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The impact of *begin to* ECSEL on children's self-regulation, executive functions and learning

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ABSTRACT

Research has shown that the first few years of a child's life are critical for developing executive functioning and emotional regulatory skills. This study aimed to evaluate how begin to ECSEL (Emotional, Cognitive and Social Early Learning), an intervention designed to promote young children's emotional competence, influenced children's self-regulation and executive functions. The study collected data from 94 children, aged 2–6 years old, through behavioral testing and compared them to a matched group of children who had not been exposed to the begin to ECSEL programme. Children's self-regulation and executive functioning skills were assessed using four specific tasks from the Preschool Self-Regulation Assessment: balance beam, pencil tap, snack delay and toy wrap. Results demonstrated that children who were enrolled in the begin to ECSEL programme performed significantly better than the comparison group, suggesting significantly better self-regulation and executive function skills as a result of the begin to ECSEL intervention.

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Introduction

There is an important educational movement to improve the standards of learning and to teach children to understand, positively express and manage emotional arousal within social interactions, as well as to develop their self-regulation skills (Cohen, 2017; Sovde et al., 2019). Research suggests a strong link between young children's understanding of emotion, self-regulation, early academic success and their lifelong aptitude and well-being (Blair & Raver, 2015; Denham, Bassett, Mincic, et al., 2012).

Self-regulation can be defined as one's ability to modify his/her behavioural, emotional and cognitive processes in order to cope effectively with environmental demands across a variety of contexts (Calkins, Perry, & Dollar, 2016; Posner & Rothbart, 2007). It is the ability to inhibit, activate and otherwise control one's emotional and physiological responses to stimuli or events in order to attain one's goals at a given time (Lin, Liew, & Perez, 2019). The three domains of self-regulation – emotional, cognitive and behavioural – are interdependent and emerge during the prenatal period of human development (Jahromi & Stifter, 2008). Self-regulation represents the cognitive, motivational-affective, social and physiological processes that modulate attention, emotion and behaviour to a stimulus (Posner & Rothbart, 2007). Self-regulation is usually assessed by performance-based

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measures of executive functioning or report-based tests of impulse control, sustained motivation and perseverance (Malanchini, Engelhardt, Grotzinger, Harden, & Tucker-Drob, 2018).

In order to self-regulate, one needs a set of higher-order cognitive processes called executive functions (EF), which supervise, monitor and manage more basic cognitive processes to allow for logical thinking, decision making and implementing strategies to regulate behaviour to meet goals (Malanchini et al., 2018). Children must utilize executive function skills, including working memory, planning, organization, mental flexibility and problem-solving, and both cognitive and behavioural inhibitory control to self-regulate.

There are two types of EF – hot and cool (Willoughby, Kupersmidt, Voegler-Lee, & Bryant, 2011). Hot EF features reflexes, inhibitory control, and impulse control, which involves effective cognitive abilities and goal-directed processes in contexts that are emotionally salient such as in a delayed-gratification situation (Willoughby et al., 2011). In contrast, cool EF is characterized by flexibility and a disciplined shift in attention, which requires conscious control of thoughts and behaviours and usually happens in *cognitively* (rather than emotionally) salient situations (Poon, 2018). Moreover, cool EF is often measured by abstract tasks with relatively low ecological validity, while assessments of hot EF usually involve situations with meaningful rewards or punishments (Zelazo, Qu, & Kesek, 2010). To achieve academic success, students need to maintain a healthy balance between cool EF and hot EF (Bassett, Denham, Wyatt, & Warren-Khot, 2012).

The importance of self-regulation

Children's self-regulation level reflects their cognitive complexity and has a propounding impact on their future success in school and life (Blair & Raver, 2015). Previous studies have suggested that a child's self-regulation levels in early childhood can predict their adjustment to kindergarten, behaviours in the classroom, mathematic and literacy performance, greater levels of empathy and affective perspective-taking, as well as their relationship with teachers and peers (Acar et al., 2019; Panfile & Laible, 2012; Schmitt, Pratt, & McClelland, 2014; Sher-Censor, Khafi, & Yates, 2016; Thierry, Bryant, Nobles, & Norris, 2016).

The development of self-regulation in early childhood

The development of self-regulation starts from birth. Through social interactions and observation, newborns who used to rely on their innate physiological impulses start being aware of their behaviours, understanding social norms, interpreting complex social situations, and engaging in appropriate regulatory activities, such as gaze aversion, self-soothing and organized motor behaviours (Calkins et al., 2016). Between birth and three years of age, children's brains are more malleable than they will be at any other stage in development. By 12 months of age, children's daily experiences lay the foundation for developing the capacities to retain and use new information, focus attention, control impulses and make plans (Blair & Raver, 2015). More dramatic developmental changes in self-regulation take place between the ages of 3 and 5 years (Bassett et al., 2012).

Self-regulation skills originate from one's innate ability and are heavily influenced by the experience of regulation provided by caregivers (Olson & Sameroff, 2009). Previous studies have shown that the prefrontal cortex is involved in self-regulation, attention and executive functioning (Heatherton, 2011).

Besides its connection with brain mechanisms, the development of self-regulation is influenced by early caregiving environment, and secure attachment with caregivers plays a central role in developing capacities for self-regulation (Panfile & Laible, 2012). Responsive, nurturing early experiences are associated with positive synaptic connections and support children's self-regulatory learning by providing essential emotional knowledge (i.e. emotional words), autonomy support (i.e. scaffolding) and age-appropriate problem-solving strategies (Bernier, Carlson, & Whipple, 2010).

Classrooms are critical academic and social environments for children to develop self-regulation and executive functioning (Denham, Bassett, Way, et al., 2012). Teaching must involve not only knowledge, cognition and skill but also the development of emotional competencies and self-regulation, as these skills are critical for children's academic and social success (Mayer, Salovey, & Caruso, 2004). Academic and social success requires that children pay attention, be patient, persevere, manage and deal with intense emotions, and remain focused when frustrated. Such skills are paramount for children to succeed both in school and in life and rely heavily on emotional competence and self-regulation.

The begin to *ECSEL approach*

Begin to ECSEL™ (Emotional Cognitive Social Early Learning) is a preventive intervention model that integrates theory with practice and is based on social and emotional foundations of learning and cognition (Housman, 2017). The *begin to* the ECSEL programme is designed to promote internal change in the development of human beings by becoming something more than one was before, contributing to the growth and education for character and moral development.

Given development and change happen through lived experiences and responsive interactions, at the heart of *begin to* ECSEL is a technique called Causal Talk in the context of Emotional Experience (CTEE), which refers to adult–child conversations about emotions through lived emotional experiences during a state of emotional arousal (Housman, 2017). By facilitating CTEE, the adult helps the child not only to identify and label a feeling but also to manage the feeling, while the child is in the midst of emotional arousal. Previous studies showed that teachers who participated in the *begin to* ECSEL™ training use CTEE as a general technique to increase emotional expressiveness and regulation in their students (Housman, Denham, & Cabral, 2018). A similar study found that the key to promoting children's emotional competence is to use the current emotional situation as an opportunity for learning more appropriate regulation strategies (Cole, Dennis, Smith-Simon, & Cohen, 2009).

Since children develop in the context of relationships, *begin to* ECSEL teachers become the main tools in developing self-regulation in children through co-regulation. By utilizing co-regulation techniques on a daily basis, they teach and model how to regulate emotions and how to label and express them in constructive ways (Housman, 2017). To help children internalize and metabolize emotional competencies and self-regulation skills, teachers utilized *begin to* ECSEL techniques such as CTEE and co-regulation in the repeated lived experiences. Moreover, teachers promote strengthening self-regulation skills by integrating different activities into the curriculum and by helping children access specifically developed *begin to* ECSEL tools (Housman, 2017).

Rationale

Developing social and emotional competencies during the critical period of neuroplasticity, within the first 3+ years of life, can have a significant impact on the executive functioning and emotional regulatory skills essential for successful learning and social interaction. Preschools, which are important social and emotional environments, play a significant role in developing children's regulatory skills. Sensitive, attuned and responsive teachers offer experiences to the child that help build emotional and behavioural regulation early in their lives (Jones & Bouffard, 2012). If this process begins during the period of neuroplasticity, children will not only learn the skills necessary for future success but also strengthen the neural circuitry between the executive functioning portion of the brain and the emotion system, yielding a person much more capable of regulating his or her emotions. As a result, more research should focus on the best practices of promoting emotional competence in early childhood on children's development of self-regulation. Given the paucity of research and understanding about how best to instil these skills in young children, it is particularly important to examine the efficacy of programmes like *begin to* ECSEL that employ techniques focused on developing self-regulation and EF in young children.

In terms of basic brain functioning, emotions support EF when they are well regulated, but interfere with attention and decision making when they are poorly regulated (Broderick, 2013). Children with poor emotional competence and self-regulation not only have more difficulty transitioning to school, but they are also at increased risk for low academic achievement, emotional and behavioural problems, peer rejection and school dropout (Duncan et al., 2007).

How well a child is able to regulate emotions, focus and think is influenced by the quality of a child's early environment and the availability of appropriate experiences at the right stage of development. Teaching children the connection between feelings and behaviour can provide the basis for understanding appropriate ways of resolving conflicts and solving problems. In light of this, further research on teaching methods in an early education setting, especially those employing CTEE, is warranted.

Goals and hypotheses

The current study aims to evaluate how *begin to* ECSEL programme, an emotional, cognitive and social early learning intervention that aimed to improve young children's emotional competence, influences children's self-regulation and EF. In the current study, we focus on the impacts of *begin to* ECSEL intervention on children's self-regulation and executive functioning skills assessed by behavioural testing, compared to a matched group of children who were not exposed to *begin to* ECSEL.

Based on previous research, we hypothesized that *begin to* ECSEL intervention would significantly improve children's self-regulation and executive functioning over the course of 6 months and that their functioning would outperform the comparison group. More specifically, we hypothesized that children exposed to the *begin to* ECSEL intervention would score higher on measures of self-regulation and EF relative to the comparison group. Data for this study were collected through behavioural testing within the school setting.

Method

The current study is part of a larger study focused on evaluating the influences of *begin to* ECSEL on children's emotional, cognitive and social competencies. The mission of *begin to* ECSEL is to help build and strengthen children's development of self-regulation and emotional competence during the critical developmental window (Housman, 2017). Using an integrative approach, *begin to* ECSEL endeavours to foster these competencies through emotional communication, guidance, tools and techniques–most notably co-regulation and causal talk in the CTEE. *begin to* ECSEL was implemented at the school level as an immersive programme, where teachers received ongoing training, support and supervision over the span of 6 months, and they were asked to use *begin to* ECSEL tools and techniques continuously throughout the day, integrated into the daily curriculum and in their interactions with children. Moreover, *begin to* ECSEL emphasizes offering guidance and support during lived emotional experiences, which is usually unpredictable and difficult to track during the school day. Teachers of children in the *begin to* ECSEL programme received an hour of training and mentoring bi-weekly, which focused on the use of specific tools and techniques to teach young children the foundations of self-regulation and emotional competence, as well as highlight examples of modelling, reactions and communication between and among teachers and children through observation and video recording (Housman, 2017). There were 12 teachers at the *begin to ECSEL* programme and the same teachers remained throughout the study. All teachers were between the ages of 24 and 40, had four-year college degrees and were of middle-class background. The *begin to* ECSEL trains teachers on how best to understand and promote their students' emotional competence, how to use appropriate tools and techniques, and how to increase teachers' understanding of their emotionality. All teachers received the same training. Specifically, qualified, licenced therapists work directly with educators to learn to assess their own abilities to accurately perceive, appraise and express emotions; understand emotions and emotional knowledge, such as labelling feelings; and reflect, manage and regulate emotions to promote emotional and intellectual growth (Kremenitzer & Miller, 2008). To quantitatively assess the frequency of implementation of the CTEE technique, teachers were instructed over four to six months to self-report and document how many times per day they employed the technique and then averaged their responses. Teachers self-reported using CTEE on average 30 times daily for 2- to 3-year-old classrooms, 20 times daily for 3- to 4.5-year-old classrooms, and 10 times daily for 4.5- to 6-year-old classrooms. In a previous study, data were collected over 3 years from a cohort of 100 students, aged 2–6, enrolled in the *begin to* ECSEL programme, and their growth in emotional competencies and related constructs involving attachment/relationship, initiative, empathy, prosocial skills, positive reactions to frustration, and aggressive behaviours were examined and compared to national comparison samples (Housman et al., 2018). The sample of a present study has been reduced due to attrition (e.g. data of children who missed one or two parts of testing were removed). The results demonstrated that children receiving the *begin to* ECSEL intervention experienced significant improvements in these constructs, and outperformed the comparison samples (Housman et al., 2018).

Participants

This study had two samples. In the *begin to* ECSEL sample, children receiving *begin to* ECSEL intervention consisted of 94 children, ages 2–6 years old, attending a private school in eastern Massachusetts. In accordance with Sterling Institutional Review Board standards, parents of the children received informed consent forms with a detailed explanation of the study at the beginning of each school year. Pre-test and post-test trials were administered for each newly enrolled participant over one of each of the three consecutive school years. There were two rounds of testing for students during each school year: pre-tests took place in the Fall and post-tests took place in the Spring. The testing was conducted during a two-month period in both rounds, with an average of 6 months between pre- and post-test. The mean ages at pre-test and post-test were 36.40 months (SD = 9.53) and 41.63 months (SD = 9.47), respectively. Data pertaining to race and ethnicity were not collected for research purposes due to parents opting to maintain their right not to identify their children's race or ethnicity. According to census data (TownCharts, 2018), 82.7% of residents in the school location are White or Caucasian, 2.1% are Black or African American, 10.7% are Asian and 4.2% are Hispanic or Latino. Children came from a range of socioeconomic backgrounds; confidentiality agreements precluded directly asking families about their income.

The comparison group came from a larger longitudinal study aimed at measuring young children's self-regulation and executive functioning. All of the participants in this second sample did not receive interventions at all similar to *begin to* ECSEL. Families in both samples were matched on demographics involving the type of private childcare centres they were enrolled in and maternal education to make the two samples as similar as possible in order to make a valid comparison. The comparison group included 195 children, and the mean age at pre-test was 48.14 months (SD = 7.24). On average, children in the comparison group were 11.73 months older than the *begin to* ECSEL sample when they took the pre-tests (t [df] = 10.52 [147.76], $p < .0001$). Regarding gender, 53.19% of *begin to* ECSEL children assessed were female, compared to 48.21% of the children in the comparison group (Table 1). Children in the comparison group were administered the measures twice: first in the Fall and then again in the Spring of the same year.

Table 1. Sample demographics.

	Comparison group	*Begin to* ECSEL	*t* (df)	*p*
Age in months – pre-test (SD, *n*)	48.14 (7.24, 195)	36.40 (9.53, 94)	10.52 (147.76)	<.0001
Females (*n*)	49.47% (94)	53.19% (50)		

Measures

To assess children's self-regulation skills, we utilized the Preschool Self-Regulation Assessment (PSRA; Smith-Donald, Raver, Hayes, & Richardson, 2007), which was developed to capture preschoolers' level of executive functioning with respect to self-regulation, by measuring skills such as compliance, attention, planning and inhibitory control. Children were individually assessed using four specific tasks from PSRA to tap inhibitions and behaviour regulation: balance beam, pencil tap, snack delay and toy wrap. All tasks were completed in the same session, taking approximately 15 minutes to complete. The chosen tasks included two inhibitory tasks requiring children to activate a subdominant response while suppressing a prepotent (or dominant) response (pencil tap and balance beam) and two delay tasks (toy wrap and snack delay). Previous research has provided support for the construct and concurrent validity of the measure (Smith-Donald et al., 2007).

Begin to ECSEL staff who administered PSRA measures followed training procedures detailed in a previous study conducted by one of the present study's co-authors (Bassett et al., 2012). Overall, the PSRA battery in this study was administered by 12 trained and certified research assistants who live-coded latencies or performance levels for each task. There were four trained and certified research assistants for each of the three years of participants included in the *begin to* ECSEL sample. For the balance beam, children were instructed to walk along a straight line taped to the floor while the examiner timed the walk. Two more trials were conducted after the first trial. At each successive trial, the children were asked to walk slower, emphasized in the assessor's facial and vocal tones. The average duration for the second two trials was subtracted from the duration of the first trial to yield an overall score. A positive balance beam score indicates that children were able to slow their walk; a negative score indicates that children were not able to slow their walk.

For the pencil tap, children were instructed to tap once when the examiner tapped twice and tap twice when the examiner tapped once. The test score was the percentage of correct responses across all tap trials.

For the snack delay, children were instructed to wait for a signal before 'finding' an M&M under a cup. The outcome was measured during three trials of waiting times – 20, 30 and 60 s, and children could receive a score of 1–4 for their 'level of waiting'. A score of 1 indicates the child ate the M&M before end of trial, 2 indicates the child touched the M&M before end of trial, 3 indicates the child touched the cup/timer before end of trial, and 4 indicated the child waited for the timer to beep and complied with all directions. A higher score indicates a greater ability to self-regulate and comply with given directions. A total score was computed by averaging the scores across the four trials.

For the toy wrap and wait portion of the assessment, the child was given directions and assessed based on their level of compliance. For toy wrap/peek, the child was instructed not to peek while the examiner noisily wrapped a gift. For toy-wait/touch, the child was instructed to wait without touching the gift. Peeking during the wrapping, time of peek, touching the gift before time was up and time of touch were recorded. If the child did not peek or touch, the time was censored at 60.5 s. These assessments derived censored variables that required Cox proportional hazards models.

Data analyses

Data analyses were conducted using SPSS and SAS. To determine the effectiveness of the programme, *begin to* ECSEL children were compared to those in the comparison group also attending private childcare centres using multiple linear regression analyses. These analyses compared the post-test score PSRA measurements of children enrolled in the *begin to* ECSEL programme to children within the comparison group, after about six months in their respective programmes and controlled for pre-test scores. The balance beam, pencil tap and snack delay outcomes were continuous data, and the toy wrap/wait assessment was censored continuous data on time-to-event. Paired t-tests were conducted for analyses of pre-test and post-test scores within the *begin to* ECSEL and comparison groups respectively, and multiple linear regression was used on post-test scores for comparisons of the *begin to* ECSEL and comparison groups, controlling for age, gender and pre-test scores. The interactions among age, gender, pre-test scores, and group were tested and excluded in the final models, because none of these interaction terms was statistically significant. The censored data were analysed using Cox proportional hazards regression analysis, with the assumption of proportional hazards verified using Schoenfeld residuals.

Results

Balance beam task

As shown in Table 2, *begin to* ECSEL children during the balance beam assessment increased their time from pre- to post-test by an average of 1.66 s (SD = 7.09), which was statistically significant (t [df] = 2.11 [81], $p = 0.0375$) with a small-to-moderate effect size (Cohen's $d = 0.27$). Children in the comparison group were also able to increase their time by 1.23 s (SD = 4.53), which was also statistically significant (t [df] = 3.37 [153], $p = 0.0010$) with a small-to-moderate effect size (Cohen's $d =$ 0.32).

A multiple linear regression model was conducted using balance beam post-test scores as the outcome measurement. Adjusted for age, gender and pre-test scores, balance beam post-test scores were significantly different between the *begin to* ECSEL and comparison groups (B [SE] = 3.41 [0.84], $p < .0001$, Table 2). *Begin to* ECSEL children had, on average, a higher balance beam score by 3.41 s than the comparison group, adjusted for age, gender and pre-test score ($p <$ 0.0001). For every-month increase in age, the balance beam post-test score increased by 0.20 s ($p < 0.0001$), and higher pre-scores predicted higher post-test scores ($p = 0.0001$, Table 2).

Pencil tap task

A multiple linear regression model was conducted using pencil tap correct response post-test scores as the outcome measurement (see Table 3). Adjusted for age, gender and pre-score, pencil tap post-test scores were significantly different between the *begin to* ECSEL and comparison groups (B [SE] = 10.41 (4.25), $p = 0.015$). *Begin to* ECSEL children had, on average, a higher percentage correct at post-test by 10.41% compared to the comparison group, adjusted for age, gender and pre-test score ($p =$ 0.015). As well, for every one-month increase in age, post-test scores increased by 1.50% ($p < 0.0001$), and for every one-point increase in pre-test scores, there was, on average, a 0.51% increase in the post-test score ($p < .0001$). About 53.65% of the variability in Pencil Tap post-test scores can be attributed to the group, age, gender and pre-test score.

Table 2. Descriptive statistics and ANCOVA model for balance beam test.

Descriptive statistics		Comparison group			*Begin to* ECSEL
Pre-test mean (SD)		1.68 (3.39)			2.87 (5.62)
Post-test mean (SD)		3.06 (4.33)			4.45 (6.66)
Change-mean (SD)		1.23 (4.53)			1.66 (7.09)
Pre–post-test difference (within group)					
t (df)		3.37 (153)			2.11 (81)
p		0.0010			0.0375
Cohen's *d*		0.32			0.27
***Begin to* ECSEL vs. Comparison group: ANCOVA Model[a]**	**Beta (SE)**	***t* (df)**	***p***	***Model F* (df), *p***	***Model* R^2**
Group (reference = comparison group)	3.41 (0.84)	4.08 (226)	<.0001	15.72 (4,4226), $p < .0001$	21.76%
Age	0.20 (0.04)	4.83 (226)	<.0001		
Gender (reference = male)	−0.22 (0.63)	−0.34 (226)	0.730		
Pre-test Score	0.30 (0.08)	3.93 (226)	0.0001		

[a]Comparing post-test scores while adjusting for age, gender and pre-test score.

Table 3. Descriptive statistics and linear regression model for pencil tap test.

Descriptive statistics	Comparison group			*Begin to* ECSEL	
Pre-test mean (SD)	47.43 (33.55)			40.24 (30.18)	
Post-test mean (SD)	63.34 (33.85)			50.89 (37.55)	
Change-mean (SD)	14.65 (28.70)			11.28 (27.37)	
Pre–post-test difference (within group)					
t (df)	6.34 (153)			3.73 (81)	
p	<.0001			0.0004	
Cohen's *d*	0.43			0.33	
Begin to ECSEL vs. Comparison group: ANCOVA Model[a]	Beta (SE)	*t* (df)	*p*	Model *F* (df), *p*	Model R^2
Group (reference = comparison group)	10.41 (4.25)	2.45 (225)	0.015	65.11 (4, 4225), $p < .0001$	53.65%
Age	1.50 (0.24)	6.24 (225)	<.0001		
Gender (reference = male)	5.79 (3.26)	1.77 (225)	0.077		
Pre-test Score	0.51 (0.06)	8.36 (225)	<.0001		

[a]Comparing post-test scores while adjusting for age, gender and pre-test score.

Snack delay task

For the snack delay assessment, within the *begin to* ECSEL sample, there was no significant evidence of a difference in pre-test and post-test scores in the 20-, 30- or 60-s trial, as well as in the overall analysis (mean score of 20-, 30- and 60-s trials per child), all reflecting small effect sizes (see Table 4). Within the comparison group, there was significant evidence of a difference in pre-test and post-test scores in the 30 s trial, but not the 20 or 60, or overall scores, all reflecting small effect sizes.

Adjusted (age, gender and pre-test score) multiple linear regression models were run on post-test scores for the three trials and the overall measurement to compare the *begin to* ECSEL and comparison groups (see Table 4). No significant results were found in the 20-s and 30-s trial models. However, for the 60-s trial, *begin to* ECSEL children had a higher snack delay post-test scores, adjusted for age, gender and pre-test score, compared to the comparison group ($p = 0.002$). Further, post-test scores increased with age ($p = 0.065$); and for every one-point increase in pre-test score, the post-test score increased by 0.19 points ($p = 0.0008$).

Lastly, for the overall trial estimate, the three trials were averaged per child. *Begin to* ECSEL children had higher overall snack delay post-test scores, adjusted for age, gender and pre-test score, compared to the comparison group, but this was not statistically significant ($p = 0.077$). Further, for every one-point increase in the pre-test score, the post-test score increased by 0.25 ($p <$ 0.0001, Table 4).

Although significant pre-test and post-test differences in the snack delay scores were not found within the *begin to* ECSEL sample, it was found that *begin to* ECSEL children had significantly higher snack delay post-test scores than the comparison group in the 60-s trial, controlling for their age, gender and pre-test score.

Toy wrap task

As shown in Table 5, in the peek trials, 36.36% of children in the comparison group did not peek in either pre- or post-test, 23.38% peeked in pre-test but not in the post-test, 12.34% peeked in post-test but not the pre-test, and 27.92% peeked in both. For *begin to* ECSEL, 25.61% did not peek at all, 35.37% peeked in pre-test but not in the post-test, 15.85% peeked in post-test but not in the pre-test, and 23.17% peeked in both. In the touch trials, 79.17% of children in the comparison group did not touch in either pre- or post-test, 5.56% touched in pre-test but not in the post-test, 9.72% touched in post-test but not in the pre-test, and 5.56% did not touch at all. For *begin to* ECSEL, 84.15% did not touch, 3.66% touched in pre-test but not in the post-test, 7.32% touched in post-test and not in the pre-test, and 4.88% touched in both.

Table 4. Descriptive statistics and linear regression Model for Snack Delay Test (mean change).

Descriptive statistics		Comparison group			*Begin to* ECSEL	
Pre-test mean (SD)						
20 s		3.71 (0.71)			3.91 (0.30)	
30 s		3.61 (0.81)			3.89 (0.35)	
60 s		3.60 (0.80)			3.87 (0.46)	
Overall		3.64 (0.71)			3.87 (0.28)	
Post-test mean (SD)						
20 s		3.79 (0.58)			3.93 (0.26)	
30 s		3.77 (0.62)			3.89 (0.41)	
60 s		3.69 (0.67)			3.90 (0.30)	
Overall		3.75 (0.57)			3.91 (0.23)	
Change-mean (SD)						
20 s		0.08 (0.77)			0.03 (0.39)	
30 s		0.16 (0.92)			0.01 (0.48)	
60 s		0.05 (0.90)			0.06 (0.53)	
Overall		0.09 (0.76)			0.03 (0.34)	
Pre–post-test difference (within group)	*t* (df)	*p*	Cohen's *d*	*t* (df)	*P*	Cohen's *d*
20 s	1.27 (151)	0.27	0.12	0.57 (80)	0.57	0.07
30 s	2.11 (151)	0.04	0.22	0.23 (81)	0.82	0.00
60 s	0.65 (143)	0.52	0.13	1.04 (81)	0.30	0.08
Overall	1.47 (142)	0.14	0.17	0.86 (80)	0.39	0.16
Begin to ECSEL vs. Comparison group: ANCOVA Model[a]	Beta (SE)	*t* (df)	*p*	Model *F* (df), *p*	Model R^2	
20 s						
Group (reference = comparison group)	0.09 (0.08)	−0.39 (223)	0.292	8.12	12.71%	
Age	−0.002 (0.004)	0.93 (223)	0.700	(4, 4223),		
Gender (reference = male)	0.05 (0.07)	0.81 (223)	0.419	$p < .0001$		
Pre-test Score	**0.26 (0.05)**	**5.06 (223)**	**<.0001**			
30 s						
Group (reference = comparison group)	**0.092 (0.10)**	0.93 (224)	0.352	3.63	6.09%	
Age	−0.001 (0.01)	−0.15 (224)	0.883	(4,4224),		
Gender (reference = male)	0.04 (0.07)	0.49 (224)	0.625	$p =$		
Pre-test Score	**0.18 (0.05)**	**3.22 (224)**	**0.0015**	0.0069		
60 s						
Group (reference = comparison group)	**0.30 (0.01)**	**3.07 (215)**	**0.002**	7.14	11.72%	
Age	0.01 (0.01)	1.85 (215)	0.065	(4, 4215),		
Gender (reference = male)	0.01 (0.08)	1.27 (215)	0.204	$p < .0001$		
Pre-test Score	**0.19 (0.06)**	**3.40 (215)**	**0.0008**			
Overall						
Group (reference = comparison group)	0.15 (0.08)	1.78 (214)	0.077	8.45 (4, 4214), $p < .0001$	13.64%	
Age	0.002 (0.004)	0.50 (214)	0.615			
Gender (reference = male)	0.07 (0.06)	1.11 (214)	0.268			
Pre-test Score	**0.25 (0.53)**	**4.76 (214)**	**<.0001**			

Results in bold text are statistically significant at the 0.05 level [a]Comparing post-test scores while adjusting for age, gender and pre-test score.

Table 5. Frequency of pre- and post-test opening within the *begin to* ECSEL and comparison group.

	Comparison group				*Begin to* ECSEL			
	Category				Category			
	Pre	Post	Frequency	%	Pre	Post	Frequency	%
Peek	No	No	56	36.36	No	No	21	25.61
	Yes	No	36	23.38	Yes	No	29	35.37
	No	Yes	19	12.34	No	Yes	13	15.85
	Yes	Yes	43	27.92	Yes	Yes	19	23.17
Touch	No	No	114	79.17	No	No	69	84.15
	Yes	No	8	5.56	Yes	No	3	3.66
	No	Yes	14	9.72	No	Yes	6	7.32
	Yes	Yes	8	5.56	Yes	Yes	4	4.88

Table 6. Descriptive statistics and Cox proportional hazards model analysing change in peek and touch trial outcomes within *begin to* ECSEL and comparison group.

	Comparison group		*Begin to* ECSEL	
	Peek	Touch	Peek	Touch
Pre-test Mean (SD, *n*)	40.36 (23.40, 178)	55.58 (14.74, 172)	44.50 (22.09, 89)	57.49 (11.57, 89)
Pre-test Percent (*n*)	50 (89)	12.21 (21)	56.18 (50)	7.87 (7)
Post-test Mean (SD, *n*)	44.78 (21.77, 162)	54.95 (15.14, 159)	44.55 (23.36, 84)	55.08 (16.42, 84)
Post-percent (*n*)	40.49 (66)	13.84 (22)	39.29 (33)	11.90 (10)
Change-mean (SD, *n*)	4.69 (24.68, 153)	−1.24 (19.26, 144)	−0.217 (28.76, 82)	−2.29 (16.92, 82)
Pre–post-Test Difference (within group)[a]				
Pre- or Post-test Parameter Estimate (*SE*) (reference = pre-test)	−0.30 (0.16)	0.13 (0.31)	−0.35 (0.22)	0.45 (0.49)
Estimate Chi-Square (DF)	3.49 (1)	0.19 (1)	2.50 (1)	0.84 (1)
Hazard ratio (*p*) (reference = pre-test)	0.74 (0.06)	1.14 (0.67)	0.70 (0.11)	1.57 (0.36)
Overall model x^2 (df, *p*)	3.52 (1, 0.06)	0.18 (1, 0.67)	2.54 (1, 0.11)	0.85 (1, 0.36)

[a]Using Cox Proportional Hazards Model.

Within the *begin to* ECSEL and comparison groups, in Cox regression analyses evaluating the time-to-peeking, we found no significant hazard ratios indicating differences between groups in the pre-test or post-test assessments (Table 6). In the post-test, *begin to* ECSEL children had 0.70 times the hazard of peeking, and 1.57 times the hazard of touching, compared to the pre-test. For the comparison group, children in post-test had 0.74 times the hazard of peeking, and 1.14 times the hazard of touching, compared to the pre-test.

In terms of between-group comparisons (shown in Table 7), the overall adjusted Cox model for the peeking trials was significant (X^2 [df] = 57.45 [4], $p < 0.0001$). Further, there is evidence in the adjusted model that the hazard ratio for peeking between samples was not equal to one. Adjusted for age, pre- or post-test, and gender, *begin to* ECSEL children compared to children in the comparison group, had 0.56 times the hazard of peeking ($p = 0.003$). Thus, *begin to* ECSEL children were less likely to peek than children in the comparison group, after controlling for other factors. In the pre-test, children had 1.33 times the hazard of peeking ($p = 0.021$) as compared to the post-test; males had 0.51 times the hazard of peeking ($p < 0.0001$) as compared to females; and the hazard ratio for age in months was 0.95 ($p < 0.0001$), all adjusted for the other variables in the model.

However, the adjusted overall Cox models for touching were not significant (X^2 [df] = 7.18 [4], $p =$ 0.113). Adjusted for age, pre- or post-test, gender and group, *begin to* ECSEL children had 0.81 times

Table 7. Cox proportional hazards models comparing *begin to* ECSEL to the comparison group for peek and touch trials.

	Parameter estimate (SE)	Chi-square (df)	Hazard ratio	*p* value for hazard ratio	Chi-square of overall model (df), *p*
Begin to ECSEL vs. Comparison Group: Toy Peek[a]					
Group (reference = comparison group)	−0.57 (0.19)	8.84 (1)	0.56	0.003	57.45 (4), $p < .0001$
Age	−0.047 (0.010)	5.30 (1)	0.95	<.0001	
Gender (reference = female)	−0.683 (0.145)	23.60 (1)	0.51	<.0001	
Pre- or post-test (reference = pre-test)	0.284 (0.123)	22.05 (1)	1.33	0.021	
Begin to ECSEL vs. Comparison Group: Toy Touch[b]					
Group (reference = comparison group)	−0.213 (0.426)	0.25 (1)	0.81	0.617	7.48 (4), $p = 0.113$
Age	0.002 (0.017)	1.22 (1)	1.00	0.920	
Gender (reference = female)	−0.651 (0.308)	4.46 (1)	0.52	0.035	
Pre- or post-test (reference = pre-test)	−0.233 (0.211)	0.01 (1)	0.79	0.269	

[a]Adjusted for age, gender and pre- or post-test.
[b]Adjusted for age, gender and pre- or post-test.

the hazard for touching ($p = 0.617$). In the adjusted model, the hazard ratio for gender, adjusted for all other variables, was significant, and males had 0.52 times the hazard of touching compared to females ($p = 0.035$).

Overall, although within each sample there was no demonstrable evidence that the peek and touch hazards were different in the pre-tests and post-tests when comparing the two samples, there was evidence that *begin to* ECSEL children had a lower hazard of *peeking* compared to children in the comparison group, adjusted for age, gender and pre- or post-test. However, there was no significant evidence that *begin to* ECSEL children had a different hazard of *touching*, adjusted for age, gender and pre- or post-test, compared to the comparison group.

Discussion

The importance of developing self-regulation skills early on has been found beneficial not only for a child's learning, but also for the development of empathy, problem-solving and prosocial skills. Prior research suggests that the brain develops more quickly during the first few years of life than at any other time. People and experiences that are present in a child's life from birth work towards 'wiring the brain's architecture,' laying the foundation for what is to come (Center on the Developing Child, 2007).

Recognizing that thinking can be impaired and the brain cannot learn when feelings are not regulated (Cohen, 2017), an intervention-prevention approach that promotes the regulation of emotion comes at a critical juncture. An approach that utilizes a teacher-as-socializer model in the context of co-regulation to promote self-regulation, emotional competence and executive function skills could be instrumental in early childhood education. Our findings demonstrate that *begin to* ECSEL results in multifaceted change, showing significant improvement in self-regulation and executive functioning. These findings come at a time when skills associated with the regulation of emotion, thinking and behaviour are now deemed critical for many fundamental abilities, including memory, attention and stress management (Osher, Cantor, Berg, Steyer, & Rose, 2020) and when children with poor emotion management skills are considered prone to act aggressively and impulsively, rather than use problem-solving skills to analyse situations, anticipate consequences and plan a response. Teaching the connection between feelings, thoughts and behaviour provides the bridge for understanding appropriate ways of getting one's needs met and constructively resolving conflicts and solving problems.

Early childhood programmes that serve students from birth are in desperate need of evidence-based programmes promoting emotional competence and regulation. The *begin to* ECSEL approach has incorporated a variety of specific tools and techniques to help teachers promote these skills among children as young as three months old. This programme recognizes that regulation is deeply embedded in the child's relationship with the significant caregiver, i.e. the teacher. Previously, it was proposed that the *begin to* ECSEL approach could have long-term benefits on children's mental health, well-being and success, and – pending the results of ongoing and future research – could therefore be recommended for integration into early childhood education globally (Housman, 2017). The goal of *begin to* ECSEL is to use every emotional situation that a child experiences as an opportunity for him or her to learn more appropriate regulation strategies.

The purpose of this study was to examine the effectiveness of the *begin to* ECSEL programme on children's self-regulation and EF. By conducting 'hot' and 'cool' tasks of the Preschool Self-regulation Assessment, we were able to assess children's level of self-regulation (Smith-Donald et al., 2007). In the past, PSRA was found promising in assessing children's self-regulation in preschool and elementary school contexts (Raver et al., 2011). It also has offered a strong potential for helping researchers to evaluate the impact of interventions on children's executive function and self-regulation skills (Duncan et al., 2007).

Results showed that the average age of children from the *begin to* ECSEL programme was significantly younger than the comparison group. In the pre-tests, *begin to* ECSEL participants had an average age of 36.40 months, while the average age of children in the comparison group was 48.14 months. Even though the average age of *begin to* ECSEL children was almost one year younger than the comparison group, the significant results on three important tasks of PSRA suggest a considerable positive effect of the intervention programme when introducing the skills of emotional competence within the earliest years (first 3 years of life). This suggests the need to promote the growth of self-regulation and executive functioning – skills that undergird children's learning and academic success.

In comparing the overall performances of the two groups of students, children from the *begin to* ECSEL program revealed better level of attentiveness to the assessor's instructions, skills in inhibiting their first impulse to copy the number of pencil taps that the assessor completed, and better working memory compared to the comparison group during the Pencil Tap task. Children from both the comparison group and *begin to* ECSEL programme easily completed 20- and 30-s trials during the Snack Delay task. However, children of *begin to* ECSEL programme were able to wait much longer for a snack compared to the comparison group for the 60-s trial. Previously, the ability to wait for a reward was found to tap effortful control (EC), while the lack of this ability might reflect either low EC or a strong reactive approach to rewards (Spinrad et al., 2007). In addition, *begin to* ECSEL participants demonstrated greater inhibitory control (hot EF) when instructed not to peek during the toy wrap task. The ability to control impulses from an early age is inextricably linked to and facilitates the development of, other critical skills necessary for learning.

While there was a significant decrease in *peeking* during the toy wrap task, there was also an increase in *touching* from pre-test to post-test for both the *begin to* ECSEL and comparison groups, and the *begin to* ECSEL sample had slightly greater post-test scores than the comparison group. It is possible, however, that children from *begin to* ECSEL programme might have become familiar with the examiners who were working at the school over the 6-month period between the pre-test and post-test, leading them to have a higher tendency to touch the toy at the post-test.

Several limitations of the present study are important to note. Due to the restrictions of the school educational setting and parent consent, the present research was a quasi-experimental study using comparison samples and pre- and post-test measures to evaluate the effectiveness of the *begin to* ECSEL intervention on children's self-regulation and executive functioning skills. Future studies can utilize a randomized experimental design with concurrent enrolment in the target population to further validate the intervention outcomes. Considering the current study results and the fact that a previous study demonstrated the effectiveness of the *begin to* ECSEL programme in promoting children's emotional competence (Housman et al., 2018), it would be interesting to explore in future studies whether emotional competence mediates the influences of the *begin to* ECSEL on self-regulation and executive functioning.

ECSEL was developed and implemented in a particular cultural context, i.e. in working with middle-to-upper class families in Western society. Within this context, the emphasis, for example, on verbal expression, independent selfhood, and dyadic relational constellations are consistent with the cultural assumptions of many of the teachers, parents and children who have thus far used the approach. In a different locale, it remains to be seen whether these assumptions might require adaptation to fit the particular assumptions of the prevailing culture. Within all cultures, however, the self is expressed to varying degrees through action, such as crying, movement and gestures (e.g. Elfenbein & Ambady, 2002; Sauter, Eisner, Ekman, & Scott, 2010). The goal of ECSEL is to transfer that action into expressive forms (i.e. gestures, sign language and emotion talk) so that children are better able to label, understand and manage their emotions in a more organized and meaningful way, while respecting different cultural norms and values. Although we have not yet applied ECSEL outside the United States, it has been used with the *begin to* ECSEL multicultural population that includes native English, Mandarin, Korean, Italian, Greek, Farsi, Spanish and Hindi speakers who originate from diverse cultures.

A final potential limitation to note is that in-person teacher training, communication and reflective mentorship are important facets of the current *begin to* ECSEL programme. To achieve greater programme impact, future research should investigate the efficacy of using online learning technology to provide training and mentoring support.

Conclusions

In conclusion, our findings suggest that children who were enrolled in the *begin to* ECSEL programme demonstrated greater improvements in self-regulation and executive function skills than the comparison group. Children in the *begin to* ECSEL programme were able to perform significantly better in both the pencil tap task, measuring control and development of executive function skills, and the 60-s trial of the snack delay task, reflecting the socio-emotional aspects of self-regulation (Smith-Donald et al., 2007). Such results support our hypothesis that preschool children, when introduced to programmes promoting emotional competence and regulation from birth, are better able to develop self-regulation and EF critical to success in learning, academics and life. The *begin to* ECSEL programme promotes developing a greater emotional maturity, therefore equilibrium, which unleashes a greater capacity to learn.

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Disclosure statement

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Data availability statement

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

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