Staying self-regulated in the classroom: the role of children's executive functions and situational factors

Janina Eberhart, Donna Bryce, Sara Baker

Angaben zur Veröffentlichung / Publication details:

Eberhart, Janina, Donna Bryce, and Sara Baker. 2024. "Staying self-regulated in the classroom: the role of children's executive functions and situational factors." *Educational Psychology* 94 (3): 995–1010. https://doi.org/10.1111/bjep.12700.

Received: 17 March 2023 | Accepted: 29 May 2024

DOI: 10.1111/bjep.12700

Check for updates

ARTICLE

the british psychological society
promoting excellence in psychology

Staying self-regulated in the classroom: The role of children's executive functions and situational factors

Janina Eberhart[1,2] | **Donna Bryce**[2,3] | **Sara T. Baker**[1]

[1]University of Cambridge, Cambridge, UK
[2]University of Tübingen, Tübingen, Germany
[3]University of Augsburg, Augsburg, Germany

Correspondence
Janina Eberhart, University of Tübingen, Europastraße 6, Tübingen 72072, Germany.
Email: janina.eberhart@uni-tuebingen.de

Funding information
LEGO Foundation; Cambridge Trust; Deutsche Forschungsgemeinschaft (BR 6057/3-1)

Abstract

Background: Self-regulation is crucial for children's learning and development. Several studies have explored children's inter-individual differences in self-regulation, but little is known about sources of intra-individual variation.

Aims: This study addressed the variability of children's self-regulation across typical classroom situations and how this might be associated with children's executive functions (EFs).

Sample: The study included 148 children (54.7% girls; M_{age} = 56.73 months).

Methods: Self-regulation was assessed with an observational measure in teacher-led and child-led activities within naturalistic classroom settings. Children's EFs were assessed with direct assessments at the start and end of the school year.

Results: Linear mixed-effect models showed that children demonstrated higher levels of self-regulation in child-led in comparison with teacher-led activities. Children with higher levels of EFs at the start of the school year showed less variation across teacher-led and child-led activities in comparison with children with lower levels of EFs. Regarding other aspects of the classroom context, neither the group size in which the activity took place nor which school subject it was focused on were associated with children's self-regulation. However, in teacher-led activities the type of interaction involved in the activity and the type of task influenced children's self-regulation.

Conclusion: These results suggest that children who start school with higher levels of EFs are more able to adapt to different situations, highlighting the importance of fostering these skills in early childhood. In turn, children with

lower levels of EFs may need additional support from teachers to remain self-regulated across different contexts.

KEYWORDS

executive functions, intra-individual variability of self-regulation, self-regulation

INTRODUCTION

Young children have a wide range of experiences in a typical day at school. These may include circle time where children join in teacher-led activities, free play where children decide on activities by themselves, as well as emotionally taxing situations such as when another child takes a desired toy. Across the day children need to pay attention, make plans, and keep their emotions in a balanced state, relying on a skillset commonly referred to as self-regulation (McClelland & Cameron, 2012). While self-regulation is generally assumed to be a stable skill within a child, recent work suggests that children's self-regulation can vary across situations (McCoy et al., 2022; Timmons et al., 2016; Zachariou & Whitebread, 2022). Little is known about factors that might be associated with this variation. In the current study, we explore the variation of children's self-regulation across typical classroom activities. Further, we investigate how individual differences in children's executive functions (EFs), higher order cognitive skills consisting of three components (working memory, inhibitory control, shifting) which support self-regulation (Hofmann et al., 2012), impact their ability to successfully self-regulate across different situations.

Self-regulation is the ability to flexibly regulate internal states such as emotions or cognition as well as outwardly noticeable states such as behaviour in response to situational or contextual demands (Nigg, 2017). Self-regulation is important for paying attention in class, adapting to the demands of different activities, and keeping emotions in a balanced state (Blair & Raver, 2015; Rimm-Kaufman et al., 2009); as such, self-regulated children are ready to learn (Blair, 2002). During the preschool years children's self-regulation develops rapidly (McClelland & Cameron, 2012). Furthermore, children from high socioeconomic backgrounds tend to outperform their counterparts from more disadvantaged family backgrounds in measures of self-regulation (e.g., Crook & Evans, 2014; Evans & Kim, 2013; Hackman et al., 2010, 2015). Aspects such as parental scaffolding or structured family routines are positively associated with children's regulatory behaviour (Bernier et al., 2010; Berry et al., 2016; Hughes & Ensor, 2009). In sum, there is ample empirical evidence that self-regulation is crucial for children's learning and development and that distal contextual factors (i.e., family background) give rise to inter-individual differences in this skillset.

At the same time, there is little evidence about how children's self-regulation might vary from moment to moment. One reason for this might be the types of measurement approaches traditionally applied in this field. Direct assessments, such as the Head-to-Toes (Cameron Ponitz et al., 2008) or delay of gratification tasks (Mischel et al., 1989), are administered in lab-like environments where extraneous influences are kept to a minimum and typically repeated measures are averaged. In adult reports, teachers or parents provide a general evaluation of children's self-regulation (McCoy, 2019; Obradović et al., 2018), usually not related to specific activities or situations. By design, both direct assessments and adult reports of self-regulation gloss over variation across situations. In contrast child observations can be used to assess variations in children's self-regulation in different situations as they occur (McCoy, 2019). In particular, every day in their classrooms, children are confronted with a variety of situations that might systematically elicit varying levels of self-regulation.

Many early years classrooms are characterized by a mix of teacher-led learning activities and play-based workstations that children explore in a child-led fashion (Early et al., 2010; Goble & Pianta, 2017). Teacher-led and child-led activities may make different regulatory demands on children. In teacher-led activities, all children in the classroom follow the instructions of the teacher. Children have to put aside their individual impulses to join in with the group. In contrast, in child-led activities, children have to manage their own behaviour and make choices about the activities they engage in (Goble & Pianta, 2017).

Empirical evidence suggests that children's self-regulation varies as a function of who is leading the activity. Whitebread et al. (2007) coded instances of self-regulation in 3- to 5-year-olds and found that children displayed relatively more regulatory behaviour in child-led activities in comparison with teacher-led activities. These findings are in line with Robson (2016a, 2016b) who observed 4- to 5-year-old children in their naturalistic classroom environment and found that children demonstrated more instances of self-regulation in child-initiated situations where teachers were absent in comparison with teacher-led situations where teachers were present. Similarly, Zachariou and Whitebread (2022) showed that 6- to 8-year-old children expressed numerically more instances of self-regulation in child-initiated and led musical activities in comparison with those that were teacher-initiated and led. More recently, McCoy et al. (2022) used a different coding approach and rated children's successful self-regulation. They explored intra-individual differences of children's observed self-regulation across teacher- and child-led classroom activities and transitions. They found that children's levels of observed self-regulation were lower in teacher-led and child-led activities in comparison with transitions (McCoy et al., 2022). Taken together, it appears that there is variation of children's self-regulation across classroom situations. However, there is no clear pattern that indicates whether children are better able to self-regulate in activities initiated by the teacher or by themselves.

One possible reason for these mixed findings is that teacher-led and child-led activities are usually conflated with other classroom context variables (e.g., group size, type of interaction, type of task, school subject), all of which might also influence children's ability to self-regulate. In teacher-led activities, children often work in structured whole class settings (e.g., listening to a story) or in small groups (e.g., completing a worksheet or writing at a workstation) on tasks that tap the more core school subjects such as literacy and mathematics (Early et al., 2010). In child-led activities, children often work independently or in small groups in relatively unstructured ways and their tasks may tap into a wider range of school subjects for example also including the arts. In teacher-led activities children may more often listen to the teacher or engage in a group discussion which involves listening and talking, whereas in child-led activities, children may be more likely to collaborate with peers or work independently.

Some previous studies can provide insights into how such classroom context variables might affect children's self-regulation. For instance, teachers' ability to scaffold children's self-regulation by adjusting the activity or by providing external supports may be affected by group size. This has been indicated by Puntambekar (2022) who proposed that scaffolding is more effective when teachers interact with individual children or a smaller group of children (Puntambekar, 2022). Timmons et al. (2016) also assessed kindergarteners' ability to successfully self-regulate in different classroom situations (whole group, small group, play, and transitions). Their results indicated the highest self-regulation scores when children were in small groups, followed by play, whole group, and transitions (Timmons et al., 2016). Working in small groups may also pose specific self-regulatory challenges as children may experience that their own goals deviate from the goals of their peers and that they are required to share, negotiate roles, and collaborate (Fisher et al., 2010). Whitebread et al. (2007) also examined group size and found that children showed more instances of regulation when they worked in pairs, followed by small groups and whole class. The previously mentioned study by Zachariou and Whitebread (2022) applied a similar coding approach to Whitebread et al. (2007) and coded the frequency of regulatory behaviour of the same 6- to 8-year-old children in musical play activities taking place in different group sizes and with varying levels of teacher involvement. They found most instances of regulatory behaviour during play in pairs, followed by individual play and group play (Zachariou & Whitebread, 2022). It is important to note that both studies assessed instances where attempts to self-regulate were apparent, not considering if children's self-regulatory behaviour was successful. Taken together, children's self-regulation may be influenced by classroom context variables such as group size, type of interaction, type of task, and subject. However, more evidence is needed before firm conclusions can be drawn.

In addition to situational demands potentially eliciting varying levels of self-regulation in young children, there may be individual differences in children's own cognitive skills that explain moment to moment variations in self-regulation. As mentioned previously, EF skills support self-regulation (Blair & Ursache, 2011; Hofmann et al., 2012). EFs are foundational cognitive skills that encompass the updating of working memory, inhibitory control, and shifting (Miyake et al., 2000). Working memory is important for keeping goals in mind while inhibitory control and shifting help to limit distraction and to consider alternative ways to approach tasks or activities (Hofmann et al., 2012). Both cross-sectional (e.g., Fuhs et al., 2015; Howard et al., 2021; McCoy et al., 2022) and longitudinal studies (e.g., Rimm-Kaufman et al., 2009) show a general association between children's self-regulation and EFs. However, to the best of our knowledge no study has assessed how these foundational cognitive skills, assessed at the beginning and end of the school year, relate to variations in children's self-regulation in the classroom from moment to moment. Children with higher levels of EFs might employ their working memory, inhibitory control and shifting to adapt flexibly to a range of activities (whether teacher-led or child-led) and their self-regulation might therefore be less impacted by situational factors. Conversely, children with lower levels of EFs might find it more difficult to adapt to various activities (and perhaps especially to structured teacher-led activities that they have not initiated); therefore, their self-regulation might be more variable from moment to moment.

The present study

The present study measured children's EFs at the beginning and at the end of the school year with a comprehensive task battery. At the end of the school year, children's self-regulation was assessed in a naturalistic teacher-led and child-led activity. We assessed children's EFs at two timepoints because EFs at this age change rapidly and we wanted to explore whether the EF skills on entering school and at the end of the school year differently predict children's ability to self-regulate in different contexts. The study addresses two research questions regarding the variation of children's self-regulation across typical classroom activities: (1) Does children's self-regulation vary across typical classroom activities (teacher-led vs. child-led)? (2) Are children's EFs associated with their self-regulation as observed in the classroom? In additional exploratory analyses, we examined the influence of various classroom context variables on children's self-regulation while participating in both teacher-led and child-led activities. No previous study to the best of our knowledge has explored the contribution of EFs to explaining variation in children's classroom-based self-regulation. A novel aspect of the present study is that it addressed this question with children attending the first year of mandatory schooling in England (Reception class).

METHODS

Participants

We observed 148 4- and 5-year-olds (81 girls, 54.7%; M_{age} = 56.73 months; SD_{age} = 3.49 months) in 28 classrooms across 14 schools in England. Teachers provided information on 129 children's spoken languages and ethnicity using categories from the School Census 2017 and 2018 (Department for Education, 2018). Of those 129 children, 68 children (52.71%) spoke English at home. Teachers identified 24.44% as White British, 25.92% as White Non-British, 26.67% as Asian or Asian British, 5.19% as Black or Black British, 7.41% as Mixed/Dual background, 1.48% as Chinese, 4.44% as Any Other ethnic group. No information was provided for a further 4.44%. Ten of the 14 schools were in deprived areas according to the Multiple Deprivation Index (MDI), which is based on several indicators of deprivation such as income deprivation, employment deprivation, crime, and barriers to housing and services (MDI; Ministry of Housing, Communities, & Local Government, 2019), and 11 of the schools were around or above the national average pupil premium level, which reflects the number of disadvantaged children who are eligible for free school meals (Department for Education, 2020). The study was reviewed by the ethics committee of the University of Cambridge. On average we included six children per classroom. Parents gave written consent and children gave verbal assent prior to data collection. Children received stickers after each task and a small gift upon completion. Teachers received a £15 voucher after study completion.

Materials

Self-regulation

The Regulation-Related Skills Measure (RRSM; McCoy et al., 2017) is an observational measure to assess children's self-regulation in their naturalistic classroom environment. For this measure, each child is videoed in two activities: once during the last 5 min of a teacher-led activity and once during the last 5 min of a child-led activity. Teacher-led activities typically involve the whole class (e.g., reading a story or sounding out words/phonics) or small groups of children (e.g., math exercises). In child-led activities, children decide for themselves in what type of activities they want to engage (e.g., drawing, reading, puzzles or role play) and with whom. Researchers rated children's self-regulation based on 16 items. The items tapped children's cognitive self-regulation (e.g., 'Child pays attention to the activity at hand') and emotional self-regulation (e.g., 'Child modulates emotional arousal or maintains appropriate level of emotional arousal in response to classroom expectations (e.g., 'gets excited or calms self down'). Each item was scored on a 4-point scale whereby higher scores indicated more regulated behaviour. That is, the item could be rated as (1) 'child consistently *does not* show the behaviour, with few exceptions', (2) 'child most of the time *does not* show the behaviour, with exceptions', (3) 'child most of the time *does* show the behaviour, with exceptions' and (4) 'child consistently *does* show the behaviour, with few exceptions'. Some of the items have a 'not-observed' option (e.g., 'maintains focus during or quickly returns focus after disruption/interruption'). That is, some items can only be scored if the child experienced specific situations (e.g., a disruption or interruption). In the current data, there were eight items for which many children (more than 50%) had no observations and therefore these items were excluded from further analysis (see Table 1 for a list of all RRSM items and the items that were included in the current analysis). Thus, two RRSM scores per child entered data analysis, one for teacher-led and one for child-led activities, each of which consisted of the mean score of eight items (scores could range between 1 and 4). Thirty percent of the teacher-led and child-led activities were coded by two independent coders who obtained acceptable inter-rater agreement (Cohen' kappa teacher-led = .74 and Cohen's kappa child-led = .72).

Situation description

Additionally, coders completed a contextual checklist regarding group size (e.g., whole group, small group, individual activity), type of interaction the child was predominantly engaged in (e.g., listening, talking, listening and talking [e.g., Q&A], collaboration), subject (e.g., arts, literacy, sciences, gross motor, other [e.g., building blocks]), and type of task (e.g., games, pretend play, materials and manipulatives, worksheet). This information was used to categorize teacher-led and child-led activities and classroom contexts.

Executive functions

The EF task battery consisted of five widely used EF tasks. A self-ordered pointing task, Spin the Pots (Beck et al., 2011; Hughes & Ensor, 2005), was administered to assess working memory. In this

TABLE 1 List of all RRSM items.

#	Description of items
1	Child controls physical movements
2	Child pays attention to the activity at hand
3	Child can shift attention appropriately *within* an activity or task
4	*Child maintains focus during or quickly returns focus after disruption/interruption
5	Child can ignore distractions during an activity
6	*Child shows evidence of independent planning or monitoring
7	Child shows evidence of listening
8	*Child remembers and follows a series of instructions of completes multi-step activity
9	*Child co-creates and/or follows group norms or rules when interacting with peers
10	Child follows classroom rules and routines independently
11	*Child can transition to new activities, tasks or major parts of the day
12	Child inhibits inappropriate or automatic responses and enacts appropriate responses
13	Child modulates emotional arousal or maintains appropriate level of emotional arousal in response to classroom expectations (e.g., gets excited or calms self down)
14	*Child regulates behaviour in the face of own emotional arousal
15	*Child is able to wait for something (e.g., turn, talk, materials, etc.)
16	*Child shows evidence of ability to solve and cope with social dilemmas and conflict with peers

Note: Items with an asterisk were not included in the calculation of children's final RRSM scores as more than 50% of children had missing data on them.

task, the researcher hid 10 stickers in 12 visually distinct boxes on a Lazy Susan tray and children were asked to find the stickers in the boxes. After each attempt, the researcher covered the boxes and spun the tray. The number of attempts until children made the first mistake (picked a box that had no sticker inside) was the dependent variable (Diamond et al., 1997). The Day/Night task (Gerstadt et al., 1994) was administered to assess inhibition. In this task, children were introduced to a game where they had to inhibit an automatic response and show another response instead. They were shown picture cards of a sun and moon and they were asked to say 'day' for the picture card with the moon and 'night' for the card with the sun. The number of correctly answered trials was the dependent variable. The Dimensional Change Card Sort (DCCS; Zelazo, 2006) was applied to assess shifting. In this task, children sorted cards by either colour or shape in single blocks and had to switch between the two dimensions during mixed blocks. The number of correct answers across all trials was the dependent variable. Children's complex EF was assessed via two fluency tasks. In the verbal fluency task, children had to generate as many words as possible regarding a given word category within 1 min (Snyder & Munakata, 2010). This task makes demands on multiple EF components as it requires children to keep their answers in mind, inhibit previously given answers and to resist perseveration in a specific category if no new answers come to mind. Finally, the design fluency task (Korkman et al., 1997) was included for children's non-verbal generativity. Children were asked to draw as many different designs as possible by connecting two or more dots with straight lines. Children's raw scores on the EF tasks were standardized within each timepoint and a composite score was created for children's EFs at the beginning of the school year (T_1) and their EFs at the end of the school year (T_2).

Procedure

Children participated in a comprehensive EF task battery at the beginning (T_1) and at the end (T_2) of the school year. The task battery was administered by one of four trained researchers in a quiet area of children's schools. The task battery took approximately 50 min with breaks. At the end of the school year, each child was also videoed twice in their naturalistic classroom environment; once during the last 5 min of a teacher-led and once during the last 5 min of a child-led activity. Research assistants worked with teachers to learn about the schedule for the day and to identify suitable time windows. Typically, one child was videoed at a time. In very rare occasions multiple consented children were videoed simultaneously. Children's self-regulation in teacher-led and child-led activities was later coded by two of the four researchers who also administered the EF task battery.

Data analysis

The EF composite scores and the RRSM variables were explored for univariate outliers (scores larger than 3 standard deviations). Only the RRSM variables had four outliers which were true scores of children's performance and therefore, not excluded or adapted. Descriptive statistics and correlations among all dependent variables were calculated and whether RRSM scores were affected by the classroom was tested via Kruskal–Wallis tests.

In the planned analysis to address the research questions, the impact of (1) different classroom activities (teacher-led vs. child-led) and (2) a child's EF skills on the self-regulation observed in the classroom (RRSM scores) were investigated using linear mixed- effect models (LMMs; using the R package lmerTest, Kuznetsova et al., 2017). The dependent variable was RRSM score and predictor variables were Activity (teacher-led vs. child-led; this categorical predictor was treatment coded), child's age at time 1 (Age), EF score at time 1 (EFs T_1) and EF score at time 2 (EFs T_2; all continuous variables were centred). An exploratory analysis aimed to find the best fitting model via a process of model selection, in which all predictors and their two-way interactions were entered into the full model as fixed effects. A nested random effect reflecting the fact that children were nested within classrooms was also included in all models. Which of the interaction terms belonged in the best fitting model was determined by iteratively removing one term and comparing it to the full model using likelihood ratio tests. Which of the simple effects belonged in the best fitting model was determined by iteratively removing one term and comparing it to the model containing only simple effects, also using likelihood ratio tests.

In additional exploratory analyses, we examined the influence of specific classroom context variables on a child's RRSM score, namely group size, type of interaction, type of task and subject in which the activity occurred. For this further confirmatory LMM analyses were conducted. The data were split by Activity (teacher-led vs. child-led) and then for each classroom context variable two models were compared: a model that contained the predictor as a fixed effect and a model that contained no fixed effects. In all cases intercepts were permitted to vary by classroom (i.e. a random effect of classroom was included). For each of these analyses, a level of a predictor was only included if there were more than five observations. For teacher-led activities, group size had two levels (whole class vs. small group) and for child-led activities group size had two levels (small group vs. individual). In terms of type of interaction, for teacher-led activities there were two levels (talking vs. listening and talking). Type of interaction could not be analysed for child-led activities as most children were in collaborative activities. For teacher-led activities, type of task had three levels (games vs. materials and manipulatives vs. worksheets) and child-led activities had three levels (games vs. materials and manipulatives vs. pretend play). Finally, considering school subject, in teacher-led activities, subject had four levels (arts vs. literacy vs. science vs. other) and for child-led activities, there were five levels (arts vs. literacy vs. science vs. other vs. gross motor).

RESULTS

Table 2 shows the descriptive statistics of all dependent variables (see also Table S1). Children's EFs at T_1 and T_2 were normally distributed. Most children showed well-regulated behaviour and obtained high scores on the RRSM, in both teacher-led and child-led activities. Thus, the RRSM variables were negatively skewed.

Table 2 also presents correlations between EFs T_1, EFs T_2, teacher-led RRSM and child-led RRSM. There were strong, positive and statistically significant correlations between children's EFs at T_1 and T_2. Children's EFs at T_1 were also consistently associated with their RRSM scores. However, children's EFs at T_2 were only significantly associated with their RRSM score in child-led activities.

A Kruskal–Wallis test showed that there was no statistically significant effect of classroom on children's RRSM scores in teacher-led ($\chi^2(27) = 35.06$; $p = .137$) or child-led ($\chi^2(27) = 23.07$; $p = .681$) activities. Thus, belonging to a specific classroom does not seem to determine children's RRSM scores.

The role of activity and EFs in self-regulation in the classroom

To explore whether the self-regulation children demonstrate in the classroom can be explained by the Activity (teacher-led vs. child-led) and/or their EF skills, LMMs were conducted. The exploratory LMM indicated a statistically significant effect of Activity, $\chi^2(1) = 34.02$, $p < .001$ and EFs T_1, $\chi^2(1) = 9.69$, $p = .002$, as well as a statistically significant interaction of Activity and EFs T_1, $\chi^2(1) = 5.44$, $p = .020$. The results of the best fitting LMM (Model 1) is presented in Table 3. These results can be interpreted as follows: (1) lower levels of self-regulation in the classroom are observed in teacher-led than child-led activities, (2) the higher the EF score at T_1, the higher the self-regulation shown in the classroom and (3) EF scores at T_1 make a greater contribution to self-regulation in teacher-led than child-led activities. These relationships can also be observed in Figure 1. The fixed effects accounted for 16.7% of the variance in self-regulation (the marginal R^2), the nested random effect accounted for approximately 6% (adjusted ICC = .059). Accordingly, 21.7% of variance in RRSM was explained by the entire model (the conditional R^2).

Follow-up analysis was conducted to investigate which of the five separate EF tasks may have been particularly predictive of children's self-regulation in the classroom. The EF battery in the current study consisted of three component EF tasks (Spin the pots for working memory, Day/Night for inhibitory control, DCCS for shifting) and two complex EF tasks (verbal and design fluency). In this exploratory analysis, the best fitting model described above was expanded to include scores from each of the five EF tasks at T_1, as well as their interactions with Activity. Through a process of model selection, only interactions and/or simple effects that significantly improved the model were retained and the best fitting model indicated that both Activity, $\chi^2(1) = 34.19$, $p < .001$ and the design fluency, $\chi^2(1) = 4.09$, $p = .043$, significantly improved the model, as did the interaction between the design fluency and Activity, $\chi^2(1) = 9.88$, $p = .002$ (please refer to Table S2 in the Supplementary Material for the LMM estimates). This model explained a very similar proportion of variance in RRSM as the one using the composite EF score. That is, the fixed effects accounted for 16.4% of the variance in self-regulation (the marginal R^2), the nested random effect accounted for approximately 11% (adjusted ICC = .11). Accordingly, 25.6% of variance in RRSM was explained by the entire model (the conditional R^2).

TABLE 2 Descriptive statistics and Pearson's correlations for study variables.

Variable	*M*	*SD*	Min, Max	1	2	3
1. EFs T_1	.04	.61	−1.23, 1.73	–		
2. EFs T_2	.01	.68	−1.84, 1.32	.67**	–	
3. TL RRSM	3.44	.48	1.50, 4.00	.29**	.15	–
4. CL RRSM	3.71	.31	1.88, 4.00	.21*	.24**	.12

Note: $N = 148$. Standardized composite EF scores are presented here.

Abbreviations: CL, child-led; EFs, executive functions; RRSM, regulation related skills measure; T_1, beginning of the school year; T_2, end of the school year; TL, teacher-led.

*$p < .05$, **$p < .01$.

TABLE 3 Estimates for fixed effects in the best fitting LMM with the dependent variable RRSM score.

Predictor	Estimate (*SE*)	95% CI	*p*-value
(Intercept)	3.71 (.03)	[3.65, 3.78]	<.001
Activity[a]	−.27 (.04)	[−.36, −.19]	<.001
EFs T_1	.11 (.05)	[.01, .21]	.039
Activity[a] × EFs T_1	.12 (.07)	[−.02, .26]	.091

Note: *p* values are based on the Wald statistic.

[a]Baseline: Child-led.

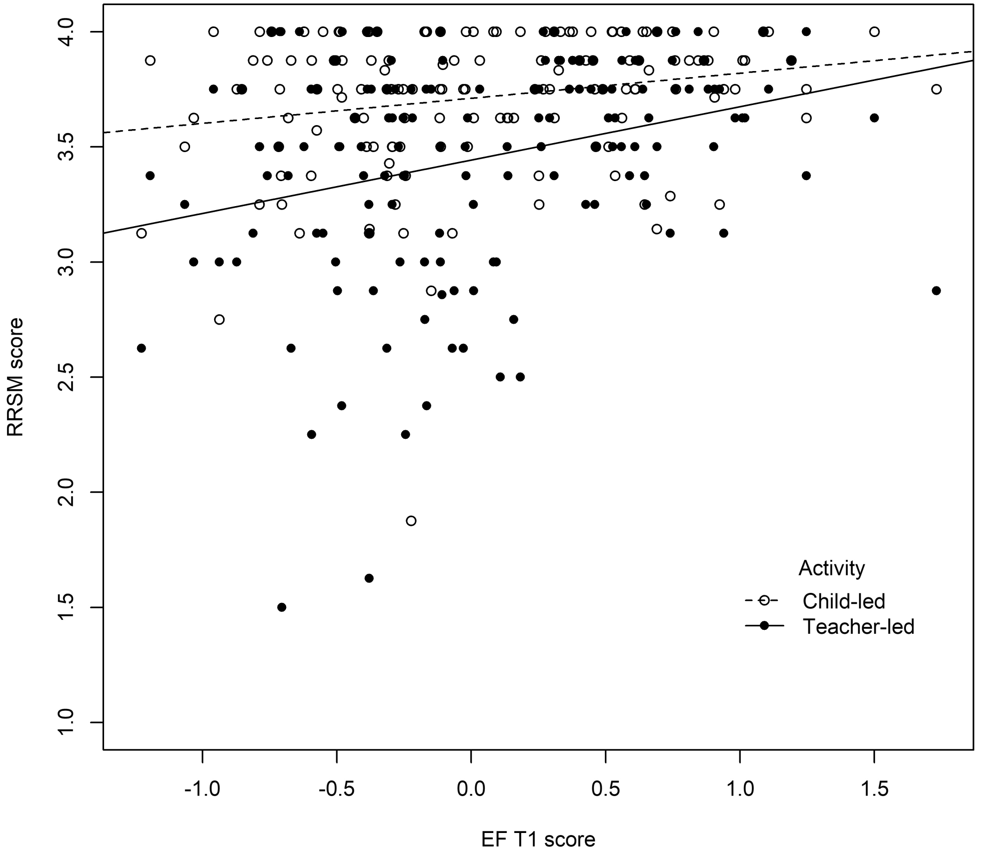

FIGURE 1 The relationships among EF T_1 Score, activity and self-regulation in the classroom. *Note*: EF T1 score, standardized executive function score at the beginning of the school year; RRSM, regulation related skills measure.

The role of classroom context in self-regulation in the classroom

To address whether children's observed self-regulation in the classroom was associated with classroom context variables including group size, the type of interaction, the type of task and the subject children engaged in, separate confirmatory LMMs were conducted for RRSM scores in teacher-led and child-led activities.

In terms of group size, there were numerically very similar mean scores on the RRSM across the different group sizes (see Table 4). Reflecting this, in both teacher-led and child-led activities, entering group size as a predictor variable did not significantly improve the model, teacher-led $\chi^2(1) = 1.85$, $p = .174$, child-led $\chi^2(1) = 1.67$, $p = .197$. Thus, there was no evidence that group size was associated with children's self-regulation.

TABLE 4 Descriptive statistics of children's RRSM scores in different classroom contexts.

	Teacher-led			Child-led	
Feature	***n***	***M* (*SD*)**	**Feature**	***n***	***M* (*SD*)**
Group size					
Whole class	103	3.38 (.46)	Small group	50	3.66 (.39)
Small group	35	3.51 (.52)	Individual	95	3.73 (.26)
Interaction					
Listening	58	3.28 (.58)	–	–	–
Listening & talking	59	3.48 (.39)	–	–	–
Task					
Games	10	3.26 (.68)	Games	7	3.48 (.42)
Materials & manipulatives	42	3.65 (.29)	Materials & manipulatives	97	3.72 (.32)
Worksheet	7	3.66 (.38)	Pretend play	34	3.75 (.24)
Subject					
Arts	19	3.50 (.35)	Arts	85	3.72 (.34)
Literacy	75	3.46 (.49)	Literacy	15	3.81 (.23)
Sciences	51	3.40 (.52)	Sciences	17	3.62 (.29)
Gross motor	–	–	Gross Motor	8	3.77 (.25)
Other	–	–	Other	22	3.66 (.28)

Note: Data are only reported for categories that include more than five observations to avoid too much influence of a very small number of observations.

Abbreviation: *n*, number of child observations.

Entering type of interaction as a predictor variable did significantly improve the model predicting RRSM scores in teacher-led activities, $\chi^2(1) = 4.76$, $p = .029$; children had higher levels of self-regulation in teacher-led activities in which they were listening and talking in comparison with those in which they were only listening (see Table 4).

LMMs indicated that type of task was a statistically significant predictor of self-regulation during teacher-led activities, $\chi^2(2) = 8.03$, $p = .018$, with children showing the highest levels of self-regulation while working on worksheets, followed by materials and manipulatives and finally games. In child-led activities, type of task did not significantly improve the model, $\chi^2(2) = 4.41$, $p = .110$, i.e., it does not predict self-regulation in child-led activities in this dataset.

Finally, it was examined whether the school subject children were engaged in was associated with self-regulation observed in the classroom. Subject did not significantly improve the model for teacher-led, $\chi^2(2) = .78$, $p = .677$ or child-led activities, $\chi^2(4) = 4.25$, $p = .373$.

DISCUSSION

The current study sought to identify systematic variation in children's self-regulation across typical classroom activities (teacher-led vs. child-led) and as a function of classroom context variables in the first year of formal schooling in England. As a novel aspect, the study also examined whether a child-level factor, namely their EFs, was associated with this variation. Naturalistic classroom observations of children's self-regulation revealed generally high levels of self-regulation. However, some variation was observed. Children displayed higher levels of self-regulation in child-led than in teacher-led activities. Children's EFs, measured with direct assessments, appeared to contribute to their ability to self-regulate in different naturalistic classroom situations. That is, children who started the school year with higher levels of EFs showed more stable self-regulation across different situations than the children who started the school year with lower levels of EFs. We also checked for a potential influence of other classroom context variables and found that children's self-regulation was not related to group size or school subject. However, children's self-regulation in teacher-led activities was associated with the type of interaction taking place during the activity and the type of task being completed.

Most children successfully self-regulated in the classroom

Most children in this study obtained high scores on the naturalistic classroom observations. Ratings towards the upper end of the scale were also found by the developers of the classroom observation measure (McCoy et al., 2022) indicating that high ratings were not specific to our sample. There are several explanations why children might obtain high scores on the measure. Firstly, we decided to exclude some RRSM items that have a 'not observed' option as few children of our sample experienced these situations. Most of these items referred to less common and more emotionally charged situations in which children may struggle to self-regulate (e.g., 'Regulates behavior in the face of own emotional arousal' or 'Shows evidence of independent planning or monitoring'). The removal of these items might have led to higher scores overall. Given that other research teams who used the RRSM also found a trend towards high ratings, additional adaptations of the measure might be required to deal with the skewed data. Authors of other scales that aimed to capture natural variation in children's behaviour and found a skew in their data were able to improve their scales by rewording some items and increasing the number of response ratings (Swanson et al., 2012). Perhaps a similar development of the RRSM would be desirable. Another explanation for the high scores on the RRSM is that Reception class teachers are sensitive towards the needs of their students and they adapt tasks and activities to the developmental stage of the children in their classroom. Thus, children's high scores might reflect teachers' abilities to create environments in which children are able to self-regulate effectively. Thus, there are several reasons why children might have obtained high scores on the RRSM. Still, as discussed in the next section, there was also variation across children and classroom situations.

Children showed higher levels of self-regulation in child-led than in teacher-led classroom activities

Consistent with previous studies, in the present study children's self-regulation varied by classroom situation (McCoy et al., 2022; Robson, 2016b; Timmons et al., 2016; Whitebread et al., 2007; Zachariou & Whitebread, 2022). In the current study, children showed higher levels of self-regulation in child-led than in teacher-led classroom activities. As suggested previously, a possible reason for poorer self-regulation in teacher-led activities could be group size (e.g., more distraction). However, our additional analysis of group size did not support this interpretation, as group size (whole group vs. small group) did not explain variation in RRSM scores during teacher-led activities. An alternative explanation is that degree of choice may affect self-regulation during classroom activities. The strategies that are available to children to regulate their motivational state are much more restricted in teacher-led activities than child-led, which may lead to lower RRSM scores. In teacher-led activities children frequently have little choice. Thus, children might be less motivated in teacher-led activities because the goals and often the means for achieving them, are set for the whole group and not for the individual child (Baker et al., 2021; Stefanou et al., 2004). In contrast, in child-led activities children can choose what they want to work on and they can alter their goals as they go. Thus, there is more flexibility in comparison with tasks where goals are set externally (Perry, 2013). More research is needed to understand how motivation and self-regulation interact during teacher-led and child-led activities.

Furthermore, in the present study other classroom context variables were considered such as type of interaction, school subject and type of task. In child-led activities, none of these classroom context variables influenced the level of self-regulation shown by children. However, in teacher-led activities children demonstrated higher levels of self-regulation in activities where they had the opportunity to interact more actively such as listening and talking (e.g., Q&A) versus only listening (e.g., listening to a story). Similarly, in teacher-led activities higher levels of self-regulation were found when children engaged with materials and manipulatives or worksheets in comparison with when engaging with games. Materials and manipulatives as well as worksheets can be considered as tools that support children's self-regulation by structuring the task for the child. Thus, taken together these results may suggest that children's self-regulation should be purposefully supported with such tools.

Finally, a combination of the overall duration of the activity and the time point of the observation could explain why children showed higher levels of self-regulation in child-led in comparison with teacher-led activities. In both activities, children were observed during the last 5 min of the activity and the following transition. However, in child-led activities children could leave the activity at any time whereas this was not possible during teacher-led activities where the duration of the activity was determined by the teacher. Similar to the point above, it is possible that children who lost interest in a child-led activity would move on quickly and were therefore less likely to be observed during that activity. Future studies could take the overall duration of the activities into account and compare children's levels of self-regulation in teacher-led and child-led activities of comparable durations.

Children with higher EFs showed more stable self-regulation across situations

Our results indicated that children who started the school year with higher levels of EFs also showed higher levels of self-regulation in the classroom at the end of the school year. This is consistent with other research studies where associations between children's EFs at the beginning of the school year and self-regulation were found (e.g., Rimm-Kaufman et al., 2009). However, most of the existing studies assessed children's self-regulation with adult reports. In the current study, we showed that similar associations exist if children's self-regulation is observed in a naturalistic setting. This corroborates findings by Howard et al. (2021) and McCoy et al. (2022) who found associations between children's concurrent EFs and observed self-regulation.

Extending these findings, our data revealed that children who started school with lower EFs showed more variation of self-regulation across teacher- and child-led activities than children with higher levels of EF. In contrast, children who started school with higher EFs demonstrated similar self-regulation in both teacher-led and child-led activities. Consistent with the interaction effects, correlational analysis indicated that children who started the school year with higher EFs also showed higher levels of observed self-regulation in teacher-led and child-led activities. This makes sense as children with higher levels of EFs might have the cognitive skills to flexibly adapt to different activities and they can use their EFs to deal with the different challenges they face. In turn, children with lower levels of EF might need support to stay self-regulated across different situations.

While children's EFs measured at the beginning of the school year were associated with children's observed self-regulation at the end of the school year, it is puzzling that a different pattern emerged for children's EFs measured at the end of the school year. Children's EFs assessed at the end of the school year were associated with their self-regulation in child-led but not teacher-led activities. It can be speculated that even though at the end of the school year, overall, children showed lower levels of self-regulation in teacher-led in comparison with child-led activities, some children may still have benefitted from external regulatory support in the teacher-led activities. Due to this external regulation from teachers, children may be relatively less dependent on their concurrent EFs in teacher-led compared to child-led activities. However, children's EFs assessed at the beginning of the school year may still determine children's general levels of self-regulation at the end of the school year. However, this was a surprising finding which needs to be replicated before strong interpretations are drawn.

Follow-up analysis with the five EF tasks included separately showed that one of the complex EF tasks (Design Fluency) was particularly predictive for children's self-regulation in the classroom. This finding corresponds with McCoy et al. (2022) who found stronger associations between the RRSM and more complex direct assessments that tapped multiple EF components. This may suggest that complex EF tasks are more representative of children's self-regulation skills in the classroom than EF tasks that only assess one EF component.

In sum, our data suggest that child-led activities allow children to demonstrate higher levels of self-regulation than teacher-led activities, especially for those children whose EFs are lower at the start of the school year. Furthermore, as mentioned previously, studies by Robson (2016b) and Zachariou and Whitebread (2022) found that children showed more instances of self-regulation in child-initiated activities in comparison with teacher-initiated activities. Considering their findings together with our findings, it can be proposed that child-led activities offer children more opportunities to engage in self-regulatory behaviour and children with high and low EF seem to be able to effectively self-regulate in child-led activities. Thus, these findings indicate the importance of allocating time for child-led activities in the classroom.

An important note of caution has to be raised here. It is of course possible that this interaction effect emerged due to skewed data from the RRSM. Perhaps children with high EFs at the start of the school year would also have shown a similar degree of benefit in child-led activities as their less EF-skilled counterparts if the RRSM had revealed more variation in scores. This highlights the importance of developing the RRSM further with the aim of eliciting data that are normally distributed, as mentioned above.

Although direct assessments of EFs are often critiqued for their low ecological validity (Obradović et al., 2018), they still seem to capture skills that are relevant for children's naturalistic behaviour. McCoy et al. (2022) found significant but somewhat inconsistent correlations between the same observational measure and direct assessments. However, our study as well as theirs did not show strong correlations which suggests that these constructs do not overlap completely. Similarly, children's EFs did not explain all the variance in RRSM, suggesting that while EFs contribute to self-regulation, other factors also play a role.

Limitations and future directions

Our study is not without limitations. In the current study situations were defined as being teacher- or child-led and classroom context variables were noted. However, there remained a lot of variation across activities. For example, activities could vary in content (e.g., teacher-led activities could focus on math, book reading, morning circle etc.) and structure (e.g., child-led activities could include workstations that were prepared by teachers or completely unstructured free play) and classroom context variables had unequal numbers of observations. Related to that, group size varied across teacher-led activities (whole group or small group) and child-led activities (small group or individual) and could not be meaningfully compared. Future studies should take the number of children per group into consideration. Even though the naturalistic nature of these activities offers ecologically valid data, it also limits our ability to draw conclusions about why children's self-regulation varied across these situations. Thus, future research studies could select activities more intentionally (e.g., observe children in book reading, Q&A or specific free play sessions) to tease out the most important factors. Finally, in the current study, a composite score was created to reflect children's EFs. A recent study suggested that findings can vary depending on whether EFs are modelled with a latent variable measurement model or a composite score (Camerota et al., 2020). In contrast to Camerota et al. (2020), in our study we observed decent stability between the two timepoints. Furthermore, we applied the same tasks at both timepoints possibly introducing less error variance. Nevertheless, we want to acknowledge that a different modelling approach may have an influence on the results.

Implications and conclusions

We found that starting the school year with high levels of EFs is beneficial for children's self-regulation across classroom situations. This could imply that children with high levels of EFs are in a better position to make more out of opportunities that they face in the classroom (Blair & Raver, 2015). In turn, children who start the school year with lower levels of EFs need more scaffolding and support to apply their self-regulation successfully and are likely to benefit especially from child-led activities. This aligns with previous work showing teacher-led activities lead to lower levels of self-regulation (Timmons et al., 2016) in comparison with other situations.

Until recently, children's self-regulation has been considered a relatively stable skill and situational factors have rarely been taken into account. This study demonstrates how observations can be used in conjunction with direct assessments to explore individual differences in the development of self-regulation. Given the importance of self-regulation for children's learning and development it is crucial to understand not only broad developmental trajectories but also intraindividual differences and situational influences.

AUTHOR CONTRIBUTIONS

Janina Eberhart: Conceptualization; data curation; formal analysis; investigation; writing – original draft; methodology; writing – review and editing; project administration; supervision; resources. **Donna Bryce:** Funding acquisition; formal analysis; methodology; visualization; writing – original draft; writing – review and editing. **Sara T. Baker:** Conceptualization; data curation; funding acquisition; investigation; methodology; project administration; resources; supervision; formal analysis; writing – review and editing; writing – original draft.

ACKNOWLEDGEMENTS

This study was supported by the LEGO Foundation, Cambridge Trust and the Deutsche Forschungsgemeinschaft (BR 6057/3-1). The authors thank the participating children, families, schools and teachers and acknowledge the assistance of a group of data collectors and research assistants, particularly Hayley Gains and Krishna Kulkarni. These data were collected within Janina Eberhart's PhD thesis.

CONFLICT OF INTEREST STATEMENT

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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.

ORCID

Janina Eberhart https://orcid.org/0000-0002-3650-5452
Donna Bryce https://orcid.org/0000-0001-8311-4457
Sara T. Baker https://orcid.org/0000-0002-8239-2882

REFERENCES

Baker, S. T., Le Courtois, S., & Eberhart, J. (2021). Making space for children's agency with playful learning. *International Journal of Early Years Education*, *31*, 372–384. https://doi.org/10.1080/09669760.2021.1997726

Beck, D. M., Schaefer, C., Pang, K., & Carlson, S. M. (2011). Executive function in preschool children: Test–retest reliability. *Journal of Cognition and Development*, *12*(2), 169–193. https://doi.org/10.1080/15248372.2011.563485

Bernier, A., Carlson, S. M., & Whipple, N. (2010). From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development*, *81*(1), 326–339. https://doi.org/10.1111/j.1467-8624.2009.01397.x

Berry, D., Blair, C., Willoughby, M., Garrett-Peters, P., Vernon-Feagans, L., Mills-Koonce, W. R., Cox, M., Burchinal, P., Burton, L., Crnic, K., Crouter, A., Greenberg, M., Lanza, S., & Werner, E. (2016). Household chaos and children's cognitive and socio-emotional development in early childhood: Does childcare play a buffering role? *Early Childhood Research Quarterly*, *34*, 115–127. https://doi.org/10.1016/j.ecresq.2015.09.003

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist*, *57*(2), 111–127. https://doi.org/10.1037/0003-066X.57.2.111

Blair, C., & Raver, C. (2015). School readiness and self-regulation: A developmental psychobiological approach. *Annual Review of Psychology*, *66*, 711–731. https://doi.org/10.1146/annurev-psych-010814-015221

Blair, C., & Ursache, A. (2011). A bidirectional model of executive functions and self-regulation. In K. D. Vohs & R. F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (2nd ed., pp. 300–320). Guilford Press.

Cameron Ponitz, C. E., McClelland, M. M., Jewkes, A. M., Connor, C. M. D., Farris, C. L., & Morrison, F. J. (2008). Touch your toes! Developing a direct measure of behavioral regulation in early childhood. *Early Childhood Research Quarterly*, *23*(2), 141–158. https://doi.org/10.1016/j.ecresq.2007.01.004

Camerota, M., Willoughby, M. T., & Blair, C. (2020). Measurement models for studying child executive functioning: Questioning the status quo. *Developmental Psychology*, *56*(12), 2236–2245. https://doi.org/10.1037/dev0001127

Crook, S. R., & Evans, G. W. (2014). The role of planning skills in the income–achievement gap. *Child Development*, *85*(2), 405–411. https://doi.org/10.1111/cdev.12129

Department for Education. (2018). *Schools, pupils and their characteristics: January 2018*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/719226/Schools_Pupils_and_their_Characteristics_2018_Main_Text.pdf

Department for Education. (2020). *Pupil premium*. https://www.gov.uk/government/publications/pupil-premium/pupil-premium

Diamond, A., Prevor, M. B., Callender, G., & Druin, D. P. (1997). Prefrontal cortex cognitive deficits in children treated Early and continuously for PKU. *Monographs of the Society of Research in Child Development*, *62*(4), 1–206.

Early, D. M., Iruka, I. U., Ritchie, S., Barbarin, O. A., Winn, D.-M. C., Crawford, G. M., Frome, P. M., Clifford, R. M., Burchinal, M., Howes, C., Bryant, D. M., & Pianta, R. C. (2010). How do pre-kindergarteners spend their time? Gender, ethnicity, and income as predictors of experiences in pre-kindergarten classrooms. *Early Childhood Research Quarterly*, *25*(2), 177–193. https://doi.org/10.1016/j.ecresq.2009.10.003

Evans, G. W., & Kim, P. (2013). Childhood poverty, chronic stress, self-regulation, and coping. *Child Development Perspectives*, *7*(1), 43–48. https://doi.org/10.1111/cdep.12013

Fisher, K., Hirsh-Pasek, K., Golinkoff, R. M., Singer, D. G., & Berk, L. (2010). Playing around in school: Implications for learning and educational policy. In P. Nathan & A. D. Pellegrini (Eds.), *The Oxford handbook of the development of play*. (pp. 341–360). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195393002.013.0025

Fuhs, M. W., Farran, D. C., & Nesbitt, K. T. (2015). Prekindergarten children's executive functioning skills and achievement gains: The utility of direct assessments and teacher ratings. *Journal of Educational Psychology*, *107*(1), 207–221. https://doi.org/10.1037/a0037366

Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3 1/2-7 years old on a Stroop-like day-night test. *Cognition*, *53*(2), 129–153. https://doi.org/10.1016/0010-0277(94)90068-X

Goble, P., & Pianta, R. C. (2017). Teacher–child interactions in free choice and teacher-directed activity settings: Prediction to school readiness. *Early Education and Development*, *28*(8), 1035–1051. https://doi.org/10.1080/10409289.2017.1322449

Hackman, D. A., Farah, M. J., & Meaney, M. J. (2010). Socioeconomic status and the brain: Mechanistic insights from human and animal research. *Nature Reviews Neuroscience*, *11*(9), 651–659. https://doi.org/10.1038/nrn2897

Hackman, D. A., Gallop, R., Evans, G. W., & Farah, M. J. (2015). Socioeconomic status and executive function: Developmental trajectories and mediation. *Developmental Science*, *18*(5), 686–702. https://doi.org/10.1111/desc.12246

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences*, *16*(3), 174–180. https://doi.org/10.1016/j.tics.2012.01.006

Howard, S. J., Vasseleu, E., Neilsen-Hewett, C., de Rosnay, M., & Williams, K. E. (2021). Predicting academic school readiness and risk status from different assessment approaches and constructs of early self-regulation. *Child & Youth Care Forum*, *51*, 369–393. https://doi.org/10.1007/s10566-021-09636-y

Hughes, C., & Ensor, R. (2005). Executive function and theory of mind in 2 year olds: A family affair? *Developmental Neuropsychology*, *28*(2), 645–668. https://doi.org/10.1207/s15326942dn2802_5

Hughes, C., & Ensor, R. (2009). How do families help or hinder the emergence of early executive function? In C. Lewis & J. I. M. Carpendale (Eds.), *Social interaction and the development of executive function*. *New directions in child and adolescent development*, 123 (pp. 35–50). Wiley InterScience. https://doi.org/10.1002/cd.234

Korkman, M., Kirk, U., & Kemp, S. L. (1997). *NEPSY. A developmental neuropsychological assessment*. Psychological Corporation.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13), 1–26. https://doi.org/10.18637/jss.v082.i13

McClelland, M. M., & Cameron, C. E. (2012). Self-regulation in early childhood: Improving conceptual clarity and developing ecologically valid measures. *Child Development Perspectives*, *6*(2), 136–142. https://doi.org/10.1111/j.1750-8606.2011.00191.x

McCoy, D. C. (2019). Measuring young children's executive function and self-regulation in classrooms and other real-world settings. *Clinical Child and Family Psychology Review*, *22*(1), 63–74. https://doi.org/10.1007/s10567-019-00285-1

McCoy, D. C., Jones, S. M., Leong, D., Bodrova, E., Koepp, A., & Hemmenway, A. (2017). *The regulation-related skills measure*. Harvard University.

McCoy, D. C., Koepp, A. E., Jones, S. M., Bodrova, E., Leong, D. J., & Deaver, A. H. (2022). An observational approach for exploring variability in young children's regulation-related skills within classroom contexts. *Developmental Science*, *25*, e13250. https://doi.org/10.1111/desc.13250

Ministry of Housing, Communities & Local Government. (2019). *The English Indices of Deprivation 2019*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833947/IoD2019_Research_Report.pdf

Mischel, W., Shoda, Y., & Rodriguez, M. (1989). Delay of gratification in children. *Science*, *244*(4907), 933–938. https://doi.org/10.1126/science.2658056

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex 'frontal lobe' tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Nigg, J. T. (2017). Annual research review: On the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *58*(4), 361–383. https://doi.org/10.1111/jcpp.12675

Obradović, J., Sulik, M. J., Finch, J. E., & Tirado-Strayer, N. (2018). Assessing students' executive functions in the classroom: Validating a scalable group-based procedure. *Journal of Applied Developmental Psychology*, *55*, 4–13. https://doi.org/10.1016/j.appdev.2017.03.003

Perry, N. E. (2013). *Understanding classroom processes that support children's self-regulation of learning*. BJEP Monograph Series II, Number 10 - Self-Regulation and Dialogue in Primary Classrooms, 45–68. https://doi.org/10.1348/000000015815745185

Puntambekar, S. (2022). Distributed scaffolding: Scaffolding students in classroom environments. *Educational Psychology Review*, *34*(1), 451–472. https://doi.org/10.1007/s10648-021-09636-3

Rimm-Kaufman, S. E., Curby, T. W., Grimm, K. J., Nathanson, L., & Brock, L. L. (2009). The contribution of children's self-regulation and classroom quality to children's adaptive behaviors in the kindergarten classroom. *Developmental Psychology*, *45*(4), 958–972. https://doi.org/10.1037/a0015861

Robson, S. (2016a). Self-regulation and metacognition in young children: Does it matter if adults are present or not? *British Educational Research Journal*, *42*(2), 185–206. https://doi.org/10.1002/berj.3205

Robson, S. (2016b). Self-regulation, metacognition and child- and adult-initiated activity: Does it matter who initiates the task? *Early Child Development and Care*, *186*(5), 764–784. https://doi.org/10.1080/03004430.2015.1057581

Snyder, H. R., & Munakata, Y. (2010). Becoming self-directed: Abstract representations support endogenous flexibility in children. *Cognition*, *116*(2), 155–167. https://doi.org/10.1016/j.cognition.2010.04.007

Stefanou, C. R., Perencevich, K. C., DiCintio, M., & Turner, J. C. (2004). Supporting autonomy in the classroom: Ways teachers encourage student decision making and ownership. *Educational Psychologist*, *39*(2), 97–110. https://doi.org/10.1207/s15326985ep3902

Swanson, J. M., Schuck, S., Porter, M. M., Carlson, C., Hartman, C. A., Sergeant, J. A., Clevenger, W., Wasdell, M., McCleary, R., Lakes, K., & Wigal, T. (2012). Categorical and dimensional definitions and evaluations of symptoms of ADHD: History of the SNAP and the SWAN rating scales. *The International Journal of Educational and Psychological Assessment*, *10*(1), 51–70.

Timmons, K., Pelletier, J., & Corter, C. (2016). Understanding children's self-regulation within different classroom contexts. *Early Child Development and Care*, *186*(2), 249–267. https://doi.org/10.1080/03004430.2015.1027699

Whitebread, D., Bingham, S., Grau, V., Pino Pasternak, D., & Sangster, C. (2007). Development of metacognition and self-regulated learning in young children: Role of collaborative and peer-assisted learning. *Journal of Cognitive Education and Psychology*, *6*(3), 433–455. https://doi.org/10.1891/194589507787382043

Zachariou, A., & Whitebread, D. (2022). The relation between early self-regulation and classroom context: The role of adult presence, the task's source of initiation, and social context. *British Journal of Educational Psychology*, *92*(3), 861–880. https://doi.org/10.1111/bjep.12476

Zelazo, P. D. (2006). The dimensional change card Sort (DCCS): A method of assessing executive function in children. *Nature Protocols*, *1*(1), 297–301. https://doi.org/10.1038/nprot.2006.46

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Eberhart, J., Bryce, D., & Baker, S. T. (2024). Staying self-regulated in the classroom: The role of children's executive functions and situational factors. *British Journal of Educational Psychology*, *94*, 995–1010. https://doi.org/10.1111/bjep.12700