigating the links among these aspects of self-regulation and maths as well as literacy and examining the moderating effects of age and gender.

To summarise, the current study aims to provide a comprehensive profile of a sample of Chinese children's behavioural, cognitive and emotional self-regulation regarding their gender differences, developmental patterns and relationships with academic outcomes. The first aim of the study is to explore the characteristics of Chinese children's behavioural, cognitive and emotional self-regulation in terms of gender and age. The second aim of the study is to examine the extent to which these dimensions of self-regulation collectively and uniquely account for Chinese preschoolers' maths and literacy outcomes and whether gender and age can moderate these associations.

2.5.1. Research Questions and Hypotheses

Research questions (RQs) are as follows:

1) What are the profiles of Chinese preschool children's behavioural, cognitive and emotional self-regulation? Are there any gender or age differences in these aspects of self-regulation?
2) Can behavioural, cognitive and emotional aspects of self-regulation predict children's academic outcomes? If they do, does age or gender moderate these associations?

In terms of RQ1, it remains unclear whether gender differences in self-regulation could be identified among Chinese children because of the limited evidence. However, in the light of the finding that girls tend to show better self-regulation skills than boys among Western samples, it can be expected Chinese girls will outperform boys on all aspects of self-regulation. Further, given the robust evidence regarding the positive association between age and self-regulation skills, the study hypothesises that older children tend to show better self-regulation skills than younger children among the current sample. In terms of RQ2, as previous studies have consistently reported the relationship between self-regulation and academic outcomes, the present study hypothesises that self-regulation significantly contributes to Chinese preschoolers' maths as well as literacy performance and that different aspects of self-regulation play an independent role in these academic measures, even after statistically controlling for age and gender. Finally, the study hypothesises that gender plays a moderating role in the associations among these aspects of self-regulation and academic outcomes, given that gender has consistently been shown to moderate the associations between academic achievement and a wide

range of explanatory factors. However, in terms of age, it is difficult to make specific predictions because of the dearth of studies on the moderating effects of age.

3. Methodology

This chapter describes the methodological approach of the current study. As a secondary data analysis, the description of the original database and inclusion criteria for the sample will be provided. The advantages and drawbacks of secondary data analysis will also be discussed. It will also review existing self-regulation measures and indicate their strength as well as weakness, leading to the description of the self-regulation measured adopted by the current study. The reliability index of measures will also be reported. Ethical considerations and an analysis plan will be presented at the end of this chapter.

3.1. Database

The data used in the current study is a part of a larger database that was collected by a DPhil student from the Department of Education, University of Oxford (Huang, 2022 forthcoming). The DPhil student has collected pre- and post-intervention data, while the current study only has access to the baseline data and the present research purpose is entirely different from that of the DPhil study which explores the effects of a professional development intervention. Therefore, the current study will not overlap with the DPhil's analysis or further work.

3.2. Participants

The data utilised in the present study was collected in Shenzhen China. There are ten districts and 1268 kindergartens and preschools in Shenzhen, while four districts that can represent different socio-economic background have been selected based on the Gross Domestic Product in 2020. Specifically, Nanshan (4287.86 billion) and Longgang districts (3714.57 billion) were identified as high-developed areas, Longhua district (2130.16 billion) represented a middle-developed area, and Pingshan district (701.66 billion) represented a less-developed area.

After selecting these four districts, a total of 700 kindergartens were identified (Huang, 2022 forthcoming).

The DPhil student has set several criteria regarding the inclusion of kindergartens: 1) at least eight teachers from a kindergarten agree to complete the whole project period; 2) the kindergarten should not be currently involved in any reform or research project. Kindergarten administrators showed their interest in the DPhil's study by completing an online questionnaire and provided some basic information about their institutions including the number of teachers, location, classification and funding, etc. To ensure the diversity and representativeness of the sample, a total of 24 kindergartens from the four abovementioned districts have been randomly selected with an equal number in different school types, socio-economic status, and school classifications (Huang, 2022 forthcoming).

After selecting eligible kindergartens, there were 96 classrooms including 48 K1 classrooms which primarily consisted of children aged between 3 and 4, and 48 K2 classrooms which consisted of children aged between 4 and 5. Teachers in each classroom provided a name list of children and researchers have randomly selected three boys and three girls from each classroom based on the alphabetical order of their first name (i.e., the third, sixth and tenth children in the boy's and girl's name lists were selected). In total, 576 Chinese preschoolers (286 girls, 290 boys; 288 K1 children, 288 K2 children; M = 49.39 months, SD = 6.70 months, *range* = 35-69 months) were recruited from 24 kindergartens in Shenzhen China (Huang, 2022 forthcoming).

3.3. Measures

3.3.1. Background of Self-Regulation Measures

Quantifying self-regulation is of great significance for researchers and educators who are interested in investigating the effects of self-regulation on varied outcomes or evaluating the effectiveness of an intervention. However, similar to the diverse approaches to defining and fostering self-regulation, its assessments are also varied and there is less agreement on the optimal measures and their configurations (Blair et al., 2005; Howard & Melhuish, 2007; Lakes, 2013). Self-regulation measures can typically be categorised into task-based and report-based (Duckworth & Kern, 2011; Robson et al., 2020).

Task-based measures

Researchers have attempted to measure self-regulation skills by evaluating performance on tasks designed to measure specific constructs included under the umbrella of self-regulation (Lakes, 2013). Given the close relationship between EFs and self-regulation, it is not surprising that measures of them are used interchangeably, indicating the performance on EF tasks can represent levels of self-regulation ability (Howard & Melhuish, 2007). Since executive functioning typically involves working memory, inhibitory control and shifting, the tasks are designed to assess these abilities. However, since any single EF task tends to require a bundle of these cognitive processes, it is not feasible to organise EF tasks according to proposed taxonomies of EF (Duckworth & Kern, 2011; Hubert et al., 2017). Quintessential tasks used in self-regulation literature include continuous performance task (i.e., Go/No-go; Rosvold et al., 1956), Stroop task (Stroop, 1935), Backward digit span (Hubert et al., 2017), Wisconsin card sorting task (Heaton & Pendelton, 1981), Dimensional change card sort task (Muller et al., 2006), Stop-signal task (Logan, 1994), Tower of London or Tower of Hanoi (Bull et al., 2004),

Flanker task (Eriksen & Eriksen, 1974) and Self-Regulation Test for Children (Howse et al., 2003; Kuhl & Kraska, 1993). Given the intensive cognitive effort required for these tasks, it can be further assumed that children's performance on them reflect their ability of the cognitive domain of self-regulation. Indeed, most studies that employed those measures targeting executive functioning, have either explicitly or implicitly stated that they were attempting to capture children's cognitive self-regulation. For example, Jahromi and Stifter (2008) investigated individual differences in children's cognitive self-regulation that was assessed by Go/No-go task, day/night task, tapping task and three-pegs task. Similarly, Hubert et al. (2017) employed the Backward digit span task to assess children's verbal working memory as a key component of EFs.

These above-mentioned tasks are effective in capturing children's self-regulation, particularly cognitive regulation, but are limited to an experimental setting rather than nonlaboratory contexts which may provide unique self-regulatory challenges (Calkin, 2007; Fahie & Symons, 2003; Howse et al., 2003). Therefore, it is necessary to bridge the gap among the performance from the laboratory, classroom and the real world (McClelland et al., 2010; Rimm-Kaufman, et al., 2000). The Head-to-Toes task (HTT; Ponitz et al., 2008) and its complex version, Head-Toes-Knees-Shoulders task (HTKS; Ponitz et al., 2009) are more structured self-regulation measures that can be used in normal classroom settings and do not require the use of electronic equipment (Morrison et al, 2010). However, there is ambiguity regarding which aspects of self-regulation the HTKS assesses (Smithers et al., 2018). During the HTKS task, the child needs to remember the conflicting rules, inhibit the natural response and do the opposite of what they are instructed to do (Ponitz et al., 2009). For example, touching the head when hearing touching your toes, and touching the knees when hearing touching your shoulders. Therefore, it

is sensible to infer that several capacities are required for this task, including working memory, inhibitory and attentional control (Diamond, 2002; Hubert et al., 2017; von Suchodoletz et al., 2013), which can be bundled as EFs and therefore cognitive self-regulation. Although the authors of the HTT and the HTKS (Ponitz et al., 2008, 2009; McClelland et al., 2007) and several researchers (e.g., Day et al., 2015; Montroy et al., 2016) agree that the prominent cognitive abilities captured by these tasks are working memory, inhibitory and attentional control, they generally consider the task as a behavioural assessment of cognitive abilities and therefore, use the term *behavioural* instead of *cognitive* self-regulation to describe the performance on the HTKS task. A possible explanation is that since performance on the HTKS task depends on children's responses and behaviours instead of the underlying process (i.e., two points for a correct response, one point for an initially wrong but later correct response and zero points for an incorrect response), researchers may want to examine how children's EF skills translate into behaviours in particular research settings (Day et al., 2015). Arguably, such use may still lead to confusion. Since the HTKS requires children to be self-regulated both on the body- and mind-level and therefore, it might be more accurate to propose that both behavioural and cognitive self-regulation have been assessed by the HTKS.

Compared with the various task-based measures targeting behavioural and cognitive self-regulation, fewer studies have assessed the emotional dimension of self-regulation using task-based measures. For example, Dennis (2006) assessed children's ability of persistence, frustration and compliance as key constructs of emotional self-regulation, in which children's level of persistence and frustration were represented during two emotionally challenging tasks: the Impossibly Perfect Circle task and the Transparent Box Task. The level of persistence was rated based on the number of seconds spent participating in the task and the number of seconds

before interrupting the task. However, it is worth noting that Dennis (2006) also employed teacher ratings of persistence and frustration during tasks. A possible explanation of the relatively fewer task-based measures developing for assessing emotionality is that task-based measures are often result-oriented, in which researchers tend to focus on the outcome rather than the process of achieving or underachieving the outcome, while emotional self-regulation is more likely to be reflected during the task process. Given the extensive behaviourally and cognitively task-based measures, further research may pay more attention to the task process and add emotional components into the scoring criteria. Taken together, these task-based measures have demonstrated the value of assessing self-regulation in a situational context in which researchers present children with a challenge for which a successful response requires self-regulation in different domains (Lakes, 2013)

Report-based measures

Compared with task-based measures, self-regulation is more often measured by report-based measures in research (Duckworth & Kern, 2011). It is generally agreed that there are two different forms of report-based measures: observational rating and self-, parent- or teacher-rating. Observational rating examines the extent to which an individual has difficulty waiting between impulse-inducing tasks (Robson et al., 2020). Several widely used observational measures include the Preschool Self-Regulation Assessment (Denham et al., 2012; Raver et al., 2011; Smith-Donald et al., 2007; Willoughby et al., 2011), Response to Challenge Scale (Lakes, 2013; Lakes & Hoyt, 2004) and the Preschool Situational Self-Regulation Toolkit assessment (Howard et al., 2020).

Another type of report-based measure can generally be defined as self-regulation questionnaires. Individuals can rate themselves on a wide range of items regarding self-

regulation, including goal-setting, self-inhibition and persistence, etc (Lakes, 2013). Common self-report measures include the Self-Control Scale (Cho, 2017; Chui & Chan, 2013), the Self-Control Rating Schedule (Finigan-Carr et al., 2015) and the Early Adolescence Temperament Questionnaire-Revised (Capaldi & Rothbart, 1992; Lotze et al., 2010; Muris et al., 2007; Zhou et al., 2009).

Given that young children might be unable to rate themselves, however, it is more common to ask parents or informants (i.e., teachers) to rate children's self-regulation skills. Several studies that have selected relevant items from broader scales then performed factor analysis to categorise and label them. For instance, Sawyer et al. (2014) chose several parent-rated items that assess children's self-regulatory behaviours from the Longitudinal Study of Australian Children questionnaire. Further factor analyses suggest that these items belong to two factors, labelled task attentiveness and emotional regulation; Similarly, in order to assess behavioural self-regulation, von Suchodoletz et al. (2013) adopted the ten items from the Child Behaviour Rating Scale (Bronson et al., 1990) which have been identified as assessing children's self-regulatory behaviours by Matthews et al.'s (2009) factor analysis.

Most studies have attempted to select stand-alone measures or relevant subscales from omnibus personality, temperament, behaviour or psychopathology inventories to represent self-regulatory ability (Duckworth & Kern, 2011). For example, the Self-Control Scale in Tangney et al.'s (2004) study, the Attention Problems and Aggressive Behaviour subscales of the Child Behavioural Checklist (Achenbach, 1991) and the Lability subscale of the Emotion Regulation Checklist (Shields & Cicchetti, 1997) were adopted by Pears et al. (2014), Ren and Fan (2018) employed the Self-Control and Behavioural Concerns subscales of the Devereux Early Childhood Assessment Rating-Preschoolers (LeBuffe & Naglieri, 1999), Eisenberg et al. (2007)

measured children's dispositional regulation and reactive under-control using the Attention Focusing and Impulsivity subscales of the Children's Behaviour Questionnaire (Rothbart et al., 1994), and the Behavioural, Cognitive and Emotional Self-Regulation subscales of the Child Self-Regulation and Behaviour Questionnaire (Howard & Melhuish, 2017) were adopted in Howard et al.'s (2020) study.

To summarise, although there seem to be diverse approaches to measuring children's self-regulation, it is still difficult to advocate for any particular measures (Robson et al., 2020). Since the extent to which approaches reflect children's real-world self-regulatory capacities is less clear and each approach only provides an approximation of a child's ability (Robston et al., 2020). Task-based measures may own better objectivity but often overlook emotional investment that is typical of children's everyday self-regulation. It remains difficult to determine to what extent these tasks can capture children's capacity for emotional self-regulation. Also, such measures are often limited to experimental and laboratory settings in which the task performance might not represent self-regulation ability in the real world. It has been evidenced that the correlation between task-based measures and teacher ratings of self-regulation is only modest (Blair, 2003). In contrast to task-based measures, report-based measures seem to address these limitations and have the additional advantage of convergent validity (Duckworth & Kern, 2011). However, both self/parent/teacher report and observational measures are more susceptible to report- and observational biases (Robson et al., 2020). For example, both the children themselves and their parents, teachers or observers may attempt to rate in a socially desirable manner. Moreover, Howard et al. (2018) suggested that observational measures and parent/teacher report fail to capture developmental change in self-regulation since adults tend to reference children to their age-equivalent peers.

Taken together, it has been documented that there is only moderate convergence and substantial heterogeneity between self-regulation measures, and the correlations between measures are weak (Duckworth & Kern, 2011; Malanchini et al., 2018; Robson et al., 2020). Robson et al.'s (2020) meta-analysis reveals that task-based and teacher-report measures produce similar effect sizes for academic outcomes, and those differ from parent-report measures to some extent. Partially supported by Allan et al.'s (2014) findings that task-based measures produce larger effect sizes than parent-report measures, nevertheless, Allan and colleagues failed to identify the difference between the effect sizes of task-based measures and those of teacher-report measures. Despite the discrepancy, such results may indicate that parent-report measures are relatively less reliable for assessing children's self-regulation, at least in relation to academic achievement. The reason might be that teachers tend to have a broader reference point than parents when situating a child within a normal developmental continuum, and teachers are likely to be more experienced than parents with regard to the required attributes for success in school (Robson et al., 2020).

Considering the assumed constructs of self-regulation including behavioural, cognitive and emotional self-regulation, although studies often employ multiple approaches to measuring self-regulation (Robson et al., 2020), there is a limited number of stand-alone measures being able to capture all these aspects, with the exception of the Child Self-Regulation and Behaviour Questionnaire (CSBQ; Howard & Melhuish, 201). Therefore, consistent with the adopted definition and components of self-regulation, the present study will employ the three self-regulation subscales of the CSBQ, including behavioural, cognitive and emotional self-regulation.

3.3.2. The Child Self-Regulation and Behaviour Questionnaire (CSBQ)

CSBQ Description

The current study adopted the Child Self-Regulation Behaviour Questionnaire (CSBQ; Howard & Melhuish, 2017) to capture children's self-regulation. The CSBQ is developed by researchers from the University of Wollongong in Australia and the Department of Education, University of Oxford, as a part of the Early Year Toolbox that assesses children's visual-spatial and phonological working memory, shifting, inhibition, vocabulary, self-regulation and social behaviour. The CSBQ consisted of 49 candidate items initially and after conducting few trials and factor analysis, the current version of the CSBQ includes 34 educator-report items and seven subscales, including Behavioural Self-Regulation, Cognitive Self-Regulation, Emotional Self-Regulation, Internalising Problems, Externalising Problems, Prosocial and Sociability. Each item asks the respondent to evaluate the general frequency of target behaviours on a 5-point Likert scale from 1 (not true) to 5 (certainly true). Although the DPhil student has implemented the full version of the CSBQ, only the data from three self-regulation subscales will be further analysed, which is necessary for addressing the research purpose. Each child's self-regulation was rated by his or her class teacher.

Validity and Reliability

In a pilot testing of the CSBQ (N = 114; discussed in Howard & Melhuish (2017)), exploratory factor analysis has shown that all items perfectly loaded on expected factors, and Cronbach's alpha is larger than .80 in each subscale, indicating good reliability. The reliability of self-regulation subscales of the CSBQ has been supported by Howard and colleagues (2017, 2020), ranging from .83 to .89 and from .79 to 89. Howard and Melhuish (2017) also demonstrated that the CSBQ showed good convergent validity with other adult-report measures,

such as the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). To our knowledge, there have been no, if any, studies implementing the CSBQ among Chinese samples. The current Chinese version of the CSBQ was translated by the DPhil student and colleagues, and reviewed by experts before implementation. The reliability of behavioural, cognitive and emotional self-regulation subscales of the CSBQ will be presented in the following sections.

Self-Regulation

Behavioural self-regulation was assessed via six items, such as "Regularly unable to sustain attention", "Waits their turn in activities" and "Good at following instructions". Two items were reversely coded and the behavioural self-regulation index was the average of these six items. The model of behavioural self-regulation showed good reliability (Cronbach's alpha = .837).

Cognitive self-regulation was captured by five items, for example, "Persists with difficult tasks", "Chooses activities on their own" and "Does not need much help with tasks". There were no reversed-coded items within this subscale, and similarly, a single cognitive self-regulation index was generated by averaging the five items. The model of cognitive self-regulation showed good reliability (Cronbach's alpha = .864).

Emotional self-regulation was measured by six items, such as "Is calm and easy-going", "Gets over being upset quickly" and "Easily upset over small events". There are four reversed-coded items in this subscale, and a single emotional self-regulation index has been generated by averaging the six items. The model of behavioural self-regulation showed acceptable reliability (Cronbach's alpha = .723).

3.3.3. The International Development Early Learning Assessment (IDELA)

IDELA Description

The current study utilised the International Development Early Learning Assessment (IDELA; Save the Children, 2011) to assess children's numeracy and literacy outcomes. The IDELA is a tool for measuring early child development and school readiness. It includes 22 subtasks spanning four developmental domains: motor skills, emergent literacy, emergent numeracy and social-emotional development (and an optional domain related to executive function). During the development phase, 65 items were initially adapted from existing assessments such as the Bayley Scales of Infant and Toddler Development, the Early Development Instrument and the Denver Developmental Screening Test (Pisani et al., 2018). This was followed by several years of testing and modification in multiple sites before its final version, which offers a balance between international applicability, feasibility, adaptability and psychometric rigour (Pisani et al., 2015, 2018). The IDELA is not a ready-to-use assessment, indicating that it not only needs translation so children understand the activities they will be doing during the assessment but also adaptation to ensure that tasks and objects discussed are familiar to them. At present, the IDELA has been available in more than 50 languages, suggesting that there might be a wealth of data publicly available to compare performance between countries. Most items are scored as correct or incorrect, but a few are scored as ordered-categorical with higher numbers indicating better performance. Although the DPhil student has implemented the full version of the IDELA, only the data from emergent numeracy and literacy domains will be further analysed, which is necessary for addressing the research purpose.

Validity and Reliability of the IDELA

Haplin et al.'s (2019) and Wolf et al.'s (2017) studies in low- and middle-income countries, including Ethiopia, Afghanistan, Bolivia, Uganda and Vietnam, support a four-factor model of the IDELA, indicating good construct validity. In the context of China, the IDELA has

been firstly translated and adapted to Chinese in 2015 and utilised in the province of Yunnan in 2016, in which researchers evaluated the development and learning performance of 142 children from five villages in Yunnan (Save the Children International China Country Office, 2016). According to their report, however, the validation procedure and reliability index cannot be obtained. The current study used the Chinese adapted version of the IDELA that was the same as the one used by the Yunnan research team. The reliability index of numeracy and literacy will be presented in the following sections.

Emergent numeracy

Emergent numeracy was captured by 40 items via seven subtasks that reflect the child's measurement and comparison (4 items), classification/sorting (2 items), shape identification (5 items), number identification (20 items), one-to-one correspondence (5 items), simple operations (3 items) and puzzle completion (1 item; 4 categories). All subtasks have more than one item with the same scoring criteria, except for puzzle completion which is measured by children's level of completion, persistence and engagement during the puzzle task. Specifically, the level of completion depends on the number of pieces correctly placed (the maximum number is 6). For scoring persistence, one score will be given if the child stays concentrated on the task at hand and is not easily distracted, zero scores if the child fails to do so and a mark of 999 if the child refuses to complete the puzzle. In terms of engagement, similarly, one score represents the child is motivated to complete the puzzle and does not want to stop the task, a score of 0 represents the child fails to do so and a mark of 999 will be given if the child refuses to complete the puzzle. The model of emergent numeracy demonstrated good reliability (Cronbach's alpha = .831).

Emergent literacy

Emergent literacy was captured by 35 items via six subtasks that assess the child's expressive vocabulary (2 items; 11 categories each), print awareness (3 items), characters identification (20 items), phonological awareness (3 items), emergent writing (1 item; 5 categorises) and listening comprehension (6 items). Among them, print awareness, characters identification, phonological awareness and listening comprehension are marked based on the score of 0, 1 and 999 criteria. In order to assess the child's phonological awareness, for example, the researcher says a target sentence including two words with a similar letter sound, the child is asked to distinguish those two words. One score will be given if the child gives a correct response. No score will be given if the child gives an incorrect response, and a mark of 999 will be given if the child refuses to respond. Children's expressive vocabulary and emergent writing subtasks are marked based on different scoring criteria. Specifically, in expressive vocabulary subtask, the child is asked to name as many foods and animals as he or she can think of. The researcher counts the number of foods and animals indicated, while the maximum number is ten respectively. During emergent writing tasks, the child is asked to write his or her name and the researcher marks the written work based on the quality of handwriting. Four scores will be given if the child is able to write in a standard way (i.e., clear constructs and strokes), three scores stand for writing in a sketched way (i.e., more like a kind of drawing rather than writing), two scores represent that the child can only write using lines or few strokes, one score stands for writing in a graffiti-like way, and no score will be given if the child does not write. The model of emergent literacy demonstrated acceptable reliability (Cronbach's alpha = .70).

Score Calculation

Scores for each subtask were calculated as the proportion of items correct with a possible range from 0 to 1. Scores for each domain were the average of its subtasks. Total weighted

scores of emergent numeracy and emergent literacy were calculated by the IDELA scoring template.

3.4. Secondary Data Analysis

As described above, the current study utilised partial data from a DPhil student's database. Although different from typical secondary data studies which used national and representative databases (Smith, 2008), such as the dataset of the Longitudinal Study of Young People in England and the dataset of the China Education Panel Survey, the current study is still considered to be a kind of secondary data analysis and therefore, shares the advantages as well as drawbacks of secondary data research.

One prominent advantage of secondary data analysis is that researchers can conserve time and resources on data collection by using an existing database (Donnellan & Lucas, 2013). Also, the large sample size and rigorous sampling plans may lead to adequate statistical power and has respectable generalisability (Devine, 2003). Further, as the data are often publicly available, other researchers may attempt to replicate findings or adopt alternative techniques or models for a given research question (Donnellan & Lucas, 2013). Although this is not the case for the current study, given that the current dataset is only available to a limited number of people within the research team, the results and findings of the present study might be beneficial for the DPhil student's thesis and further work.

Despite the advantages secondary data analysis offers, there are also several typical pitfalls that researchers should consider when thinking of this method. For example, researchers cannot control the issues in study design and measurements, especially when there is a great deal of breadth in terms of the range of constructs assessed, but these constructs are generally assessed by a limited number of items (Donnellan & Lucas, 2013). Moreover, researchers might

need hours and even weeks to be familiar with the criteria as well as codebooks and to discover which research questions have already been addressed by others using the given dataset and which files to extract to answer their research questions most reliably and efficiently.

3.5. Ethics

As a secondary data analysis, the ethical approval of the current dissertation has already been applied in the DPhil's study. After deciding the research questions of the current study, the DPhil student selected and fully anonymised relevant baseline data, this process has been approved by the supervisor of the DPhil study and the current study. The data received is in the IBM SPSS file and no private, child and school information could be identified and traced back. The data will not be shared with anyone, except for the DPhil student and the supervisor of the current study and DPhil study. The fully anonymised and non-identifiable data will be utilised for finishing the current dissertation as partial fulfilment of the requirements for the degree of Master of Science in Education – Child Development and Education and possibly for a publication if the standard is appropriate. After submitting this dissertation, the anonymised data will be permanently deleted.

3.6. Data Analysis Plan

The current study aims to provide a comprehensive profile of a sample of Chinese children's behavioural, cognitive and emotional self-regulation in terms of their characteristics and associations with academic outcomes. To investigate the characteristics, specifically the gender differences in and developmental patterns of these aspects of self-regulation, three separate two-way ANOVA tests was performed with gender (girl and boy) and age group (K1 and K2) as between-subjects factors. The dependent variables were behavioural, cognitive and emotional self-regulation respectively. Then, associations between the three aspects of self-

regulation and numeracy as well as literacy were analysed in separate hierarchical regression models. Control variables including age and gender were entered into the first block and the three aspects of self-regulation were entered into the second block. To test the moderating effects of age and gender on these associations, a further four models were constructed in which the control variables were again entered into the first block, followed by behavioural, cognitive and emotional self-regulation in the second block. Three age-related and three gender-related interaction terms (i.e., Behavioural Self-Regulation*Age in Months, Cognitive Self-Regulation*Age in Months and Emotional Self-Regulation*Age in Months; Behavioural Self-Regulation*Gender, Cognitive Self-Regulation*Gender and Emotional Self-Regulation*Gender) were derived by computing standardised *z*-scores to centre the data and then multiplying the *z*-scores for the two variables (Aiken & West, 1991). These interaction terms were then entered in the third block separately to investigate the moderating effects of age and gender on the associations between different aspects of self-regulation and numeracy as well as literacy. All analyses were carried out using IBM SPSS 27. There were no missing data. Power analysis suggested that the sample size is sufficient to detect a statistical significance (see Appendix I).

4. Results

This chapter presents the results of the current study. Specifically, the descriptive statistics will be presented first, followed by the characteristics of self-regulation in relation to age and gender. The associations among behavioural, cognitive and emotional self-regulation and numeracy as well as literacy, will then be presented along with the moderation analysis of gender and age.

4.1. Preliminary Results

Table 1 displays the mean, standard deviations, range, skewness and kurtosis for all measures in the current study. Both statistical tests and visual inspection suggests these variables may not be normally distributed (see Appendix II). The Z-scores of skewness and of kurtosis for each variable were also derived and indicated a non-normal distribution. However, it has been argued when there is a large sample size (e.g., $N \geq 30$), a non-normal distribution would not cause any significant issues (Altman & Bland, 1995). Therefore, it is acceptable to assume the data is normally distributed and to use parametric statistical tests. Fagerland (2012) also suggests that parametric tests should be used in studies with a large sample size regardless of the distribution of data. This argument is also supported by the central limit theorem (Mishra et al., 2019). It remains unclear regarding the optimal method for deciding normality and there is a myth in terms of the true normality (Orcan, 2020). Given the relatively large total sample size and subsample size, these variables were treated as normal ones in the current study.

Table 1.

Descriptive statistics

Variable	N	Range	Mean	Std. Deviation	Skewness (SE)	Kurtosis (SE)
Gender	576	1-2	1.50	.50		

Age (months)	576	35-69	49.39	6.60	.03 (.10)	-.93 (.20)
BehSR	576	1.17-5.00	4.01	.74	-.82 (.10)	.52 (.20)
CogSR	576	1.20-5.00	3.76	.76	-.37 (.10)	-.21 (.20)
EmoSR	576	1.67-5.00	4.06	.64	-.70 (.10)	.44 (.20)
Numeracy	576	.05-1.00	.56	.21	.08 (.10)	-.89 (.20)
Literacy	576	.00-1.00	.48	.19	.18 (.10)	-.59 (.20)

Note. SE = standard error. Gender: 1 = girl, 2 = boy. BehSR = behavioural self-regulation. CogSR = cognitive self-regulation. EmoSR = emotional self-regulation.

Table 2 shows the Pearson correlation coefficients for all variables included in the current study. Behavioural self-regulation, cognitive self-regulation and emotional self-regulation were all moderately associated with numeracy and literacy scores, with magnitudes ranging from .10 to .30 and from .13 to .30, respectively. Gender was linked to behavioural (r = -.15, p < .001) and emotional self-regulation (r = -.14, p < .001) but not associated with cognitive self-regulation and any academic outcomes (all p > .05). Age was correlated with numeracy scores (r = .63, p < .001), literacy scores (r = .55, p < .001) and only the cognitive aspects of self-regulation (r = .18, p < .001). Numeracy and literacy scores were highly correlated (r = .72, p < .001).

Table 2.

Zero-order correlations of all measures (N = 576)

Variables	1	2	3	4	5	6	7
1. Gender	-						
2. Age	.03	-					
3. BehSR	-.15***	.07	-				
4. CogSr	-.03	.18***	.60***	-			

5. EmoSR	-.14***	.07	.68***	.52***	-		
6. Numeracy	. 06	.63***	.20***	.30***	.10*	-	
7. Literacy	-.02	.55***	.23***	.30***	.13**	.72***	-

Note. Gender: 1 = girl, 2 = boy. BehSR = Behavioural self-regulation. CogSR = Cognitive Self-regulation. EmoSR = Emotional self-regulation. *$p < .05$; **$p < .01$; ***$p < .001$.

4.2. Characteristics of Self-Regulation

Three separate two-way ANOVA tests were set with gender (girl and boy) and age group (K1 and K2) as between-subjects factors. The dependent variables were behavioural, cognitive and emotional self-regulation respectively. Before performing analysis, the assumptions of ANOVA were checked. First, scores of behavioural, cognitive and emotional self-regulation were treated as normally distributed as previously discussed. Second, the two between-subjects factors, gender and age group, consist of two independent groups respectively, suggesting the observations between groups were independent. Further, there is no relationship between the observations within each group. Third, the homogeneity of variances was tested by Levene's Test of Equality of Error Variances (see Appendix III). Levene's test revealed that only the significance value of behavioural self-regulation was less than .05, suggesting that the equal variances assumption was only violated for this variable. However, it should be noted that Levene's test is sensitive to large data files. In other words, the test can detect even small departures from homogeneity when there are a large number of cases. Given the large total sample size (N = 576) and relatively equal sub-sample sizes (N_{girl} = 286, N_{boy} = 290; N_{K1} = 288, N_{K2} = 288) in the current study, ANOVA is robust to violations of homogeneity of variances. Therefore, this assumption was considered to be met. The results of the three ANOVA tests were summarised in Table 3 and SPSS outputs were shown in Appendix IV. The mean scores of

behavioural, cognitive and emotional self-regulation for different groups were presented in Table 4.

Behavioural Self-Regulation

A two-way ANOVA was set with gender (girl and boy) and age group (K1 and K2) as between-subjects factors and behavioural self-regulation as the dependent variable. There was a main effect of gender ($F_{[1, 572]} = 13.82$, $p < .001$, partial $\eta^2 = .02$) with a small effect size. Bonferroni pairwise comparisons revealed that girls ($M = 4.13$) achieved significantly higher scores on behavioural self-regulation than boys ($M = 3.90$). There was no main effect of age group ($F_{[1, 572]} = .34$, $p = .56$, partial $\eta^2 = .00$). However, there was a significant interaction between gender and age group ($F_{[1, 572]} = 4.69$, $p = .03$, partial $\eta^2 = .01$).

To investigate this interaction, an analysis of simple main effects was performed. By using the split file command in SPSS, separate ANOVA was performed on each level of age group with gender as a between-subjects factor. As shown in Table 3, there was a significant effect of gender for the analysis on K2 age group ($F_{[1, 286]} = 16.67$, $p < .001$, partial $\eta^2 = .06$) with a medium effect size, which reflected that K2 girls ($M = 4.21$) achieved significantly higher scores of behavioural self-regulation than K2 boys ($M = 3.85$). Although, K1 girls ($M = 4.04$) also averagely received higher ratings than K1 boys ($M = 3.95$), there was no significant effect of gender for K1 age group ($F_{[1, 286]} = 1.25$, $p = .26$, partial $\eta^2 = .00$). The data were then split by gender and the effect of age group was examined. An ANOVA with age group as a between-subjects factor revealed that there was a significant effect of age group for girls ($F_{[1, 284]} = 4.78$, $p = .03$, partial $\eta^2 = .02$) with K2 girls ($M = 4.21$) received significantly higher ratings than K1 girls ($M = 4.04$). There was no significant effect of age group for boys ($F_{[1, 288]} = 1.04$, $p = .31$,

partial $\eta^2 = .00$). However, it should be noted that K2 boys ($M = 3.85$) averagely received significantly lower ratings than K1 boys ($M = 3.95$).

Cognitive Self-Regulation

To investigate cognitive self-regulation, a separate two-way ANOVA was set with gender (girl and boy) and age group (K1 and K2) as between-subjects factors and cognitive self-regulation as the dependent variable. As shown in Table 3, there was no significant effect of gender ($F_{[1, 572]} = .47$, $p = .50$, partial $\eta^2 = .00$). However, there was a main effect of age group ($F_{[1, 572]} = 4.72$, $p = .03$, partial $\eta^2 = .01$) with a small effect size. Bonferroni pairwise comparisons revealed that K2 children ($M = 3.83$) achieved significantly higher scores on cognitive self-regulation than boys ($M = 3.70$). The interaction between gender and age group was non-significant ($F_{[1, 572]} = 2.67$, $p = .10$, partial $\eta^2 = .01$).

Although a non-significant interaction might suggest that there was no need to further examine simple main effects, the study also performed separate ANOVA to confirm this finding. The data were first split by age group and the effect of gender was examined. The results showed that there was no significant effect of gender for each level of age group (K1: $F_{[1, 286]} = .48$, $p = .49$, partial $\eta^2 = .00$; K2: $F_{[1, 286]} = 2.52$, $p = .11$, partial $\eta^2 = .01$). The data were then split by gender and the effect of age group was examined. The results revealed that there was a significant effect of age group for girls ($F_{[1, 284]} = 7.47$, $p = .01$, partial $\eta^2 = .03$) with K2 girls ($M = 3.90$) received significantly higher ratings of cognitive self-regulation than K1 girls ($M = 3.67$). Although K2 boys ($M = 3.76$) also averagely received higher ratings than K1 boys ($M = 3.73$), there was no significant effect of age group for boys ($F_{[1, 288]} = .14$, $p = .71$, partial $\eta^2 = .00$).

Emotional Self-Regulation

To explore the characteristics of emotional self-regulation, a two-way ANOVA was set with gender (girl and boy) and age group (K1 and K2) as between-subjects factors and emotional self-regulation as the dependent variable. As shown in Table 3, there was a main effect of gender ($F_{[1, 572]} = 11.74$, $p < .001$, partial $\eta^2 = .02$) with a small effect size. Bonferroni pairwise comparisons revealed that girls ($M = 4.15$) achieved significantly higher scores on emotional self-regulation than boys ($M = 3.97$). There was no main effect of age group ($F_{[1, 572]} = .26$, $p = .61$, partial $\eta^2 = .00$) and no significant interaction between gender and age group ($F_{[1, 572]} = 1.25$, $p = .36$, partial $\eta^2 = .00$).

Similarly, the study also performed separate ANOVA to confirm the finding of non-significant interaction. The data were first split by age group and the effect of gender was examined. The results showed that there was no significant effect of gender for K1 age group ($F_{[1, 286]} = .2.45$, $p = .20$, partial $\eta^2 = .01$). However, there was a significant effect of gender for K2 age group ($F_{[1, 286]} = 11.34$, $p < .001$, partial $\eta^2 = .04$) with K2 girls ($M = 4.19$) received significantly higher ratings of emotional self-regulation than K2 boys ($M = 3.95$). The data were then split by gender and the effect of age group was examined. The results showed that there was no significant effect of age gender for each gender (Girl: $F_{[1, 284]} = .1.42$, $p = .24$, partial $\eta^2 = .01$; Boy: $F_{[1, 288]} = .18$, $p = .68$, partial $\eta^2 = .00$).

Table 3.

ANOVA results

Predictor	SS	*df*	MS	*F*	*p*	partial η^2
Behavioural self-regulation						
(Intercept)	9281.86	1	9281.86	17254.83**	.00	.97
Gender	7.43	1	7.43	13.82***	<.001	.02

Age group	.18	1	.18	.34	.56	.00
Gender * Age group	2.53	1	2.53	4.69*	.03	.01
Error	307.70	572	.54			
Cognitive self-regulation						
(Intercept)	8157.00	1	8157.00	14378.11**	.00	.96
Gender	.26	1	.26	.47	.50	.00
Age group	2.68	1	2.68	4.72*	.03	.01
Gender * Age group	1.51	1	1.51	2.67	.10	.01
Error	324.51	572	.57			
Emotional self-regulation						
(Intercept)	9484.52	1	9484.52	23931.85**	.00	.98
Gender	4.65	1	4.65	11.74***	<.001	.02
Age group	.10	1	.10	.26	.61	.00
Gender * Age group	.50	1	.50	1.25	.36	.00
Error	226.69	572	.40			

Note. SS = Type III Sum of Squares. MS = Mean Square. *p < .05; **p < .01; ***p < .001.

Table 4.

Mean score of behavioural, cognitive and emotional self-regulation for the total sample and different subgroups

	M								
	Total sample	Gender		Age group		Gender and Age group			
		Girl	Boy	K1	K2	K1 girl	K2 girl	K1 boy	K2 boy
BehSR	4.01	4.13	3.90	4.00	4.03	4.04	4.21	3.95	3.85
CogSR	3.76	3.78	3.74	3.70	3.83	3.67	3.90	3.73	3.76

EmoSR	4.06	4.15	3.97	4.05	4.07	4.11	4.19	3.98	3.95

Note. BehSR = Behavioural self-regulation. CogSR = Cognitive Self-regulation. EmoSR = Emotional self-regulation. Total sample: N = 576; Girl: N = 286; Boy: N = 290. K1: N = 288; K2: N = 288; K1 girl: N = 144; K2 girl: N = 142; K1 boy: N = 144; K2 boy: N = 146.

To summarise these findings, girls in total achieved significantly higher scores on behavioural and emotional self-regulation than boys, while cognitive self-regulation scores between girls and boys were not significantly different. A closer inspection of gender differences revealed that K1 girls did not receive significantly different ratings of any aspect of self-regulation compared with K1 boys, while among K2 children, girls were given significantly higher ratings of behavioural and emotional self-regulation than boys. Despite the comparison of girls and boys, the current study also compared the scores of these aspects of self-regulation between K1 and K2 age groups. The results revealed that K2 children only received significantly higher ratings of cognitive self-regulation than K1 children. A closer inspection of the developmental patterns showed that compared with K1 girls, K2 girls were given significantly higher ratings of behavioural and cognitive self-regulation, while K2 and K1 boys did not show any significantly different ratings of any aspects of self-regulation. The significance of age differences between K1 and K2 children was of particular interest. An independent samples t-test revealed that K2 children (M = 54.76 months) were significantly older than K1 children (M = 44.02 months; $t(574) = -33.60$, $p < .001$).

Following these results, the current study was interested in two questions. First, whether the gender differences were similar across specific age groups? Second, whether a similar developmental pattern also emerged among specific age groups? In order to address these two questions, the study performed additional analysis in which the sample were divided into three

different age groups: younger-aged group (age range: 35 – 44 months; N = 187, M = 42.04 months), middle-aged group (age range: 45 – 53 months; N = 213, M = 49.36 months) and older-aged group (age range: 54 – 69 months; N = 176, M = 57.24 months). Age differences were significant across three age groups (all $p < .001$). Power analysis suggested that the sample size is sufficient to detect a statistical significance when the children were divided into three age groups (see Appendix V).

In terms of the first question, the results showed that girls and boys from both younger-aged and middle-aged groups were not given significantly different ratings of all three aspects of self-regulation (all $p > .05$). In older-aged group (age range: 54 – 69 months), however, girls received significantly higher ratings than boys in behavioural ($p < .001$), cognitive ($p = .029$) and emotional self-regulation ($p = .003$). In terms of the second question, in accordance with the comparisons of K1 and K2 age groups, teachers' ratings of behavioural and emotional self-regulation were again not significant across the three age groups (all $p > .05$), while older-aged children received higher ratings of cognitive self-regulation than both middle-aged ($p = .047$) and younger-aged children ($p < .001$), and there was a trend that middle-aged children were given higher cognitive self-regulation ratings than younger-aged children ($p = .08$). When gender was taken into account, the results showed that girls from the older-aged group were given significantly higher ratings of behavioural and cognitive self-regulation than those from the middle- and younger-aged group, and middle-aged girls also received significantly higher ratings on these two aspects of self-regulation than younger-aged girls. Girls' emotional self-regulation scores were not significantly different across the three age groups. Among boys, there was no significant difference in any aspect of self-regulation across the three age groups.

4.3. Associations among different aspects of self-regulation and academic outcomes

Numeracy

The first regression analysis aimed at addressing whether the different aspects of self-regulation including behavioural, cognitive and emotional self-regulation are significantly and uniquely associated with numeracy outcomes. Before performing analysis, the assumptions of multiple regression were checked (see Appendix VI). First, both the dependent variable – numeracy, and the independent variables – age, behavioural self-regulation, cognitive self-regulation and emotional self-regulation, were treated as normally distributed and continuous variables. Gender was measured on a nominal scale with two levels: 1= girl and 2 =boy. Second, the regression analysis assumes the homoscedasticity of variance in which the variances of errors terms should be similar across the values of independent variables (Osborne & Waters, 2002). A plot of standardised residuals versus predicted values revealed that the points were equally distributed across all values of the independent variables, suggesting that this assumption was met. Third, multiple regression assumes that the independent variables are not highly correlated with each other (Daoud, 2017). Based on the collinearity statistics, no tolerance values were below 0.2, the VIF values were well below ten and the average of them was not substantially above 1, indicating that there was no evidence of multi-collinearity (Field, 2009). Therefore, all assumptions of the regression model have been met. A hierarchical and enter approach was taken to determine the amount of variance in numeracy scores that was accounted for by children's different aspects of self-regulation, taking into account the control variables (gender and age). This was done by entering gender and age in months into the first block and the three aspects of self-regulation into the second block. The dependent variable was numeracy score.

Final standardised betas were presented in Table 5 to examine the relative predictive power of the variables. Gender did not predict numeracy scores in the first step of the model (p = .22) and remained a non-significant predictor in the final model for numeracy scores (p = .11). However, age was a significant in both the first step of the model (β = 63, p < .001) and the final mode (β = 60, p < .001) for numeracy scores. Following entry of age and gender, we then considered the predictive role of behavioural, cognitive and emotional aspects of self-regulation. All three aspects of self-regulation were uniquely and significantly associated with numeracy scores, and altogether contributed an additional 5% of variance to children's numeracy scores after the effects of gender and age were statistically controlled (ΔR^2 = .05, $\Delta F_{[3, 570]}$ = 16.23, p < .001). Cognitive self-regulation was the strongest predictor of numeracy (β = .17, p < .001), followed by behavioural self-regulation (β = .14, p = .003) and emotional self-regulation (β = -.11, p = .009).

Table 5.

Hierarchical regression explaining numeracy from self-regulation

	R^2	ΔR^2	$\Delta F_{(df1, df2)}$	Final B	SE	Final β
Block 1	.40	.40	189.86 $_{(2, 573)}$***			
Gender				.02	.01	.05
Age				.02	.00	.60***
Block 2	.45	.05	16.23 $_{(3, 570)}$***			
BehSR				.04	.01	.14**
CogSR				.05	.01	.17***
EmoSR				-.04	.01	-.11**

Note. Gender: 1 = girl, 2 = boy. BehSR = Behavioural self-regulation. CogSR = Cognitive Self-regulation. EmoSR = Emotional self-regulation. *$p < .05$; **$p < .01$; ***$p < .001$.

Literacy

The second regression analysis aimed at addressing whether the different aspects of self-regulation including behavioural, cognitive and emotional self-regulation are significantly and uniquely associated with literacy outcomes. Before performing analysis, the assumptions of multiple regression were also checked. The procedures were similar to those of the first regression model's assumption test, but the dependent variable was replaced by "literacy". Appendix VII shows that all assumptions of regression analysis were met, including the characteristics of variables, homoscedasticity of variance, normally distributed residuals and non-multi-collinearity. Entered procedures were similar to the previous one, in which gender and age in months were entered into the first block and the three aspects of self-regulation into the second block, while the dependent variable in this regression model was literacy score.

Table 6 shows the results of the second regression model. Similar to the predictive pattern of numeracy, gender did not predict literacy scores in the first step of the model ($p = .33$) and remained a non-significant predictor in the final model ($p = .61$) for literacy scores. While age was a significant in both the first step of the model ($\beta = 55$, $p < .001$) and the final mode ($\beta = 52$, $p < .001$). All three aspects of self-regulation were uniquely and significantly associated with literacy scores, and altogether contributed an additional 5% of variance to children's literacy scores after the effects of gender and age were statistically controlled, ($\Delta R^2 = .05$, $\Delta F_{[3, 570]} = 15.34$, $p < .001$). Cognitive ($\beta = .16$, $p < .001$) and behavioural self-regulation ($\beta = .16$, $p = .002$) were the strongest predictors, followed by emotional self-regulation ($\beta = -.10$, $p = .047$).

Table 6.

Hierarchical regression explaining literacy from self-regulation

	R^2	ΔR^2	$\Delta F_{(df1, df2)}$	Final *B*	*SE*	Final β
Block 1	.30	.30	$125.23_{(2, 573)}^{***}$			
Gender				-.01	.01	-.02
Age				.02	.00	$.52^{***}$
Block 2	.36	.05	$15.34_{(3, 570)}^{***}$			
BehSR				.04	.01	$.16^{**}$
CogSR				.04	.01	$.16^{***}$
EmoSR				-.03	.01	$-.10^{*}$

Note. Gender: 1 = girl, 2 = boy. BehSR = Behavioural self-regulation. CogSR = Cognitive Self-regulation. EmoSR = Emotional self-regulation. *$p < .05$; **$p < .01$; ***$p < .001$.

Moderating Effects of Age and Gender

In order to determine whether age and gender interacted with the associations among any aspect of self-regulation and numeracy as well as literacy, a further four models were performed in which control variables were again entered into block 1, followed by the three aspects of self-regulation. In the third block, three interactions terms (Behavioural Self-Regulation*Age in Months, Cognitive Self-Regulation* Age in Months and Emotional Self-Regulation*Age in Months) were entered when examining the moderating role of age, while for assessing the moderating role of gender, another three interaction terms (Behavioural Self-Regulation*Gender, Cognitive Self-Regulation*Gender and Emotional Self-Regulation*Gender) were entered. None of the interaction terms was significant in any of the four models, suggesting that the associations among behavioural, cognitive and emotional self-regulation and numeracy as literacy (i.e., 6

independent associations in total) were similar for different ages, and for girls and boys (see Appendix VIII).

5. Discussion

The current study aims to provide a comprehensive profile of a sample of Chinese preschoolers' behavioural, cognitive and emotional self-regulation by investigating their characteristics in relation to gender and age, examining their associations with numeracy and literacy, and testing the moderating effects of age and gender on these associations.

5.1. Characteristics of Self-Regulation

The current study found that Chinese girls received higher teachers' ratings of behavioural and emotional self-regulation than Chinese boys in general. This result extended previous research finding that girls outperformed boys in teachers' ratings of a single construct of self-regulation among Western children (von Suchodoletz et al., 2013; Weis et al., 2013). A closer inspection of gender differences in self-regulation in relation to age revealed interesting developmental tendency which showed the girl's advantages only emerged in K2 rather than K1 classrooms. Specifically, only K2 girls received higher ratings of behavioural and emotional self-regulation than K2 boys, while the differences between K1 girls and boys were not significant. Additional analysis using the three specific age groups also confirmed this finding by revealing only girls from the older-aged group rather than the younger- and middle-aged group, showed advantages of self-regulation.

These results can be interpreted from two perspectives. First, it has been suggested that teachers may hold different expectations for boys and girls (Beaman et al., 2006; Cooper & Farran, 1988). Teachers' expectations are highly influenced by the societal expectations of gender's conception, identity and role (Bronstein, 2006). In other words, such expectations define the behaviours, thoughts and emotions that are seen as gender appropriate within one's cultural background (Bronstein, 2006). Given the consistent and robust evidence regarding girls'

advantages of self-regulation across countries, it can be further hypothesised that expectations of girls and boys may be similar globally. Further, although the current study did not adopt a task-based self-regulation measure, girls are also shown to perform better on these tasks (Duckworth & Seligman, 2006; Matthews et al., 2009; Mischel & Underwood, 1974). It can be understood from a biological perspective, such as the sexual dimorphisms within the mesocorticolimbic dopamine pathway (MCLP) and sex hormones (Hosseini-Kamkar & Morton, 2014). Therefore, it can be concluded that girls generally show better self-regulation skills than boys regardless of measures. Second, the current study found that girls failed to show advantages of self-regulation at earlier stages (e.g., those from the K1 age group or the younger-and middle-age groups). The reason can be simply attributed to the biological difference which may only exert an influence on self-regulation at later stages. However, given that relatively fewer studies have explored gender differences in self-regulation during such early years, it remains unclear whether this pattern is similar across studies. Moreover, it has been evidenced that gender differences in self-regulation existed in primary school but disappeared during young adulthood among Western samples (Vukman & Licardo, 2010). Therefore, there is certainly a need for future longitudinal research to verify these patterns and uncover the gender gap in self-regulation.

When comparing the scores of different aspects of self-regulation between K1 and K2 age groups, although K2 children were given significantly higher teachers' ratings of cognitive self-regulation than K1 children, there was no significantly different rating of either behavioural or emotional self-regulation between K1 and K2 children. Indeed, although K2 children were averagely given higher ratings by teachers on behavioural and emotional self-regulation, the differences were subtle and non-significant (i.e., behavioural self-regulation: $M_{K1} = 4.00$ and $M_{K2} = 4.03$; emotional self-regulation: $M_{K1} = 4.04$ and $M_{K2} = 4.07$). Further, as presented in Table 2,

age was not significantly associated with either behavioural or emotional self-regulation and had only small sized correlations with cognitive self-regulation. According to developmental research, it is generally assumed that children's self-regulation will increase as age (Demetriou, 2000), such findings are quite intriguing especially in the light of the finding that K2 children were significantly older than K1 children. One possible explanation of this similar performance might be attributed to the specific characteristics of Chinese preschool classrooms. As previously discussed, although Chinese preschools and kindergartens tend to adopt elements and activities from Western curriculum, the traditional Chinese values and norms still unintentionally and highly influence the daily practice within institutions, in which children are required to obey teachers' and parents' instructions in many instances. For example, "You should not express high-arousal positive emotions" (Davis et al., 2012; Tsai et al., 2007, Zhou et al., 2019), "You should not speak in the classroom without raising your hand" and "You should not eat until everyone gets their meal" (Wanless et al., 2011a). Such instructions may initially aim to enable the child to be consistent with the Chinese societal values and behave in a socially acceptable manner. However, children's self-regulation might develop unintentionally and rapidly, particularly the development of behavioural and emotional regulation which may be more directly affected by these given instructions both in kindergartens and at home, compared with the cognitive aspect that is more reflected by executive functioning which is closely associated with the developing brain and therefore age. This assumption was supported by additional analysis using the three specific age groups which revealed that the differences in behavioural and emotional self-regulation were non-significant across the three groups, while the older-aged children were given significantly higher ratings of cognitive self-regulation than both the middle-

and younger-aged children, and there was a trend that children from the middle-aged group received higher cognitive self-regulation ratings than those from the younger-aged group.

Therefore, it is reasonable to assume that both the K1 and K2 children (or the older-aged and middle-aged children in additional analysis) may have already achieved their potential in behavioural and emotional self-regulation at their current stage, in which this potential is less influenced or even not set by their ages, rather their experiences of parenting and formal schooling. Furthermore, several longitudinal studies have provided evidence that the growth of behavioural and emotional self-regulation is non-linear with rapid gains in early years followed by a decelerating rate of gain in performance (Montroy et al., 2016; Ponitz et al., 2008). Although such rapid growth often occurs after age three and during early childhood (Kopp, 1982; Cole et al., 2010; Rothbart et al., 2006), considering the age range of children from the current study, it remains possible that Chinese children develop the skills that support their behavioural and emotional self-regulation at an earlier stage due to the characteristics of the Chinese teaching and parenting styles. On the other hand, children's ages still constrain their potential in cognitive self-regulation because self-regulation may come in different forms at different developmental stages, in which children generally progress from reactive or co-regulated behaviours and emotional regulation to more advanced cognitive forms of self-regulation from the ages of three to seven, which require the integration of EFs and language skills (Calkins, 2007; Diamond, 2002, 2016; Kopp, 1982; Montroy et al., 2016).

The above discussion of developmental patterns was based on the results when the children were analysed as a whole. However, a closer inspection of developmental patterns in relation to gender suggested that there might be different pictures of girls' and boys' development of these aspects of self-regulation. Specifically, the findings of the current study

demonstrated that K2 girls showed significantly better behavioural and cognitive self-regulation than K1 girls, while K2 and K1 boys did not show significant differences in any aspects of self-regulation. These findings were also confirmed by the additional analysis in which older-aged girls showed better behavioural and cognitive self-regulation than middle- and younger-aged girls, while boys from the older-aged group failed to show advantages of any aspects of self-regulation compared with those from the two younger groups. Further, it was unexpected that K2 boys (or older-aged boys) averagely received lower ratings of behavioural and emotional ratings of self-regulation than their younger counterparts. The current study attributed this result to the uncontrolled rating process in which children's self-regulation was rated by their class teacher rather than the researchers. As described in Section 3.2. Participants, a total of 576 children and 96 teachers participated in the study, therefore one teacher was only responsible for rating the six students from his or her class. There might be different rating standards and criteria among those teachers. On the other hand, considering that older-aged girls but not older-aged boys showed advantages of self-regulation compared with their younger counterparts, it remains possible that there might be different developmental trajectories of girls' and boys' self-regulation. Therefore, it is necessary for further research to confirm this assumption and ensure that the examiners hold similar rating standards.

5.2. Associations between Self-Regulation and Academic Outcomes

Along with exploring the characteristics of Chinese children's behavioural, cognitive and emotional self-regulation regarding gender and age, another aim of the current study is to investigate their associations with numeracy as well as literacy outcomes. To our knowledge, there have been no, if any, studies exploring the associations between different aspects of self-regulation and academic outcomes. The current study revealed that behavioural, cognitive and

emotional self-regulation were all uniquely and significantly associated with numeracy and literacy scores after controlling for age and gender. Although the relationships among self-regulation and numeracy as well as literacy have been consistently identified (Robson et al., 2020; Skibbe et al., 2019), this study extended previous research by examining different contributions of behavioural, cognitive and emotional self-regulation to academic outcomes.

In terms of numeracy, cognitive self-regulation emerged as the strongest predictor, followed by behavioural and emotional self-regulation. Previous research has suggested that the mathematical problem-solving process requires intensive cognitive and metacognitive strategies (Blair & Razza, 2007; Freeman-Green et al., 2015; Zhou et al., 2012), which might be beneficial for explaining the relatively greater predictability of cognitive self-regulation. However, although cognitive self-regulation (i.e., inhibitory control) is more important for mathematics rather than literacy performance (Allan et al., 2014; Blair & Razza, 2007; Robson et al., 2020), the current study revealed that cognitive self-regulation may be important for both numeracy and literacy to a similar extent. Literacy was also predicted by behavioural self-regulation which had a similar predictive power as cognitive self-regulation, followed by emotional self-regulation.

However, it is interesting to note that the standardised regression coefficients for emotional self-regulation were negative in both the numeracy and literacy regression models, suggesting that numeracy and literacy scores are expected to decrease when emotional self-regulation scores increase. Further, Table 2 showed that the association between emotional self-regulation and numeracy was the weakest one in numeracy's associations with the three aspects of self-regulation, and there was a similar pattern in literacy's associations. In accordance with the studies investigating the association between emotional-self-regulation and academic achievement (as discussed in Section 2.3. Self-Regulation and Academic Achievement; Belsky

et al., 2001; Howse et al., 2003; Morrison et al., 2010; Trentacosta & Izard, 2007), the findings of the current study may suggest that emotional self-regulation might not be an influential predictor of Chinese children's academic outcomes, compared with behavioural and cognitive self-regulation.

5.3. Moderating Effects of Age and Gender

Moreover, the current study tested the moderating effects of age and gender on the associations among behavioural, cognitive and emotional self-regulation and numeracy as well as literacy scores. In terms of age, the study revealed that although older children achieved higher scores on both numeracy and literacy than younger children, the associations between different aspects of self-regulation and numeracy as well as literacy were similar across ages. Additional analyses also supported this finding by revealing that these associations were similar across the K1 and K2 age groups, or the younger-, middle and older-aged groups. In contrast with most studies finding that girls outperformed boys in academic outcomes (Duckworth & Seligman, 2006; Eccles, 1997; Weis et al., 2013), the current study failed to identify a significant difference of either numeracy or literacy scores between girls and boys. Further, although the study revealed that girls outperformed boys in behavioural and emotional self-regulation after certain ages, the relationships between each aspect of self-regulation and numeracy as well literacy were similar across sexes.

6. Conclusion

6.1. Limitations

It is worth noting here that my initial plan for the current dissertation was conducting a pathway structural equation model testing of different forms of self-regulation as mediators of the association between social-emotional skills and academic achievement. However, the resulting model failed to reach an acceptable model fit (Chi-square = 2326.394, *df* = 549; Chi-square / df = 4.238, $p < .001$; TLI = .751, CFI = .770, RMSEA = .075). After discussing with my supervisor and a statistics tutor from the department, I adapted my research questions and analysis plan to the current one using the same dataset.

The current study added to the literature on Chinese children's behavioural, cognitive and emotional self-regulation by exploring their characteristics in relation to age and gender, and associations with numeracy and literacy. However, some limitations should be noted. First, all of the participants in this study came from Shenzhen, China. Initial inclusion criteria have emphasised the diversity of districts, socio-economic backgrounds and kindergarten types, however, the samples were only regionally representational of the relatively homogenous population and the results may only represent the self-regulation profile of children from Shenzhen. Therefore, it is necessary to replicate this study with a more diverse sample including children from multiple geographic areas in China, to provide a more generalisable profile of Chinese children's self-regulation.

Second, although the self-regulation measure adopted by the current study, the CSBQ, is beneficial for capturing children's three aspects of self-regulation by a single measure, it has not been validated under the Chinese setting. Due to time constraints, the current study failed to conduct a complete factor analysis (i.e., factor analysis generally includes an exploratory factor

analysis and a confirmatory factor analysis) of the CSBQ. By performing reliability analysis only, this study has attempted to evaluate the internal consistency of the three self-regulation subscales of the CSBQ. Since the CSBQ is effective not only in assessing children's different aspects of self-regulation but also in capturing children's internalising, externalising, prosocial and sociability, this study suggests that it is imperative for researchers to adapt and validate the CSBQ not only in the context of China but also in other non-native English-speaking countries, enabling the researcher to assess a wide range of self-regulation skills, behaviour problems and social functioning using a single measure. However, it should be noted that there appear to be discontinuities between reported perceptions and actual behaviours, which may influence the veracity and accuracy of results (Faulkner et al., 2014; Hammer et al., 2017; Antrop et al., 2002). Further research should also consider using a combination of task-based and report-based self-regulation measures.

Third, as a secondary data analysis, the current study was limited by the categories and number of variables collected by the original study. For example, although the only two accessed demographic variables (age and gender) were statistically controlled during analysis, this study failed to control for the effects of intelligence or socio-economic status (SES) which is strongly associated with both self-regulation and academic achievement (Edossa et al., 2017; Lengua et al., 2015). Although several studies have revealed that self-regulation predicts academic outcomes beyond the influence of intelligence and SES (Blair & Razza, 2007; von Suchodoletz et al., 2013), given that this is the first attempt to explore behavioural, cognitive and emotional self-regulation simultaneously either in China or in Western countries, it is interesting to see their unique contributions to academic outcomes after statistically controlling for influential demographic variables. Moreover, as a result of the failure to control for the abovementioned

variables, the current study did not imply any causal relationship (Edossa et al., 2017). More longitudinal research with a wide range of controlled variables is necessary to further understand the causal relationships between different aspects of self-regulation and academic outcomes. It would be beneficial if future studies could investigate this association with at least three time points.

6.2. Implications

The current study has several theoretical and practical implications. From a theoretical perspective, although it is widely evidenced that girls tend to show better self-regulation than boys, this study revealed that girls' advantages only emerged at later stages during preschool. Furthermore, girls from older-aged groups showed better self-regulation than those from younger-aged groups, while a difference was not identified among boys from different age groups. These findings provide further research with implications that biological differences between girls and boys may only exacerbate the gender differences in self-regulation at certain stages. These biological influences may be not limited to self-regulation but also a wide range of cognitive and non-cognitive outcomes. Further, it is also interesting to take into account parenting styles and the preschool as well as home learning environment, and to explore how girls and boys develop their self-regulation skills differently. In terms of practical implications, considering the mounting and compelling evidence supporting the effect of self-regulation skills on children's concurrent and long-term outcomes, effective early interventions targeting self-regulation may provide a promising opportunity for parents and educators to support children's trajectories across the lifespan (Howard et al., 2020). The findings of this study suggest that behavioural, cognitive and emotional self-regulation uniquely and significantly contributed to Chinese children's numeracy as well as literacy performance. Therefore, these areas should be

directly and effectively addressed by the design of intervention programs. Further, since the development of behavioural and emotional self-regulation is benefited from the daily practices in Chinese classrooms and families, cognitive self-regulation should receive more focus. Finally, the intervention should be embedded in children's social contexts for transferring intervention effects to real-world outcomes (Howard et al., 2020).

6.3. Conclusion

The current study might be the first to explore the profile of behavioural, cognitive and emotional self-regulation among either Chinese children or Western Children. Specifically, extending previous research finding girls outperformed boys in self-regulation, this study revealed that this advantage only emerged at later preschool stages among Chinese girls. In contrast with some studies, however, older children failed to show any advantages of behavioural and emotional self-regulation over younger children. A detailed inspection of girls and boys from different age groups revealed that girls from older-aged groups showed better behavioural and cognitive self-regulation than those from younger-aged groups, while boys did not transfer any age advantages to self-regulation. In addition, by examining the associations between different aspects of self-regulation and numeracy as well as literacy separately, the study found that behavioural, cognitive and emotional self-regulation were all significantly associated with numeracy as well as literacy scores. These findings add to a growing literature that has investigated the characteristics of Chinese children's self-regulation and to the literature focusing on the role of different aspects of self-regulation in Chinese children's early academic outcomes.

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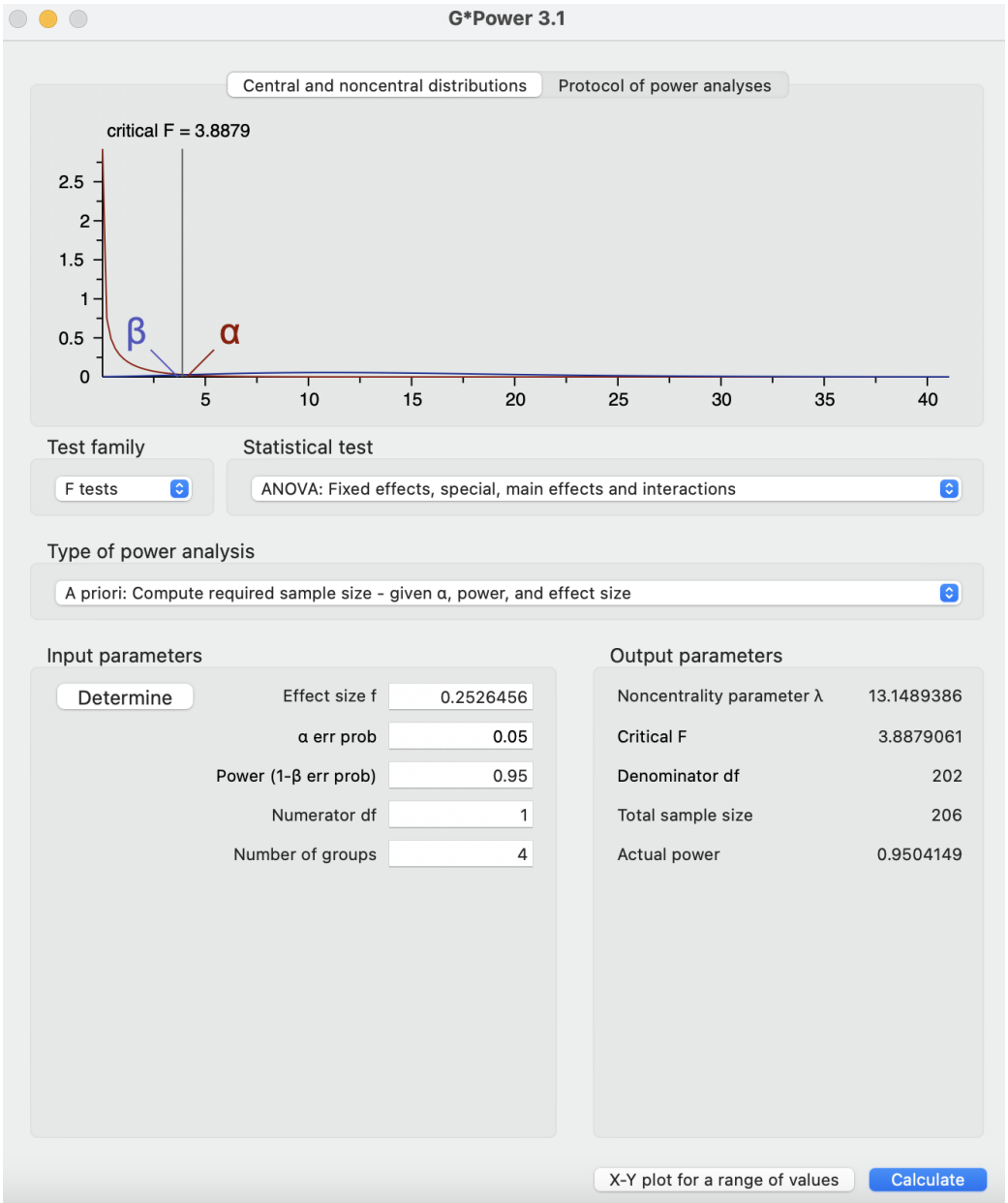
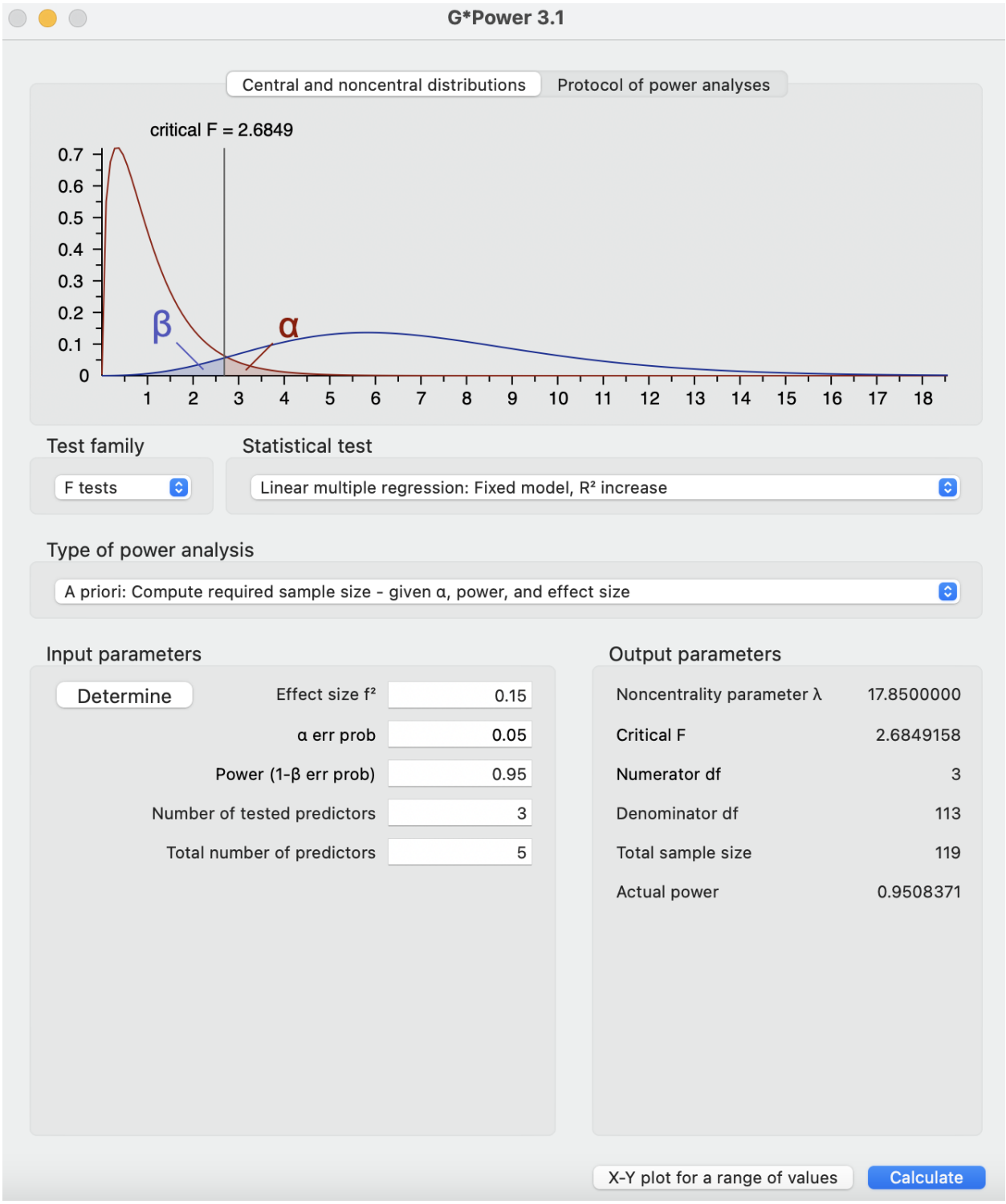
Appendix I

ANOVA power analysis

Powering the predictor variables gender (2 levels), age group (2 levels) and interactions (gender * age group). The effect size was assumed as medium effect size (0.06). The error rate was chosen as 0.05. The statistical power was selected at 0.95. The number of groups was 6 (2 * 2 = 4).The numerator df value for the predictor variable was found by the taking the number of levels and subtracting one. In this case, the numerator df values for both gender and age group were 1 (2 – 1 = 1 df). The numerator df value for the interaction was found by multiplying the df values for both predictors. In this case, the numerator df value for the interaction was 1 (1 * 1 = 1 df).

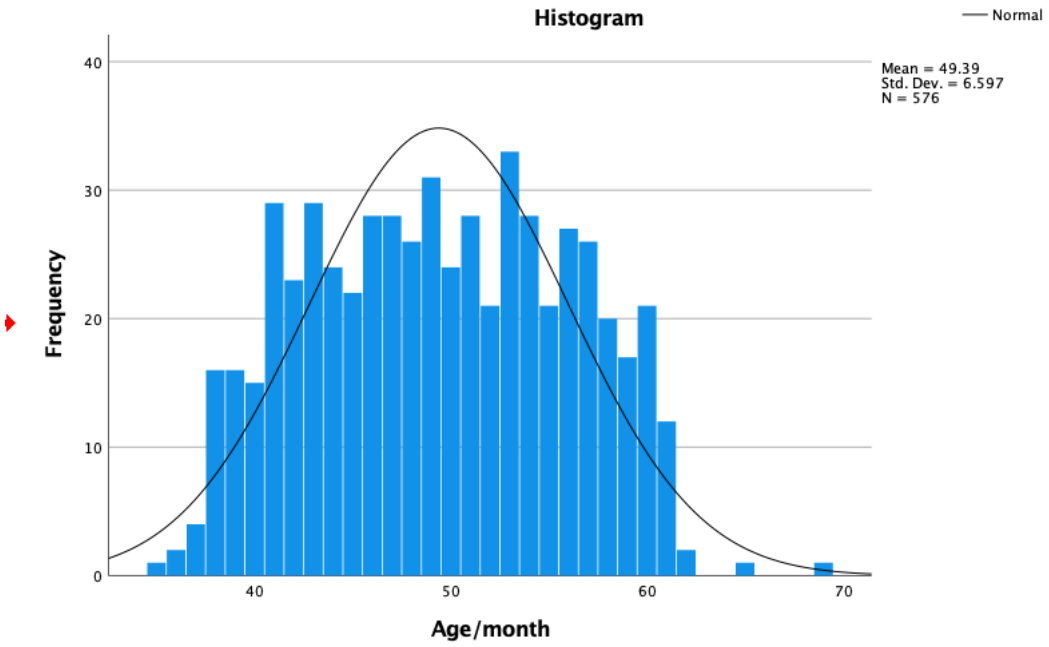


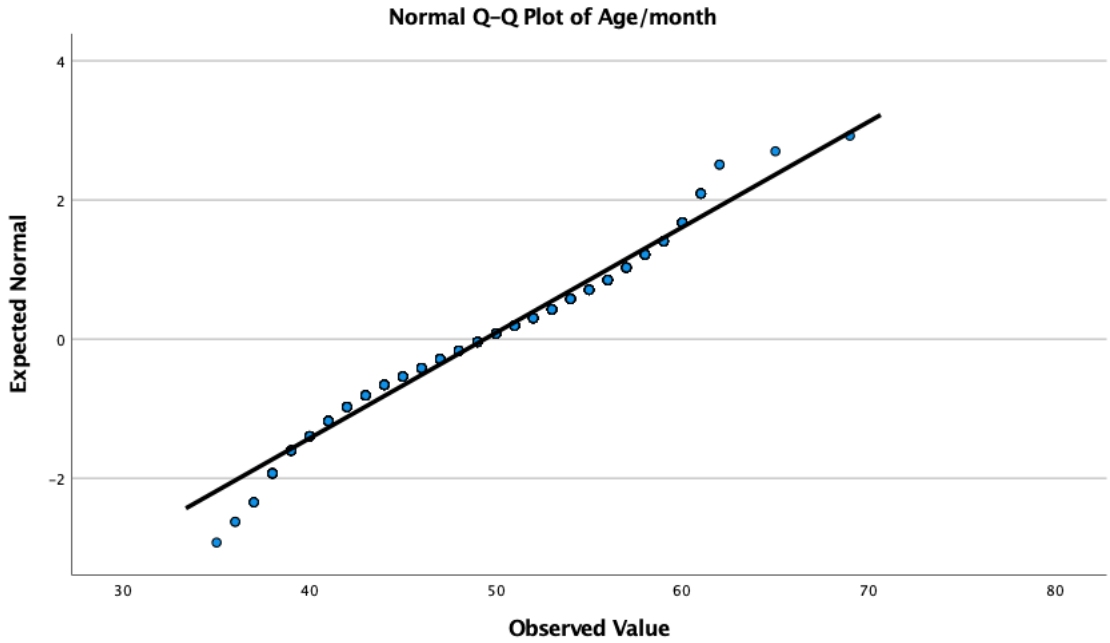
Regression power analysis



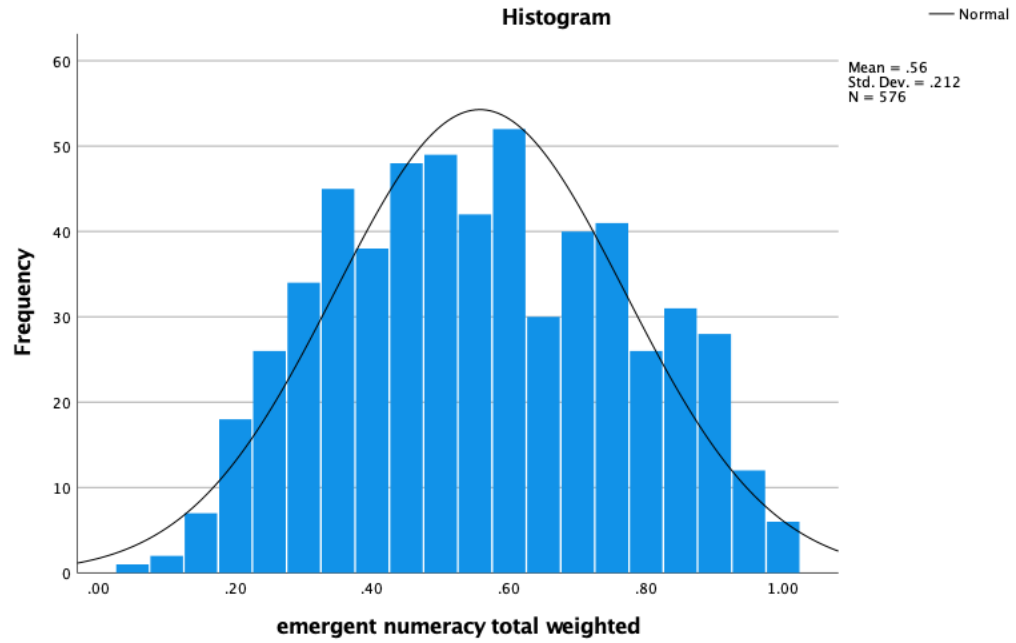
Appendix II

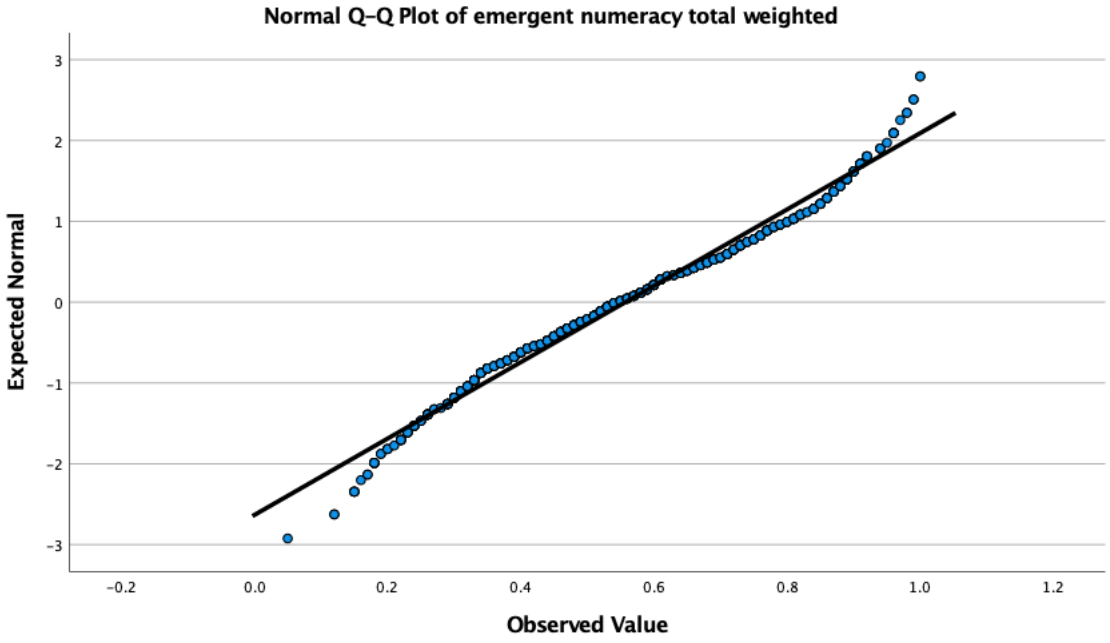
Age in months – normality check (histogram and Q-Q plot)



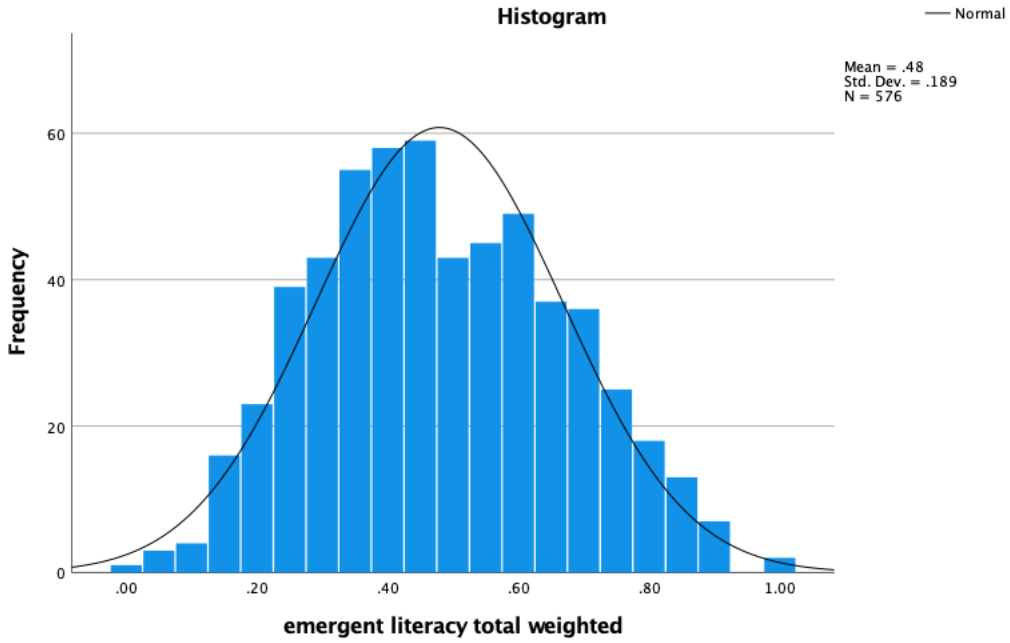


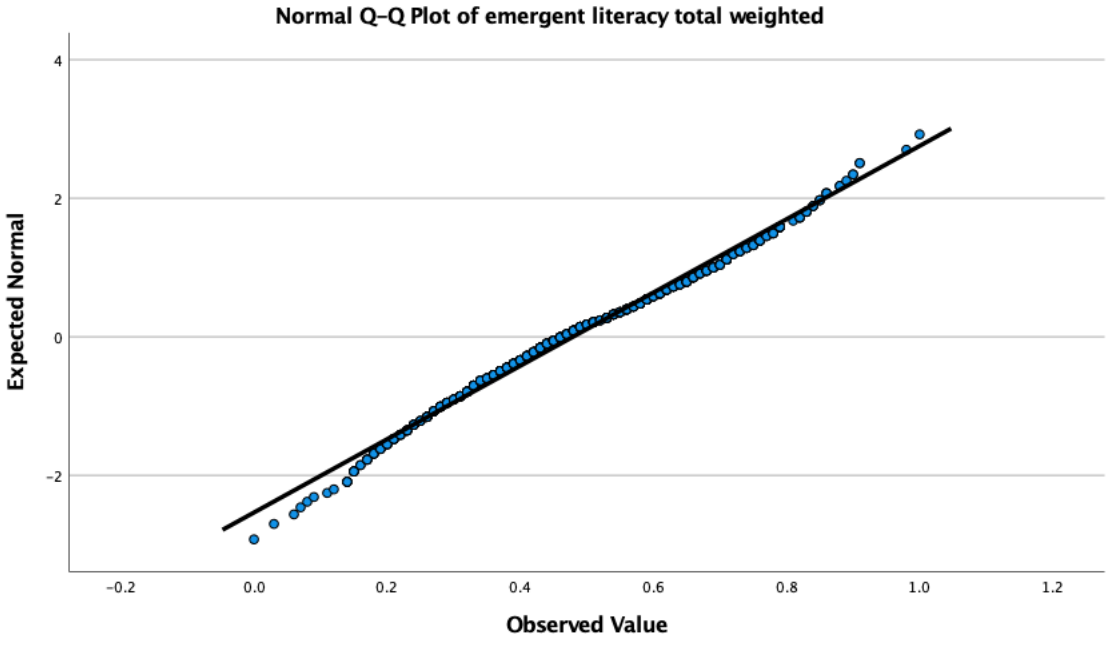
Numeracy scores – normality check (histogram and Q-Q plot)



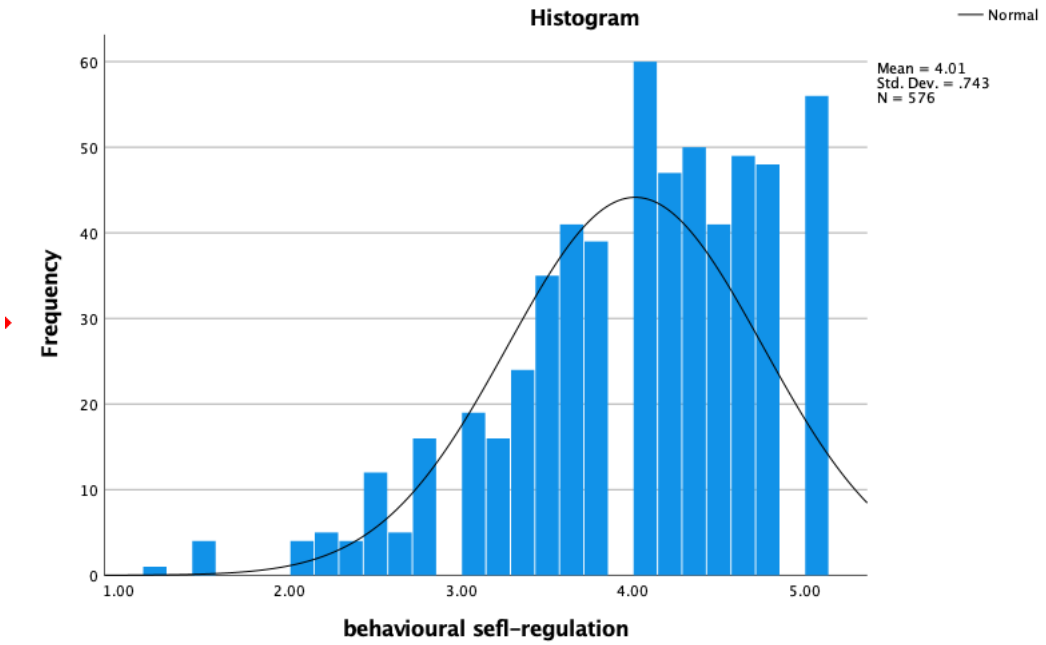


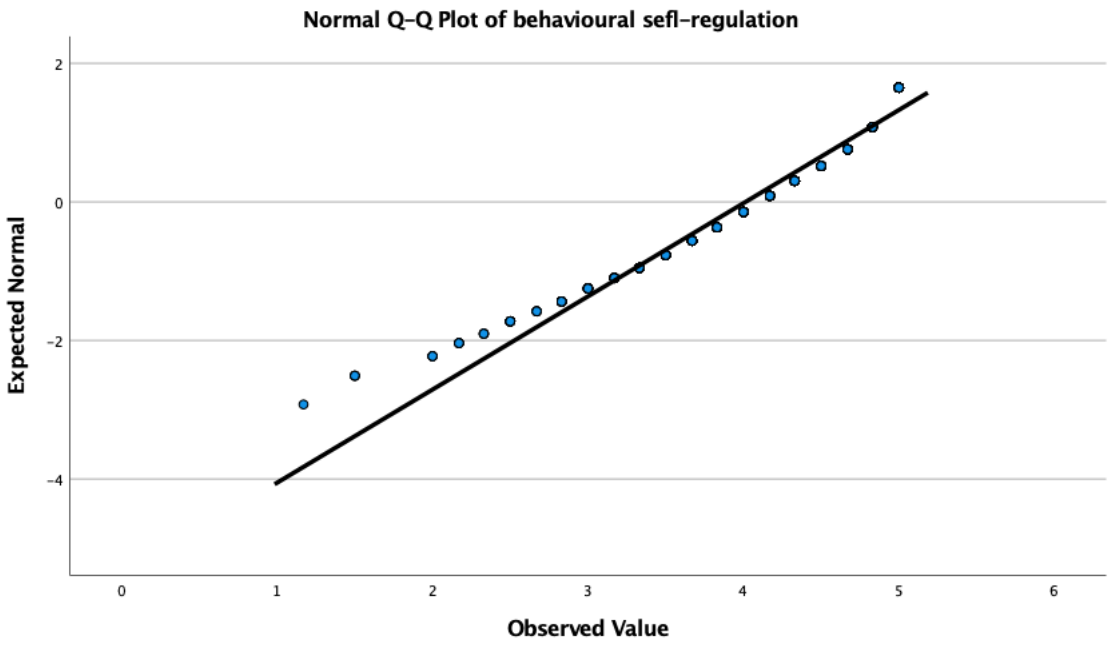
Literacy scores – normality check (histogram and Q-Q plot)



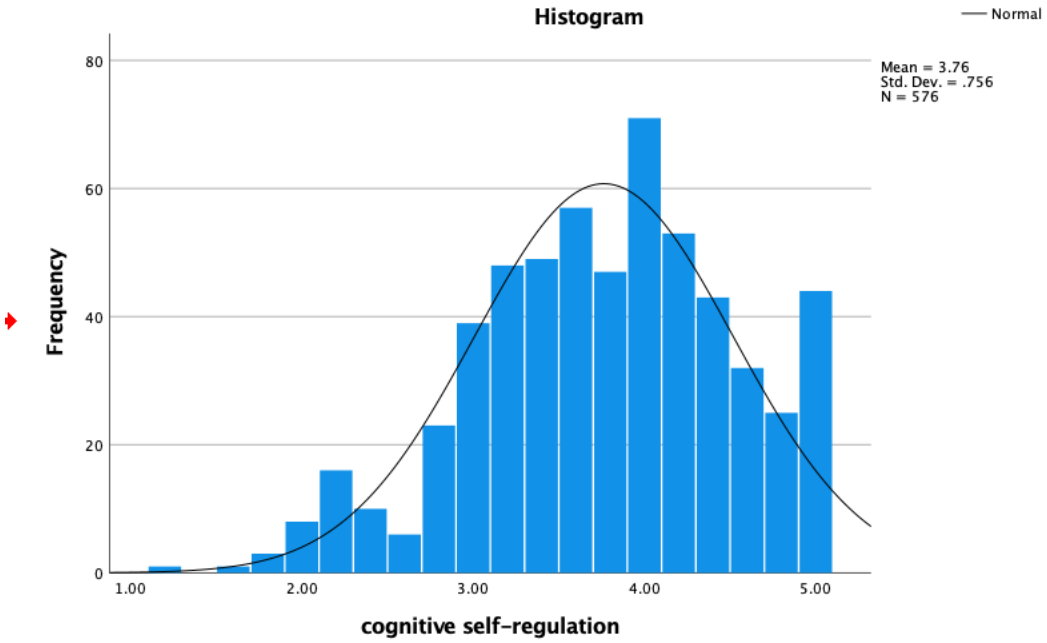


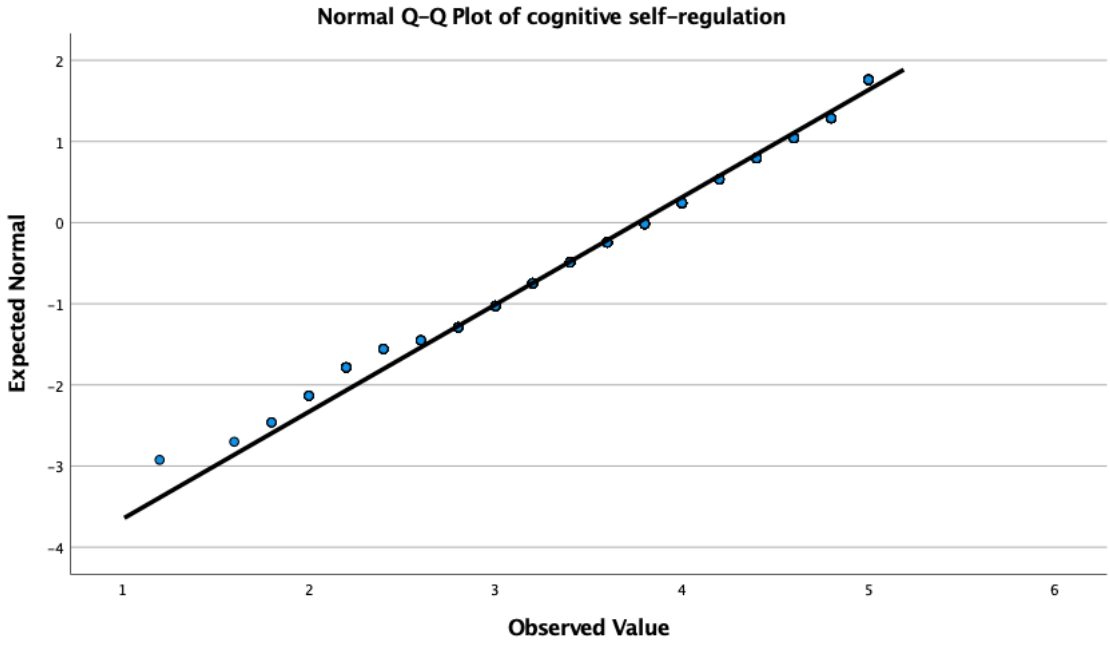
Behavioural self-regulation scores – normality check (histogram and Q-Q plot)



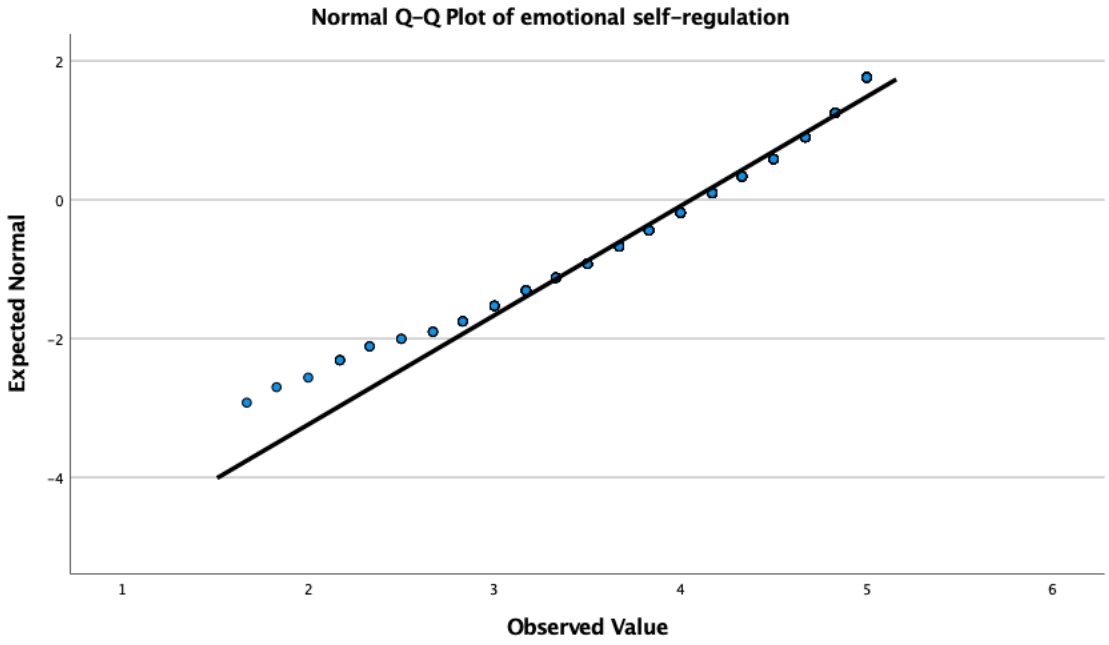


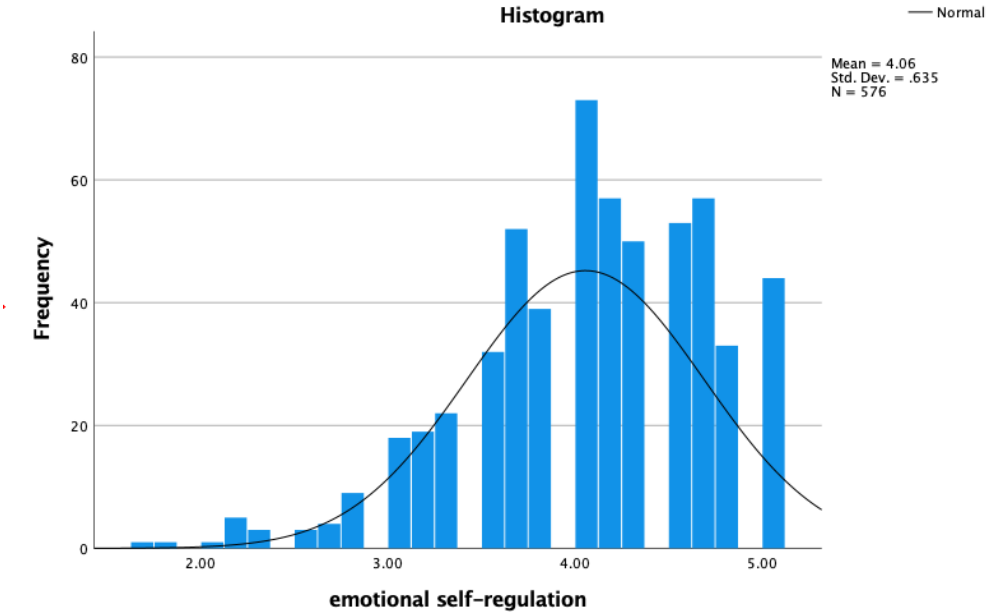
Cognitive self-regulation – normality check (histogram and Q-Q plot)





Emotional self-regulation – normality check (histogram and Q-Q plot)





All variables – normality check (skewness and kurtosis)

Descriptives

			Statistic	Std. Error
Age/month	Mean		49.39	.275
	95% Confidence Interval for Mean	Lower Bound	48.85	
		Upper Bound	49.93	
	5% Trimmed Mean		49.39	
	Median		49.00	
	Variance		43.515	
	Std. Deviation		6.597	
	Minimum		35	
	Maximum		69	
	Range		34	
	Interquartile Range		11	
	Skewness		.026	.102
	Kurtosis		-.934	.203
emergent numeracy total weighted	Mean		.5572	.00882
	95% Confidence Interval for Mean	Lower Bound	.5399	
		Upper Bound	.5745	
	5% Trimmed Mean		.5566	
	Median		.5400	
	Variance		.045	
	Std. Deviation		.21166	
	Minimum		.05	
	Maximum		1.00	
	Range		.95	
	Interquartile Range		.34	
	Skewness		.080	.102
	Kurtosis		-.889	.203
emergent literacy total weighted	Mean		.4791	.00787
	95% Confidence Interval for Mean	Lower Bound	.4637	
		Upper Bound	.4946	
	5% Trimmed Mean		.4771	
	Median		.4600	
	Variance		.036	
	Std. Deviation		.18898	
	Minimum		.00	
	Maximum		1.00	
	Range		1.00	
	Interquartile Range		.29	
	Skewness		.178	.102
	Kurtosis		-.594	.203

Descriptives

			Statistic	Std. Error
behavioural sefl-regulation	Mean		4.0132	.03098
	95% Confidence Interval for Mean	Lower Bound	3.9524	
		Upper Bound	4.0741	
	5% Trimmed Mean		4.0611	
	Median		4.1700	
	Variance		.553	
	Std. Deviation		.74345	
	Minimum		1.17	
	Maximum		5.00	
	Range		3.83	
	Interquartile Range		1.17	
	Skewness		-.820	.102
	Kurtosis		.515	.203
cognitive self-regulation	Mean		3.7628	.03151
	95% Confidence Interval for Mean	Lower Bound	3.7010	
		Upper Bound	3.8247	
	5% Trimmed Mean		3.7894	
	Median		3.8000	
	Variance		.572	
	Std. Deviation		.75634	
	Minimum		1.20	
	Maximum		5.00	
	Range		3.80	
	Interquartile Range		1.15	
	Skewness		-.370	.102
	Kurtosis		-.205	.203
emotional self-regulation	Mean		4.0572	.02646
	95% Confidence Interval for Mean	Lower Bound	4.0052	
		Upper Bound	4.1092	
	5% Trimmed Mean		4.0906	
	Median		4.1700	
	Variance		.403	
	Std. Deviation		.63510	
	Minimum		1.67	
	Maximum		5.00	
	Range		3.33	
	Interquartile Range		.83	
	Skewness		-.696	.102
	Kurtosis		.437	.203

All variables – normality check (K-S and S-W test)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age/month	.071	576	<.001	.975	576	<.001
emergent numeracy total weighted	.051	576	.001	.980	576	<.001
emergent literacy total weighted	.056	576	<.001	.990	576	<.001
behavioural sefl-regulation	.102	576	<.001	.940	576	<.001
cognitive self-regulation	.088	576	<.001	.973	576	<.001
emotional self-regulation	.101	576	<.001	.956	576	<.001

a. Lilliefors Significance Correction

Appendix III

ANOVA assumptions check

Levene's Test of Equality of Error Variances[a,b]

		Levene Statistic	df1	df2	Sig.
behavioural sefl-regulation	Based on Mean	7.024	3	572	<.001
	Based on Median	6.012	3	572	<.001
	Based on Median and with adjusted df	6.012	3	550.116	<.001
	Based on trimmed mean	6.799	3	572	<.001

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: behavioural sefl-regulation

b. Design: Intercept + GenderBoyGirl + AgeGroup + GenderBoyGirl * AgeGroup

Levene's Test of Equality of Error Variances[a,b]

		Levene Statistic	df1	df2	Sig.
cognitive self-regulation	Based on Mean	2.484	3	572	.060
	Based on Median	2.512	3	572	.058
	Based on Median and with adjusted df	2.512	3	559.902	.058
	Based on trimmed mean	2.409	3	572	.066

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: cognitive self-regulation

b. Design: Intercept + GenderBoyGirl + AgeGroup + GenderBoyGirl * AgeGroup

Levene's Test of Equality of Error Variances[a,b]

		Levene Statistic	df1	df2	Sig.
emotional self-regulation	Based on Mean	1.403	3	572	.241
	Based on Median	1.177	3	572	.318
	Based on Median and with adjusted df	1.177	3	541.317	.318
	Based on trimmed mean	1.287	3	572	.278

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: emotional self-regulation

b. Design: Intercept + GenderBoyGirl + AgeGroup + GenderBoyGirl * AgeGroup

Appendix IV

ANOVA SPSS outputs

Tests of Between-Subjects Effects

Dependent Variable: behavioural sefl-regulation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	10.115[a]	3	3.372	6.268	<.001	.032
Intercept	9281.859	1	9281.859	17254.827	.000	.968
GenderBoyGirl	7.434	1	7.434	13.819	<.001	.024
AgeGroup	.182	1	.182	.338	.561	.001
GenderBoyGirl * AgeGroup	2.525	1	2.525	4.694	.031	.008
Error	307.695	572	.538			
Total	9594.790	576				
Corrected Total	317.810	575				

a. R Squared = .032 (Adjusted R Squared = .027)

Tests of Between-Subjects Effects

Dependent Variable: cognitive self-regulation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4.418[a]	3	1.473	2.596	.052	.013
Intercept	8156.996	1	8156.996	14378.110	.000	.962
GenderBoyGirl	.264	1	.264	.465	.496	.001
AgeGroup	2.680	1	2.680	4.724	.030	.008
GenderBoyGirl * AgeGroup	1.513	1	1.513	2.668	.103	.005
Error	324.507	572	.567			
Total	8484.520	576				
Corrected Total	328.925	575				

a. R Squared = .013 (Adjusted R Squared = .008)

Tests of Between-Subjects Effects

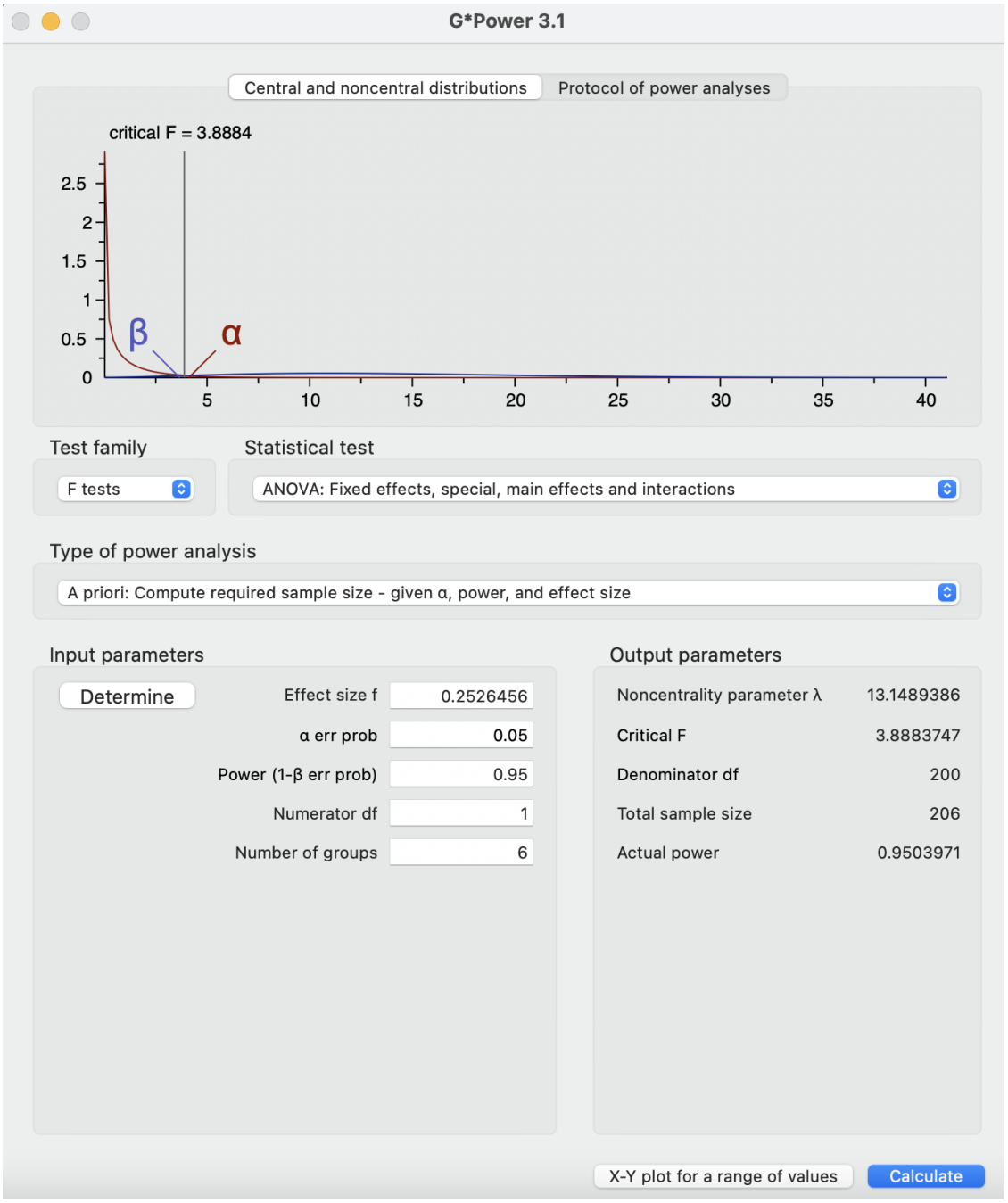
Dependent Variable: emotional self-regulation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5.235[a]	3	1.745	4.403	.004	.023
Intercept	9484.520	1	9484.520	23931.853	.000	.977
GenderBoyGirl	4.652	1	4.652	11.737	<.001	.020
AgeGroup	.101	1	.101	.255	.613	.000
GenderBoyGirl * AgeGroup	.495	1	.495	1.249	.264	.002
Error	226.691	572	.396			
Total	9713.493	576				
Corrected Total	231.927	575				

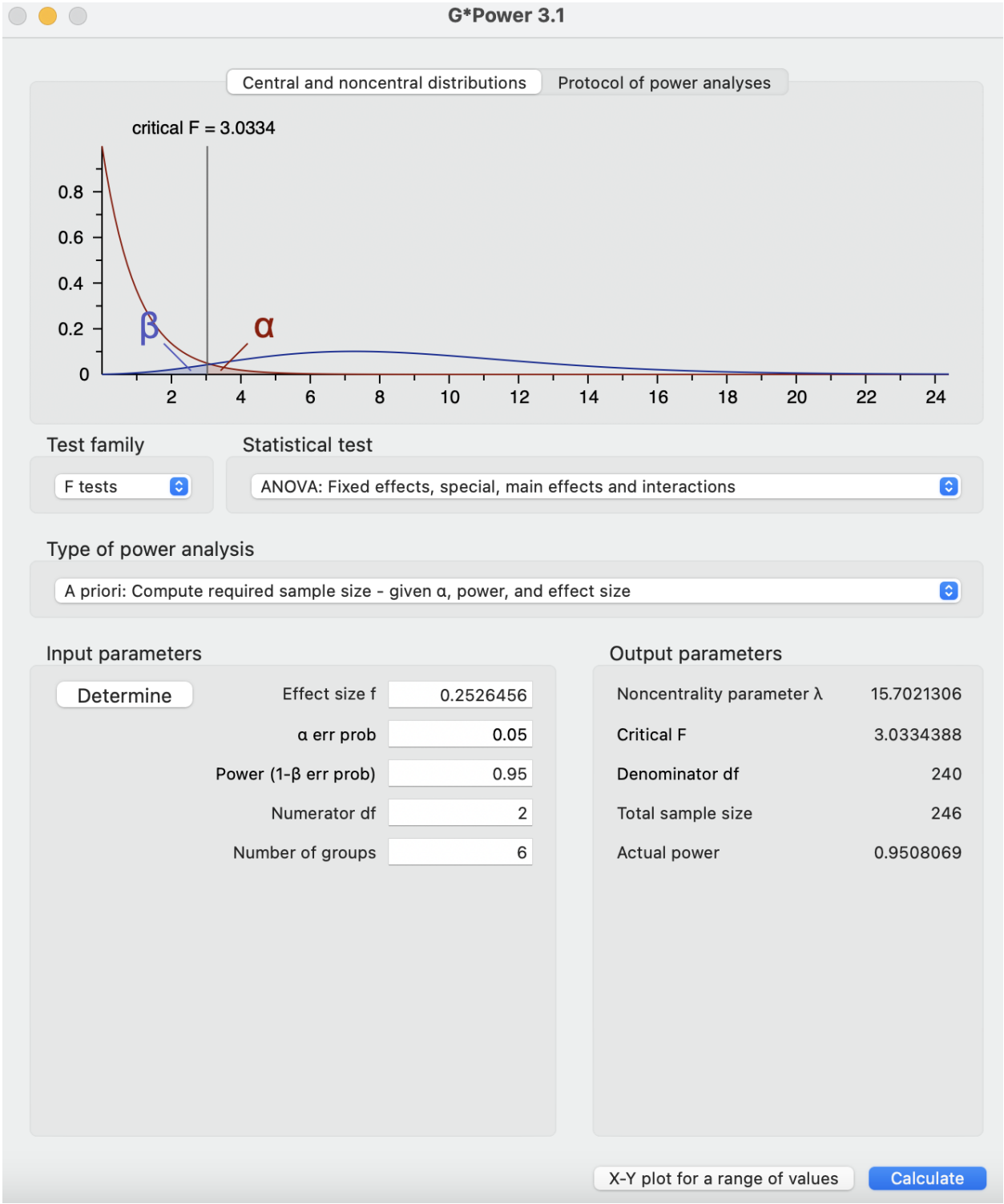
a. R Squared = .023 (Adjusted R Squared = .017)

Appendix V

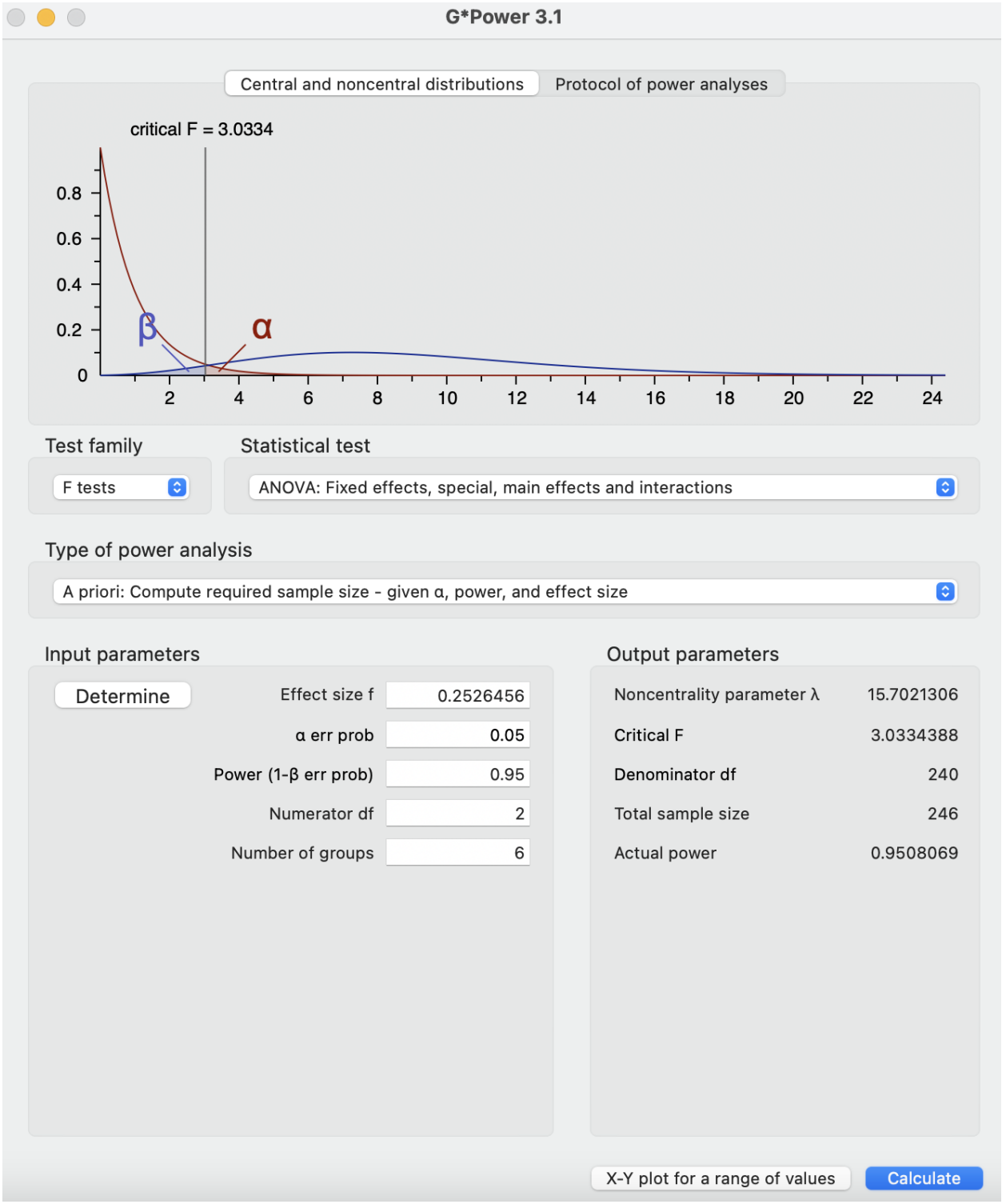
Powering the predictor variables gender (2 levels), specific age group (3 levels) and interactions (gender * specific age group). The effect size was assumed as medium effect size (0.06). The error rate was chosen as 0.05. The statistical power was selected at 0.95. The number of groups was 6 (2 * 3 = 6). For powering the predictor gender, the numerator df value was 1 (2 – 1 = 1 df).



For powering the predictor specific age group, the numerator df value was 2 (3 – 1 = 2 df).

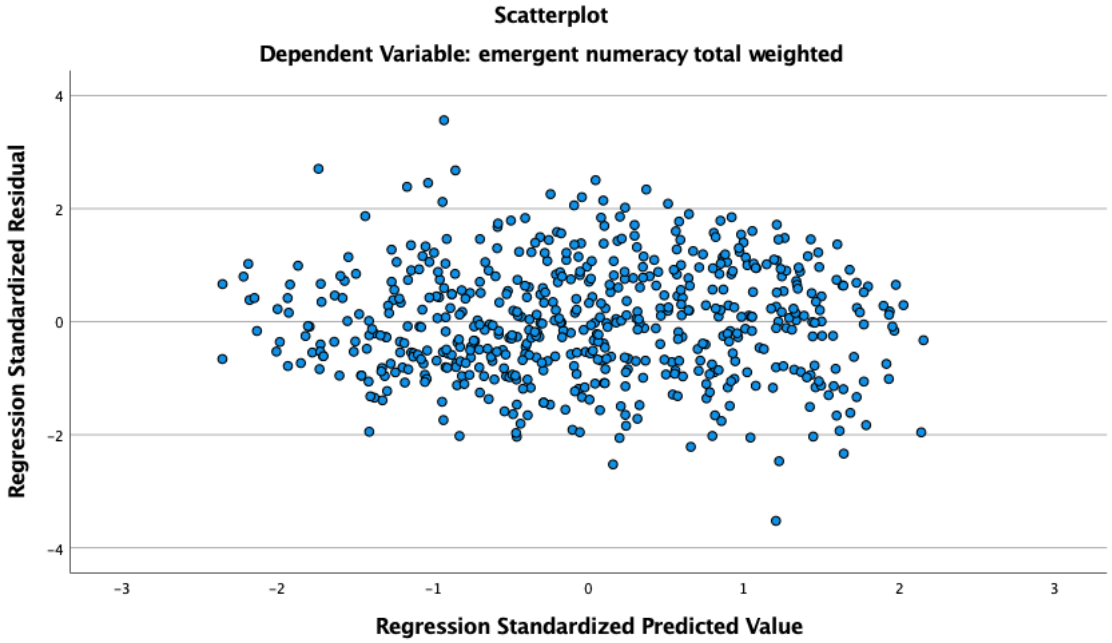


For powering the interaction, the numerator df value was 2 (1* 2 = 2 df).



Appendix VI

Regression (i.e., dependent variable = numeracy) assumptions check



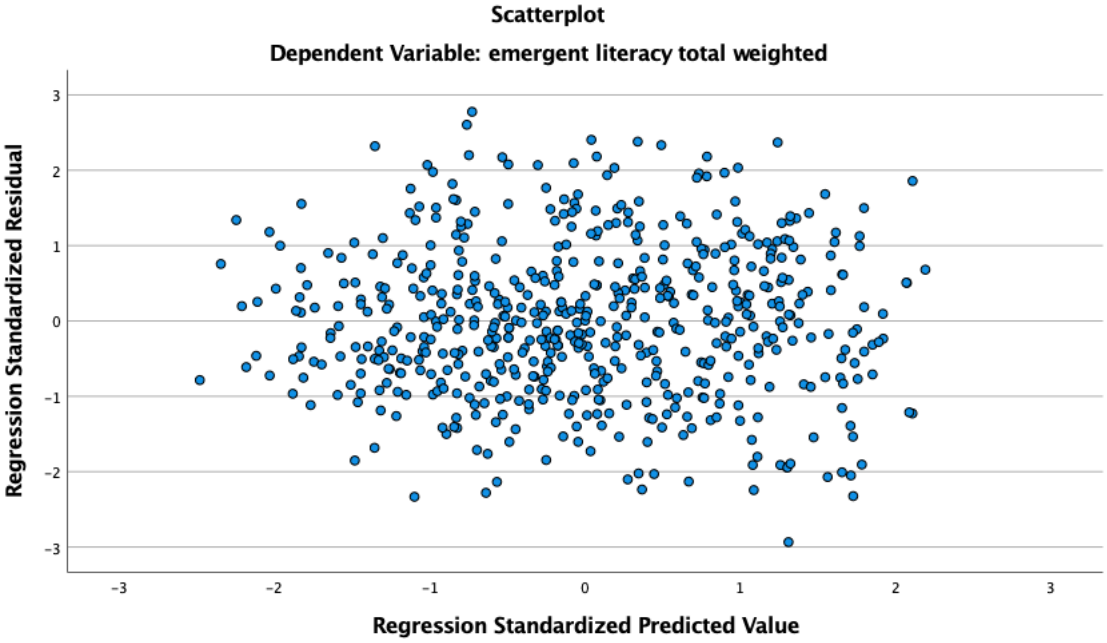
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-.465	.055		-8.423	<.001		
	Gender (Boy/Girl	.017	.014	.040	1.231	.219	.999	1.001
	Age/month	.020	.001	.629	19.399	<.001	.999	1.001
2	(Constant)	-.606	.068		-8.860	<.001		
	Gender (Boy/Girl	.022	.013	.051	1.609	.108	.965	1.037
	Age/month	.019	.001	.596	18.789	<.001	.965	1.036
	behavioural sefl-regulation	.040	.013	.141	3.023	.003	.446	2.241
	cognitive self-regulation	.047	.011	.170	4.185	<.001	.591	1.691
	emotional self-regulation	-.038	.014	-.114	-2.622	.009	.515	1.943

a. Dependent Variable: emergent numeracy total weighted

Appendix VII

Regression (i.e., dependent variable = literacy) assumptions check



Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-.282	.053		-5.323	<.001		
	Gender (Boy/Girl	-.013	.013	-.034	-.969	.333	.999	1.001
	Age/month	.016	.001	.552	15.819	<.001	.999	1.001
2	(Constant)	-.440	.066		-6.690	<.001		
	Gender (Boy/Girl	-.007	.013	-.017	-.508	.611	.965	1.037
	Age/month	.015	.001	.518	15.157	<.001	.965	1.036
	behavioural sefl-regulation	.041	.013	.161	3.193	.001	.446	2.241
	cognitive self-regulation	.039	.011	.157	3.586	<.001	.591	1.691
	emotional self-regulation	-.028	.014	-.096	-2.041	.042	.515	1.943

a. Dependent Variable: emergent literacy total weighted

Appendix VIII

Interaction effects SPSS outputs – when the dependent variable was numeracy and the moderator was gender

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-.465	.055		-8.423	<.001		
	Gender (Boy/Girl	.017	.014	.040	1.231	.219	.999	1.001
	Age/month	.020	.001	.629	19.399	<.001	.999	1.001
2	(Constant)	-.606	.068		-8.860	<.001		
	Gender (Boy/Girl	.022	.013	.051	1.609	.108	.965	1.037
	Age/month	.019	.001	.596	18.789	<.001	.965	1.036
	behavioural sefl-regulation	.040	.013	.141	3.023	.003	.446	2.241
	cognitive self-regulation	.047	.011	.170	4.185	<.001	.591	1.691
	emotional self-regulation	-.038	.014	-.114	-2.622	.009	.515	1.943
3	(Constant)	-.611	.069		-8.853	<.001		
	Gender (Boy/Girl	.022	.013	.051	1.599	.110	.963	1.039
	Age/month	.019	.001	.600	18.692	<.001	.947	1.056
	behavioural sefl-regulation	.039	.014	.138	2.907	.004	.430	2.327
	cognitive self-regulation	.047	.011	.168	4.127	<.001	.589	1.699
	emotional self-regulation	-.037	.015	-.111	-2.555	.011	.513	1.949
	BehSR * Gender	.003	.010	.016	.339	.734	.439	2.277
	CogSR * Gender	.006	.009	.030	.755	.451	.601	1.665
	EmoSR * Gender	-.007	.009	-.035	-.803	.422	.523	1.912

a. Dependent Variable: emergent numeracy total weighted

Interaction effects SPSS outputs –when the dependent variable was literacy and the moderator was gender

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.282	.053		-5.323	<.001		
	Gender (Boy/Girl	-.013	.013	-.034	-.969	.333	.999	1.001
	Age/month	.016	.001	.552	15.819	<.001	.999	1.001
2	(Constant)	-.440	.066		-6.690	<.001		
	Gender (Boy/Girl	-.007	.013	-.017	-.508	.611	.965	1.037
	Age/month	.015	.001	.518	15.157	<.001	.965	1.036
	behavioural sefl-regulation	.041	.013	.161	3.193	.001	.446	2.241
	cognitive self-regulation	.039	.011	.157	3.586	<.001	.591	1.691
	emotional self-regulation	-.028	.014	-.096	-2.041	.042	.515	1.943
3	(Constant)	-.445	.066		-6.707	<.001		
	Gender (Boy/Girl	-.007	.013	-.018	-.514	.607	.963	1.039
	Age/month	.015	.001	.523	15.109	<.001	.947	1.056
	behavioural sefl-regulation	.040	.013	.158	3.076	.002	.430	2.327
	cognitive self-regulation	.039	.011	.156	3.547	<.001	.589	1.699
	emotional self-regulation	-.028	.014	-.093	-1.988	.047	.513	1.949
	BehSR * Gender	.000	.010	.001	.022	.983	.439	2.277
	CogSR * Gender	.007	.008	.038	.879	.380	.601	1.665
	EmoSR * Gender	-.003	.009	-.014	-.292	.770	.523	1.912

a. Dependent Variable: emergent literacy total weighted

Interaction effects SPSS outputs – when the dependent variable was numeracy and the moderator was age

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.465	.055		-8.423	<.001		
	Gender (Boy/Girl	.017	.014	.040	1.231	.219	.999	1.001
	Age/month	.020	.001	.629	19.399	<.001	.999	1.001
2	(Constant)	-.606	.068		-8.860	<.001		
	Gender (Boy/Girl	.022	.013	.051	1.609	.108	.965	1.037
	Age/month	.019	.001	.596	18.789	<.001	.965	1.036
	behavioural sefl-regulation	.040	.013	.141	3.023	.003	.446	2.241
	cognitive self-regulation	.047	.011	.170	4.185	<.001	.591	1.691
	emotional self-regulation	-.038	.014	-.114	-2.622	.009	.515	1.943
3	(Constant)	-.615	.069		-8.929	<.001		
	Gender (Boy/Girl	.024	.014	.058	1.802	.072	.949	1.053
	Age/month	.019	.001	.599	18.847	<.001	.961	1.040
	behavioural sefl-regulation	.038	.013	.135	2.862	.004	.438	2.286
	cognitive self-regulation	.047	.011	.167	4.114	<.001	.588	1.702
	emotional self-regulation	-.036	.015	-.109	-2.480	.013	.505	1.979
	BehSR * Age Months	.003	.009	.015	.325	.745	.436	2.296
	CogSR * Age Months	.012	.009	.057	1.390	.165	.588	1.701
	EmoSR * Age Months	-.005	.010	-.024	-.521	.602	.447	2.235

a. Dependent Variable: emergent numeracy total weighted

Interaction effects SPSS outputs – when the dependent variable was literacy and the moderator was age

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-.282	.053		-5.323	<.001		
	Gender (Boy/Girl	-.013	.013	-.034	-.969	.333	.999	1.001
	Age/month	.016	.001	.552	15.819	<.001	.999	1.001
2	(Constant)	-.440	.066		-6.690	<.001		
	Gender (Boy/Girl	-.007	.013	-.017	-.508	.611	.965	1.037
	Age/month	.015	.001	.518	15.157	<.001	.965	1.036
	behavioural sefl-regulation	.041	.013	.161	3.193	.001	.446	2.241
	cognitive self-regulation	.039	.011	.157	3.586	<.001	.591	1.691
	emotional self-regulation	-.028	.014	-.096	-2.041	.042	.515	1.943
3	(Constant)	-.447	.066		-6.739	<.001		
	Gender (Boy/Girl	-.004	.013	-.012	-.342	.733	.949	1.053
	Age/month	.015	.001	.521	15.195	<.001	.961	1.040
	behavioural sefl-regulation	.040	.013	.158	3.104	.002	.438	2.286
	cognitive self-regulation	.039	.011	.156	3.558	<.001	.588	1.702
	emotional self-regulation	-.028	.014	-.095	-2.005	.045	.505	1.979
	BehSR * Age Months	-.004	.009	-.023	-.449	.654	.436	2.296
	CogSR * Age Months	.013	.008	.070	1.594	.111	.588	1.701
	EmoSR * Age Months	-.002	.009	-.009	-.170	.865	.447	2.235

a. Dependent Variable: emergent literacy total weighted