

Main Public Output

Interventions Supporting Early Self-Regulation: A Systematic Literature Review

Project team

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This Report is structured in two main sections: a Summary, followed by a full account of the Project.

Summary

Rationale of the project and project aims

Self-regulation (SR) is considered the foundation of lifelong functioning in a wide range of domains, from academic achievement to emotional well-being, physical and mental health (e.g. Murray et al., 2015). Self-regulation comprises the regulation (monitoring and control) of thoughts, feelings, and behaviour. It includes metacognition (the ability to think about one's own thinking) as the central cognitive element of self-regulation, and executive functions (EF) (Blair & Raver, 2012; Zelazo & Cunningham, 2007, Whitebread et al., 2010; Zachariou & Whitebread, 2022).

Crucially, evidence shows that self-regulation is malleable and can be enhanced through targeted interventions (Dignath et al., 2008), leading to significant positive outcomes that extend from early childhood into adulthood. Self-regulation has gained increasing attention in England's early years policy landscape. The Early Years Foundation Stage statutory framework for groups and school-based providers (EYFS) (DfE, 2025) identifies self-regulation as a key Early Learning Goal. However, the definition of self-regulation used in the EYFS differs somewhat from that in *Development Matters* (DfE, 2020), the non-statutory guidance designed to support its implementation. This inconsistency, which is by no means limited to England, may contribute to variation and uncertainty in practitioners' understanding of self-regulation, and their use of a narrow or restricted range of strategies for promoting it (Burgess, 2023).

Given this context, there is now a strong opportunity to implement targeted interventions that support teachers in developing children's self-regulatory skills across early years settings in England. Before such interventions are introduced, it is essential to have a comprehensive overview of existing studies, enabling researchers, policymakers, and practitioners to make

evidence-informed decisions about the most appropriate approaches for use in English early years settings and schools.

This project **aimed** to:

1) *Identify all self-regulation interventions* published between 2000 and 2024, that have been carried out with young children up to the age of 8, record their characteristics, outcomes and perform quality assessment. Through this analysis we also aim to identify all the high efficacy studies that could inspire interventions in England.

Through interventions targeting teaching and learning approaches, there is potential to improve learning and developmental outcomes. This may particularly impact disadvantaged children, as research suggests that interventions may be particularly valuable for children with low levels of self-regulatory skill at the outset (Tominey & McClelland, 2011), including those at risk because of academic difficulty (McClelland & Cameron, 2012), poverty and income inequality (Raver, 2012).

2) *Identify the self-regulation interventions applied in ethnically diverse or disadvantaged communities*, and report on what characteristics typified those interventions that appeared to be most effective in ethnically diverse or disadvantaged communities.

Thus, this review has the potential to support translation of knowledge into practice, by informing the development of an urgently needed intervention that would be culturally relevant and feasible for implementation in England.

Methods

The methodological approach adopted for this systematic literature review was based on the review protocol suggested by Pandey et al (2017) and followed PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines (PRISMA 2020). Five electronic databases were searched for peer-reviewed journal papers from 2000 onwards using an iterative search strategy. The five databases were: PsycINFO, ERIC, British Education Index, Child Development & Adolescent Studies and CENTRAL. We used Boolean terms. “Self-regulation” (or a related term), *AND* “early childhood” or a related term, *AND* “intervention” or a related term had to be mentioned in the title or abstract of the paper describing the nature of the intervention.

The initial search identified 8,832 studies, which were managed using the review platform Covidence. After removing 2,183 duplicates, completing title and abstract screening, and following full-text screening, 293 papers were included in the final review. Some of the papers reported on more than one study. Quality assessment of all the studies was also performed, using the AXIS Tool, which addresses study design, reporting quality and the risk of bias (Downes et al., 2016).

Findings and key recommendations

A total of 313 studies were identified as describing self-regulation interventions carried out between 2000 and 2024, with children up to the age of 8. The recently increased understanding of the importance of self-regulation is reflected in that almost half of studies

took place in the last five years. Out of the total sample, only 11 studies took place in the UK - a result which indicates that there is scope for further intervention studies in the UK.

Globally, around 30% of the studies focused on populations with low SES. However, when focusing on the UK, and looking for studies which focused on disadvantaged and ethnically diverse populations and which also performed above average in terms of quality assessment, no studies fulfilled these criteria. This gap highlights a significant opportunity to conduct a high-quality intervention study involving disadvantaged and ethnically diverse populations in the UK. Evidence generated from such a study would provide valuable insights to inform both policy development and practical implementation.

All self-regulation interventions carried out with young children up to the age of 8

In this systematic literature review, we first studied the characteristics of all self-regulation interventions carried out with young children up to the age of 8, and then identified the high efficacy interventions which could potentially inspire interventions in England. Based on this, our key findings and implications are presented below.

What are the key characteristics of early childhood self-regulation interventions?

- **Intervention focus:**
Most targeted Executive Functions (55%), some targeted self-regulation (31%), while 14% of interventions targeted both.
Most studies (87%) were **directly intervening** on children's self-regulation, 7% of studies indirectly intervened on children's self-regulation by targeting the teachers, and 6% of studies intervened both directly and indirectly.
- **Delivery context:**
Most studies were conducted **in schools**, using **face-to-face, group-based methods** rather than lab-based or computer-based formats.
→ This shows that interventions embedded in **everyday classroom practice** are **feasible**.
- **Who delivers interventions:**
Over half of the reviewed interventions were implemented by **teachers** rather than **researchers or external facilitators**.
→ This shows that **teacher-delivered approaches** can be **effective** within existing school structures.
- **Practical takeaway:**
Classroom-based, teacher-delivered interventions are not only realistic to implement but also capable of achieving **meaningful outcomes**. Interventions can be successfully implemented within everyday classroom practice, highlighting their feasibility, and potential for adoption in schools.
→ This strengthens the case for **investing in classroom-based, teacher-delivered interventions approaches** that can be **scaled across schools** without heavy reliance on external resources.

Which were the high efficacy studies that could inspire interventions in England?

- **13 interventions** met criteria for high efficacy (summarised in the Table below)
- In terms of **focus**: 6 targeted self-regulation (SR), 4 targeted executive functions (EF), 3 targeted both SR and EF
- In terms of **intervention approach**: 5 implemented Social emotional learning (SEL) programmes, 3 focused on curriculum and pedagogy, 3 were play-based, 2 used non-routine activities
- Among these, only 8 had results on overarching aspects of SR/EF. Six of these focused on disadvantaged and ethnically diverse populations. Two may be particularly relevant for England as they target a variety of SES populations and a range of backgrounds: **Colagrossi et al. (2024)** and **Walk et al. (2018)**

Colagrossi et al. (2024) - SEL Kernels

- Adapted an existing **SEL Kernels** framework originally developed in the USA and implemented in **Brazilian early childhood settings**
- Comprised brief, evidence-informed classroom activities aligned with **five core SEL skill areas**: Feelings Power, Friendship Power, Brain Power, Attitude Power, and Citizen Power.
- Included explicit **theories of change**, implementation guidance, and curriculum alignment
- Used a **rigorous, participatory adaptation process** involving educators, families, and school staff
- Emphasised **teacher autonomy, professional judgement, and contextual adaptation**
- Demonstrated **significant improvements in teacher-reported behaviour problems and emotion regulation**, with medium to large effect sizes
- Shows how an evidence-based intervention can be **successfully adapted across cultural contexts**.

Walk et al. (2018) – EMIL

- A **teacher training and implementation programme** targeting curriculum and pedagogy, focused on executive functions, delivered through **intensive professional development** (28.5 hours)
- Teachers applied strategies flexibly within daily preschool routines
- Focused on EF-supportive practices such as **task adaptation, mindfulness, physical activity, and role-play**
- Produced significant gains in **behavioural inhibition, working memory, and combined EF**, particularly strong effects for children with **low initial EF skills**. Shows potential to **reduce early developmental inequalities**
- Prioritised **teacher autonomy and reflective practice**, rather than scripted delivery

- Taken together, **Colagrossi et al. (2024)** and **Walk et al. (2018)**:
 - demonstrate that **indirect, teacher-led interventions can be effective**;
 - demonstrate that **embedding interventions in daily routines**, rather than operating standalone programmes, **can support teacher autonomy, and allow integration with existing curricula**;
 - could be used as a **model to explore adaptation for a UK context**;
 - highlight the importance of **stakeholder engagement and teacher buy-in** for sustainability.

Study	Total sample size	Mean age (years)	Sample sex (% of Female)	Participant SES	Country	Intervention name	Intervention Approach	Intervention approach categorisation	Directly or Indirectly intervening on SR/EF	Setting
Colagrossi et al., 2024	314	NA	47.8	not reported	Brazil	SEL Kernels (adapted)	SEL program	SEL	Directly and indirectly	School
Jansen et al., 2024	69	5.3	56.52	diverse	Germany	Mindfulness-based Kindness Curriculum	Mindfulness	SEL	Directly	School
Erdemir, 2022	711	5.46	48	low	Turkey	Summer Preschools intervention	Curricula	Curricula and Pedagogy	Directly	School
Anzman-Frasca et al., 2020	56	4.79	32.1	diverse	USA	Gem Heroes board game	Mediated structured play	Play	Directly	Laboratory
Anzman-Frasca et al., 2020	53	4.01	49.1	diverse	USA	Gem Heroes board game	Mediated structured play	Play	Directly	Laboratory
Sasser et al., 2017	356	4.59	54	low	USA	Head Start Research-Based, Developmentally Informed (REDI) preschool intervention	SEL program	SEL	Directly	School
Egger et al., 2019	142	7.91	54.9	not reported	Switzerland	Cognitively engaging physical activity breaks	Physical Activity	Non-routine activities	Directly	School
Zelazo et al., 2018	218	4.75	53.67	low	USA	Mindfulness + Reflection intervention	Mindfulness	SEL	Directly	School

Murray et al., 2018	1192	6.17	48.4	diverse	USA	The Incredible Years® Teacher Classroom Management Program (IY-TCM)	Multicomponent training	Curricula and Pedagogy	Indirectly	School
Domitrovich et al., 2007	246	4.28	51.22	low	USA	Promoting Alternative Thinking Strategies (PATHS) curriculum	SEL program	SEL	Directly	School
Robinson et al., 2016	113	4.33	50.5	low	USA	The Children's Health Activity Motor Program (CHAMP)	Physical Activity	Non-routine activities	Directly	School
Schmitt et al., 2018	59	4.6	56	diverse	USA	Block Play	Semi-structured creative play	Play	Directly	School
Walk et al., 2018	133	4	44	diverse	Germany	EMIL: A training program for preschool teachers to enhance preschooler's EF	Multicomponent training	Curricula and Pedagogy	Indirectly	School

Interventions specifically targeting ethnically diverse or disadvantaged communities

At the second stage of the project, we focused on high efficacy interventions applied in ethnically diverse or disadvantaged communities. Nine studies fulfilled these criteria, namely: Erdemir (2022), Anzman-Frasca et al. (2020, two studies), Sasser et al. (2017), Zelazo et al. (2018), Murray et al. (2018), Domitrovich et al. (2007), Robinson et al. (2016), and Schmitt et al. (2018) which are included in the table above.

From studying the characteristics of these studies, the key findings and implications are presented below:

- **Target age group:**
Evidence from the review shows that most effective interventions focused on children aged **3–6 years**, with the average participant age just over **4.5 years**.
→ *This suggests that investing in self-regulation interventions for children aged 3-6 years can be beneficial.*
- **Implementation focus:**
Interventions within this early-years age range have demonstrated positive outcomes and are therefore a key opportunity for both **early education policy** and **classroom practice**.
- **Evidence gap in the UK:**
Among the **61 relatively high in efficacy studies** involving **disadvantaged and ethnically diverse populations**, **none were conducted in the UK**.
→ *This represents an important gap in the national evidence base and highlights the need for future UK-based research in this area.*
- **Focus on self-regulation:**
Most (5) of the high efficacy interventions with disadvantaged and ethnically diverse populations targeted self-regulation (rather than executive function or both). Interestingly, in the total sample of studies in this systematic literature review, only 31% targeted SR.
→ *This suggests that there are a number of effective SR interventions that could potentially be adapted to the UK context for disadvantaged and ethnically diverse populations.*
- **Mode and format of delivery:**
All high-efficacy studies used **face-to-face, group-based** formats, with most interventions **delivered by teachers** rather than external facilitators.
→ *This demonstrates the feasibility of teacher-led, classroom-based interventions that can be embedded into school practice.* Interventions that are **easy to implement in real classrooms** can still achieve **high levels of effectiveness**, offering strong potential for **scalable, evidence-informed practice**.
- **Intervention approach:**
Three of the nine high efficacy studies used play-based intervention, three employed social-emotional learning interventions and two employed curricula and pedagogy interventions.
→ *This suggests that a range of intervention approaches can perform exceptionally high in terms of efficacy. The high efficacy and relatively higher efficacy studies suggest the value of looking at play, socioemotional approaches and curricula and pedagogy approaches as interventions, whilst non-routine activities performed least well in both groups. The former three approaches may hold particular promise for*

*interventions targeting **disadvantaged and ethnically diverse populations**. This suggests that interventions which focus on children's everyday, routine experiences, in a range of contexts, may be most likely to support higher efficacy.*

Interventions Supporting Early Self-Regulation: A Systematic Literature Review

Project Rationale and Aims

Self-regulation (SR) is considered the foundation of lifelong functioning in a wide range of domains, from academic achievement to emotional well-being, physical and mental health (e.g. Murray et al., 2015). Early self-regulation development contributes to disparities in success in learning, interpersonal behaviours, and mental and physical health in later life (Robson et al., 2020). Most importantly, self-regulation has proved to be malleable, and can be strengthened with intervention (Dignath et al., 2008), with significant positive outcomes spanning from childhood to adulthood. This project aims to identify all self-regulation interventions that have been carried out with young children up to the age of 8, record their **characteristics, outcomes and perform quality assessment**. Our ultimate goal is, upon completion of this systematic literature review, to be in a position to translate research into practice by either a) identifying the most promising intervention or b) designing a new intervention for adoption with young children coming from ethnically diverse and disadvantaged communities in England.

Self-regulation is currently receiving increasing attention in England. The Early Years Foundation Stage (EYFS, DfE, 2025) includes self-regulation as an Early Learning Goal. Confusingly, the definition of self-regulation adopted in the EYFS differs somewhat from the definition in *Development Matters* (DfE, 2020), the non-statutory curriculum guidance written to accompany the EYFS. This inconsistency, which is by no means limited to England, may contribute to variation and uncertainty in practitioners' understanding of self-regulation, and their use of a narrow or restricted range of strategies for promoting it (Burgess, 2023). Now, more than ever, there is fertile ground for an intervention to be implemented with teachers in settings across England, to help support children's self-regulatory development. However, prior to embarking on an intervention, **it is imperative that we have an overview of the interventions that have already been carried out, and their related outcomes, so that researchers, policymakers and practitioners can make informed choices about the most appropriate (and potentially effective) intervention for implementation within English early years settings and schools.**

Through interventions targeting teaching and learning approaches, there is potential to improve learning and developmental outcomes. This may particularly impact disadvantaged children, as research suggests that interventions may be particularly valuable for children with low levels of self-regulatory skill at the outset (Tominey & McClelland, 2011), including those at risk because of academic difficulty (McClelland & Cameron, 2012), poverty and income inequality (Raver, 2012). The added value of the present review lies in the fact that one of its focal points is **to record information about the context in which each intervention was conducted. For example, we record information on whether the intervention was implemented in ethnically diverse or disadvantaged (low socioeconomic status) communities** and present which of these interventions appeared to be the most effective.

Thus, this review has the potential to support translation of knowledge into practice, by informing the development of an urgently needed intervention that would be culturally relevant and feasible for implementation in England.

Conceptualising Self-regulation

It is important to begin by clarifying how we have conceptualised self-regulation. Self-regulation, for adults and children alike, comprises the regulation (monitoring and control) of thoughts, feelings, and behaviour. It includes metacognition (the ability to think about one's own thinking) as the central cognitive element of self-regulation, and executive functions (EF) (Blair & Raver, 2012; Zelazo & Cunningham, 2007, Whitebread et al., 2010; Zachariou & Whitebread, 2022). Executive functions often include foundational cognitive components (Best & Miller, 2010) and are thought to comprise: attentional or cognitive flexibility (for example, switching from one task to another), working memory, and inhibitory control (e.g., the ability to delay gratification) (Allan et al., 2019), and it is suggested that children's ability to apply EF to behaviours is important for their ability to self-regulate (Allan et al., 2019). Thus, self-regulation is an encompassing system that characterises the child's behavioural functioning and includes executive functions (Ursache, Blair and Raver, 2012), and forms 'a broader set of children's regulation skills and behaviour in real-world settings or as reported by caregivers' (Allan et al., 2019).

This definition of self-regulation, which is based on a significant body of literature, encompasses both metacognition and executive functions. Additionally, while the bodies of literature on self-regulation and executive functions have been argued to stem from different disciplines of research (Neuenschwander et al., 2012), more recent research recognizes the benefit of integrating the two (e.g. Sankalaite, et al., 2021). Hence, these factors led us to include all three elements, namely self-regulation, metacognition and executive function, in this review.

Results from previous systematic literature reviews and meta-analyses

Despite the significance of the topic, so far, very few systematic reviews have been conducted on the topic of self-regulation interventions with children and there are significant limitations to all of these. For example, Pandey et al. (2018) include interventions with children up to the age of 19, and focus more on health-related outcomes, rather than developmental and learning outcomes. Other reviews focus exclusively on specific training for self-regulation, such as mindfulness-based interventions (Bockmann & Yu, 2022), physical activity (Wood et al., 2020), and specific curricula, such as *Tools of the Mind* (Baron et al., 2017). Some reviews focus on specific elements of self-regulation, such as metacognition interventions (e.g., Eberhart et al., 2024). The latest review in self-regulation, which takes a broader approach and includes various types of interventions, focuses on a narrow age range of 3–6-year-olds (Muir et al. 2023), and thus excludes interventions carried out with children in what is globally generally viewed as the period of early childhood, i.e., till age 8.

Contribution to the evidence and why this study matters to policy and practice

The added value of this study lies in that, in order to address the limitations of previous studies, particularly for research and practice with young children, the project adopted a variety of informed decisions, aimed both at contributing to current evidence, and informing future policy and practice.

1. In this study we included interventions with children up to the age of 8, to cover the full range of early childhood.
2. The focus of the review is on developmental and learning outcomes, particularly relevant for goals which are focused on improving learning and developmental outcomes.
3. Previous meta-analyses and systematic literature reviews have been restricted to randomised-control trials, very often excluding quasi-experimental studies from their analysis (e.g., Pandey et al., 2018). This constitutes a significant gap in our knowledge, given both the rapid growth of quasi-experimental designs in Education research (Gopalan et al., 2020), and the fact that quasi-experimental studies are usually the format adopted when implementing interventions in real-life classrooms. The inclusion of these studies will thus provide rich and ecologically valid data on which to base decisions for the future step of intervention development: 'an accumulation of findings derived from a variety of designs including both randomized and quasi-experiments can often be more credible taken as a whole, than an accumulation of findings from research based solely on randomized experiments' (Reichardt, 2009, p.46). Therefore, this study brings added value to the domain of studying self-regulation interventions, by including quasi-experimental studies.
4. The review includes new studies which have been published from the latest systematic literature review on self-regulation (Muir et al., 2023) onwards. While many self-regulation interventions have hitherto taken place in US contexts, recent years have seen considerable growth of interventions in a much wider range of countries. Including these interventions in our study helps to enrich our understanding of self-regulation interventions, with the potential for invaluable insights helpful in identifying an appropriate intervention for children in ethnically diverse and disadvantaged communities in England.
5. The inclusion of newer studies may also be more context-appropriate, and relevant for current times, compared to interventions carried out in the early 2000s, and therefore supportive in the development of a future intervention (our long-term goal).

Project Objectives and Research Questions

The objective of the project is to identify all self-regulation and executive function interventions that have been carried out with young children up to the age of 8, record their characteristics and outcomes, and perform quality assessment. Results are described narratively, to enable the drawing of a clear picture of the current state in the field of self-regulation and executive function interventions.

This led to the identification of two Research Questions:

- What were the characteristics of self-regulation and executive function interventions carried out with young children up to the age of 8? Which were the high efficacy studies that could inspire interventions in England?
- Out of the interventions applied in ethnically diverse or disadvantaged communities, what characteristics typified those interventions that appeared to be most effective in ethnically diverse or disadvantaged communities?

Methods

Research design

The methodological approach adopted for this systematic literature review is based on the review protocol suggested by Pandey et al (2017) and follows PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines (PRISMA 2020). Prior to embarking on the literature search, scoping reviews were conducted to assess the existing body of literature and to refine the search terms used in the subsequent analysis. A literature search was performed in February 2025, to identify all universal interventions designed to improve self-regulation in early childhood (0-8 years), published between 2000 and February 2025. This report follows the PRISMA 2020 updated guideline for reporting systematic reviews (Page et al., 2021). This systematic literature review was registered with PROSPERO: March 28, 2025, No: CRD420250651996.

Information sources

Five electronic databases were searched for peer-reviewed journal papers from 2000 onwards using an iterative search strategy. The five databases were: PsycINFO, ERIC, British Education Index, Child Development & Adolescent Studies and CENTRAL. We did not exclude studies based on locations, provided that these were written in English and published in peer-reviewed journals from 2000 onwards.

We used Boolean terms. “Self-regulation” (or a related term), *AND* “early childhood” or a related term, *AND* “intervention” or a related term had to be mentioned in the title or abstract of the paper describing the nature of the intervention.

Inclusion and exclusion criteria

Studies were included in this systematic literature review if they fulfilled the below inclusion criteria:

- a) Published in an academic journal written in English from 2000 onwards
- b) The sample had a mean age of 8 years (96 months) or younger
- c) Reported at least one child-based outcome measure related to self-regulation skills (e.g. teacher-reported self-regulation or on-task self-regulation observations) or executive functions.
- d) Was an empirical study with more than 10 participants in the intervention group.

- e) Reported on universal interventions (targeting all children, not e.g. targeting only children identified with special educational needs) designed to improve self-regulation and executive functions in early childhood (0-8 years).

Studies were excluded if any of the below exclusion criteria were met:

- a) Study was not a universal intervention (targeting all children, not e.g. targeting only children identified with special educational needs or children in foster care, or preterm children, or low EF children or children with behaviour problems etc)
- b) Study described an intervention that targeted parents
- c) Interventions that did not provide clear information on children's mean age
- d) Intervention studies that were not quantitative or mixed methods

Search strategy

The initial search generated 8,832 results. These were imported into Covidence, a review management tool (<https://www.covidence.org/>). Covidence identified 2,143 duplicates which were automatically removed, and 40 duplicates were manually removed. The Principal Investigator then performed title and abstract screening for the remaining 6,649 papers. At the title and abstract screening stage, 6,140 papers were excluded. Inter-rater agreement was calculated. 10% of papers of the total titles and abstracts were randomly selected and independently screened by the independent expert consultant of the study, generating a Cohen's Kappa score of .73, indicating substantial agreement.

The full texts for 509 papers were sought for retrieval, and full texts were successfully obtained for 507 papers. A second round of screening took place, this time looking at the full texts of each paper and assessing whether they met all inclusion and exclusion criteria. Two researchers (the research assistant and the PI) screened all papers. Inter-rater agreement was calculated for more than 10% of the full text review data extraction and resulted in a Cohen's Kappa score of .84. The above procedure resulted in 214 papers being excluded at this stage. In total, 293 were included in this review.

Data charting and Data items

The studies included in this literature review were charted on a Population, Intervention, Comparison and Outcome (PICO) table. The data items included in this table were inspired by research by Muir et al. (2023), Eberhart et al. (2024), and Pandey et al. (2018) and are presented in Table 1 below.

Table 1

Data items included in PICO table

General information
Title
Author information
Publication year
POPULATION (Study participants)
mean age of the children in years

sample age group (age range)
sample size,
sample sex (%Female)
participant socioeconomic status
country(ies) and region(s) in which the study was conducted

INTERVENTION (Intervention characteristics)

Intervention name
Executive functions or Self-regulation or Both
Study design: RCT (randomized control trial), Experimental, Quasi-experimental, Explanatory, Longitudinal
Directly or indirectly intervening on children's SR and/or EF
Categories for intervention approaches (only for studies under focus)
Type of activity, e.g. classroom-based activities, lab-based activities etc;
Settings (school, out of school, etc)
Highly controlled (research lab or separate room in school) or naturalistic environment
Format, e.g. face to face or online;
Delivery method, e.g. group, one to one;
Mode of delivery, e.g. predominantly teacher, researcher, etc;
Group size (intervention delivered to the whole classroom, small groups or individually)
Intensity (number of sessions, frequency and duration of intervention-no of weeks)
Total hours of intervention
Context, e.g., ethnically diverse, disadvantaged communities, low SES

COMPARISON/CONTROL GROUP

Yes or No
Active or passive control group
Active control group activity

OUTCOMES

Outcome measures/variables (SR, SRL, EF, WM, IC, CF, Att, Other- Specify)
Type of measures of EF/SR used (task-based/ behaviour rating questionnaires/ combination of both, etc),
Measures of EF/SR used (aspect of EF/SR and name of measure)
Significance
Reported effect size/-s of reported sig. effects
Any other significant non-SR/EF outcomes

Quality assessment

Quality assessment of all the studies was also performed. For the purposes of Quality Assessment, we used the Appraisal tool for Cross-Sectional Analysis (AXIS): a critical appraisal tool to assess the quality of cross-sectional studies (Downes et al., 2016). The AXIS tool addresses study design, reporting quality and the risk of bias. It requires responses to the 20 questions focused on study aims (e.g., Were the aims/objectives of the study clear?), methods (e.g., Were the methods (including statistical methods) sufficiently described to enable them to be repeated?), results (e.g., Does the response rate raise concerns about non-response bias?), and the quality of discussion (Were the authors' discussions and conclusions justified by the results?). Possible responses were Yes, No and Don't know. Inter-rater agreement (between the research assistant and the PI) was calculated for more than 10% of the data, and the percentage of agreement was 84%.

The adoption of the AXIS tool for the purposes of quality assessment of the included studies allowed for all included studies to be judged and receive a score based on their quality. This was particularly important for the specific systematic literature review project, which included quasi-experimental studies and studies without control groups, which would - in the past - be automatically excluded from systematic literature reviews, as they are often thought to be of lesser quality. Despite this, the quality assessment allows us to include in the review quasi-experimental studies or studies without control groups (which might have been excluded from literature reviews in the past) and then judge them based on their quality, so that only the high quality ones would be included in the high efficacy studies, which subsequently inform the suggestions for future interventions. This is a key strength of the present study as, with the rapid growth of quasi-experimental designs in Education research (Gopalan et al., 2020), the inclusion of these studies will provide rich and ecologically valid data on which to base decisions for future intervention development.

Results

The results section is in two parts, following the research questions identified above:

- What were the characteristics of self-regulation and executive function interventions carried out with young children up to the age of 8? Which were the high efficacy studies that could inspire interventions in England?
- Out of the interventions applied in ethnically diverse or disadvantaged communities, what characteristics typified those interventions that appeared to be most effective in ethnically diverse or disadvantaged communities?

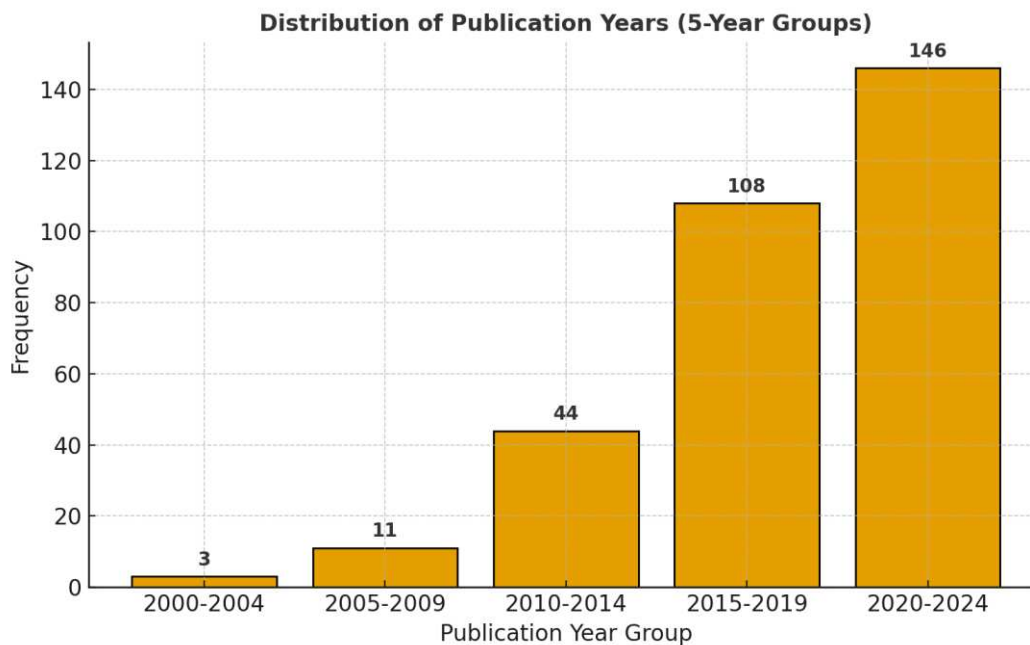
Question 1: What were the characteristics of self-regulation and executive function interventions carried out with young children up to the age of 8? Which were the high efficacy studies that could inspire interventions in England?

We examine this question in two parts. First, we look at the characteristics of interventions and then we highlight the high efficacy studies and discuss the ones which could inspire interventions in England.

For the purposes of this systematic literature review, 293 papers fulfilled the inclusion criteria and were included. In the 293 papers, 313 studies were reported which were carried out from 2000 till 2024. We note that the highest number of studies describing interventions targeting self-regulation in children up to the age of 8 took place in the last 5 years (47%), and that the publication of intervention studies had an increasing tendency throughout the years, as evidenced by Figure 1. This reflects the increasing interest in self-regulation in the last years.

Figure 1

Frequency of Publication Year (Grouped in 5-Year Intervals)



What were the characteristics of self-regulation and executive function interventions carried out with young children up to the age of 8?

When looking at the characteristics of self-regulation and executive function interventions, we first describe the population characteristics of these interventions, in order for the reader to have an informed understanding of the populations that interventions targeted, and we then describe the specific characteristics of interventions (e.g., in the form of provider of intervention, setting of intervention etc).

Population characteristics of interventions

These studies included a total sample of 113,717 children up to the age of 8 years old. Sample sizes ranged from 12 to 32,027, with a mean sample size of $M = 362$ ($Mdn = 97$), $SD = 1905$. Out of the 313 studies, 160 had less than 100 children in their sample size. This means that more than half of the studies (51%) had a relatively small sample size. The percentage of females in the sample size was on average 49.9% (M), with the minimum being 0% (for a study which included male participants only) and the maximum being 73%.

The studies took place in different countries across the six continents. The USA has the largest number of studies taking place (101), with the UK at seventh place with 11 studies.

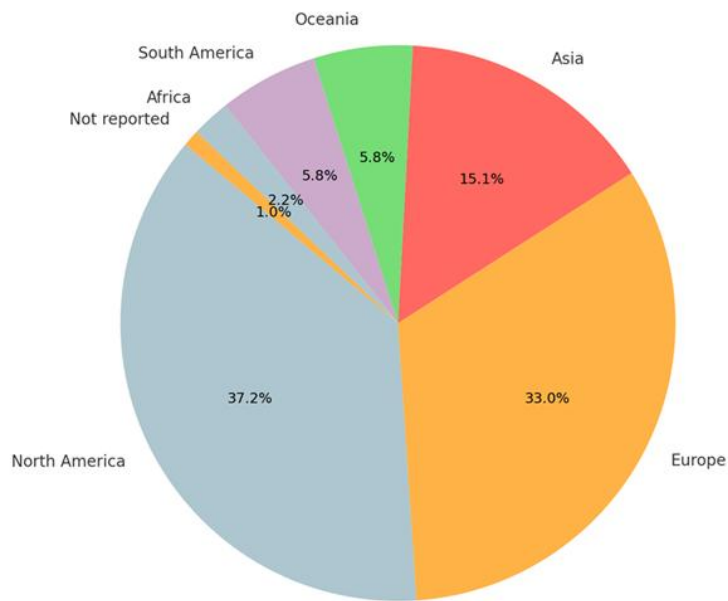
Table 2*Countries where studies took place*

Country	Count	Percentage	Country	Count	Percentage
USA	101	32.4	Ghana	2	0.6
Italy	24	7.7	Netherlands	2	0.6
China	18	5.8	Russia	2	0.6
Australia	17	5.4	Finland	2	0.6
Germany	16	5.1	Thailand	1	0.3
Canada	15	4.8	Turkey	1	0.3
UK	11	3.5	Croatia	1	0.3
Spain	10	3.2	New Zealand	1	0.3
Argentina	10	3.2	Poland	1	0.3
Switzerland	8	2.6	Cyprus	1	0.3
Japan	7	2.2	Tunisia	1	0.3
Brazil	6	1.9	Indonesia	1	0.3
Turkey	6	1.9	Greece	1	0.3
Israel	6	1.9	Kenya	1	0.3
Sweden	6	1.9	Korea	1	0.3
France	4	1.3	Colombia	1	0.3
not reported	3	1	Serbia	1	0.3
Belgium	3	1	Libya	1	0.3
Norway	2	0.6	Slovakia and	1	0.3
Hungary	2	0.6	Vanuatu		
Romania	2	0.6	Uruguay	1	0.3
Portugal	2	0.6	Malaysia	1	0.3
Iran	2	0.6	Slovenia	1	0.3
South Africa	2	0.6	Singapore	1	0.3
Taiwan	2	0.6			

Looking at the percentage of studies by continent (Figure 2), we see that 37% of studies took place in North America (driven by studies in the USA), 33% in Europe, and 15% in Asia. In each of Oceania and South America 6% of studies took place, with Africa being lower at 2%.

Figure 2

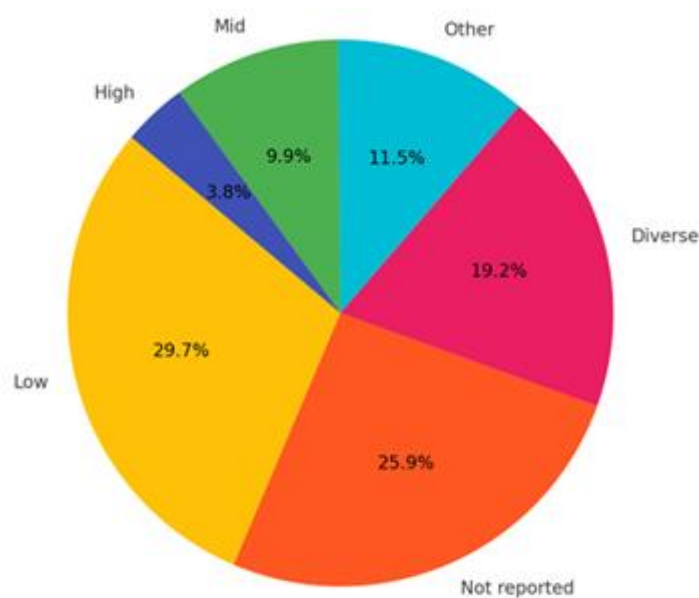
Distribution of studies by continent



We coded for participants' Socioeconomic status (SES) by categorising into low, mid, high, diverse and other (Figure 3). In the context of this study, it was most important to identify the studies that worked with low SES populations.

Figure 3

Distribution of Participant socioeconomic status



Note. 'High' means high SES, 'Low' means low SES, 'Mid' means medium level SES.

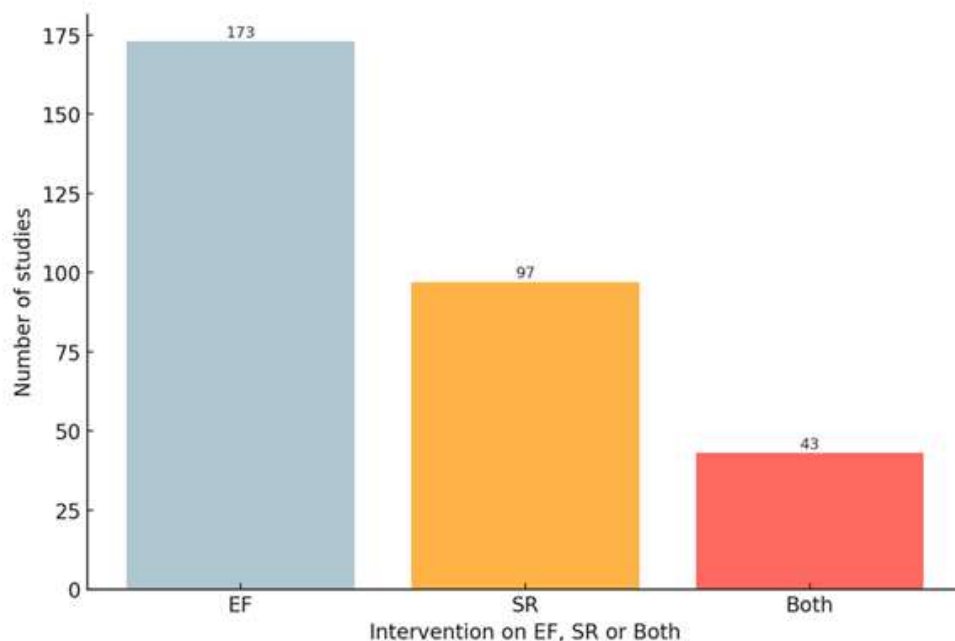
In Figure 3, it is notable that the highest percentage (29.7%) of studies focused on low SES populations. It is interesting to speculate about why this might be, and it may be related to current evidence from the literature suggesting that more change can be made/observed in low SES children. We also note that a high percentage of studies (26%) did not report their participants' SES levels).

Intervention characteristics

As is evident in Figure 4, most studies reported on interventions targeting Executive Functions (55%), while 97 interventions targeted self-regulation (31%) and 43 interventions targeted both (14%).

Figure 4

Distribution of studies by intervention on EF, SR or both

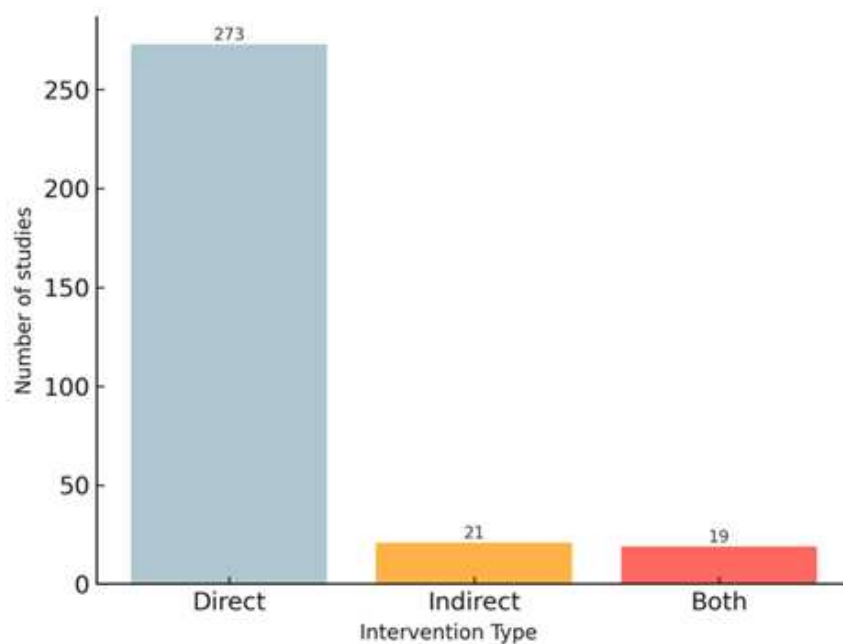


Studies directly or indirectly intervening on self-regulation

We also looked at whether the intervention was directly or indirectly intervening on children's self-regulation. Directly intervening were the studies which worked directly with children, while indirectly were those studies which worked with teachers who then went on to implement their learning with their pupils. Figure 5 shows that most studies (87%) were directly intervening on children's self-regulation. Only approximately 7% of studies indirectly intervened on children's self-regulation by targeting the teachers. Finally, 6% of studies intervened both directly and indirectly.

Figure 5

Studies directly or indirectly intervening on self-regulation

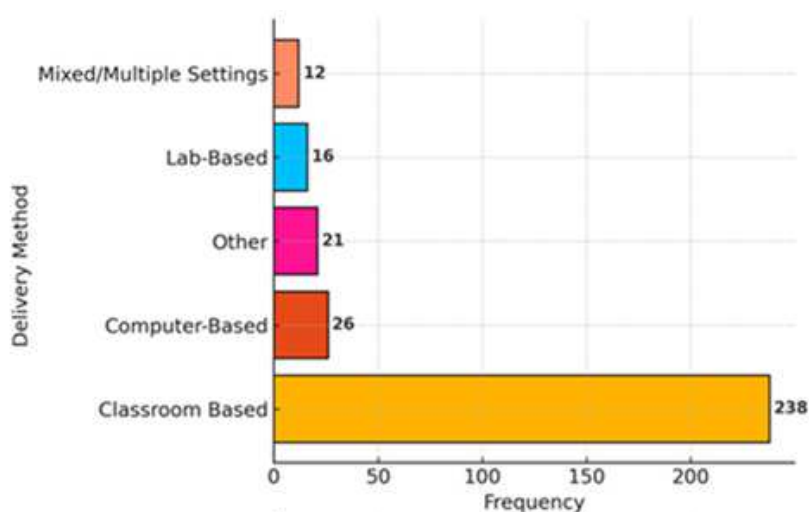


Type of activity employed during the intervention and setting of intervention

The interventions were categorised into five categories by type of activity employed during the intervention (Figure 6). Classroom based interventions comprised the great majority of interventions (76%). Computer-based interventions (8%) and lab-based interventions (7%) were both far fewer. The category of 'other' included studies using activities at e.g., a sports centre, home, outdoors, or playground etc.

Figure 6

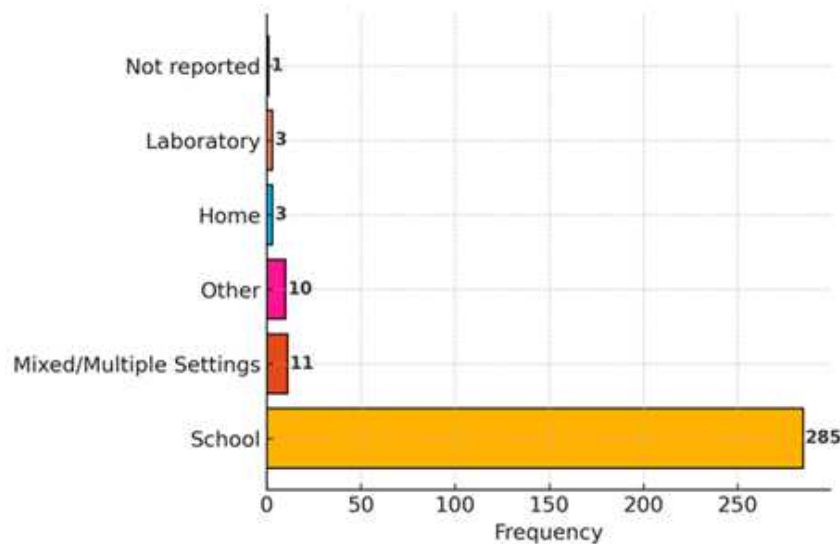
Frequency of type of activity employed during intervention



When looking at the setting where the studies took place (Figure 7), the great majority of interventions took place in children's everyday settings, such as schools. Overall, 88% (274) of studies took place in a naturalistic environment, such as a school, with 12% (39) in a controlled environment, such as a laboratory.

Figure 7

Frequency of settings of intervention



Note. 'Other' means sports centre, summer camp, university and 'multiple settings' stands for combination of settings (e.g., school and home, school and laboratory)

The majority of studies were also delivered via a face-to-face (90%) format rather than online (Figure 8) and were delivered to children in groups (79%) rather than as individuals (16%) (Figure 9).

Figure 8

Frequency of Format of delivery (online or face to face)

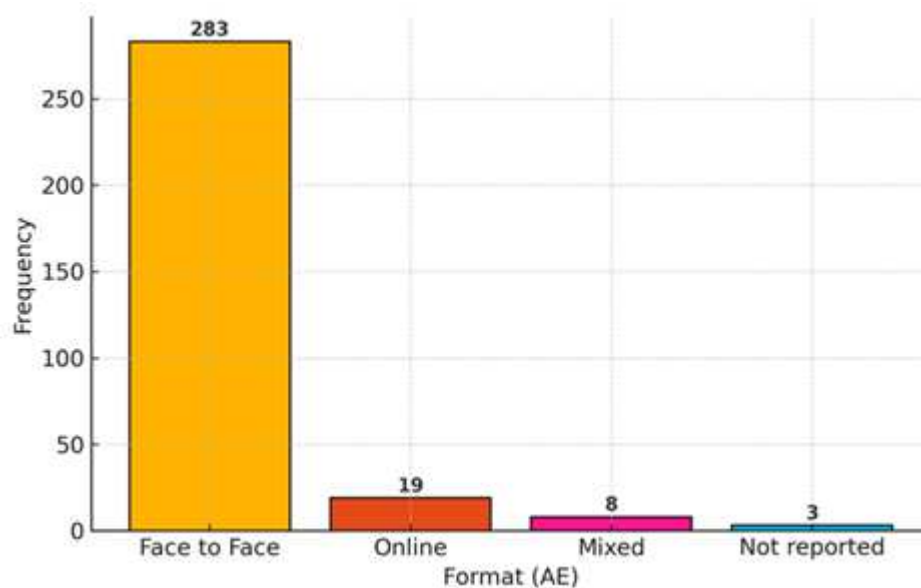
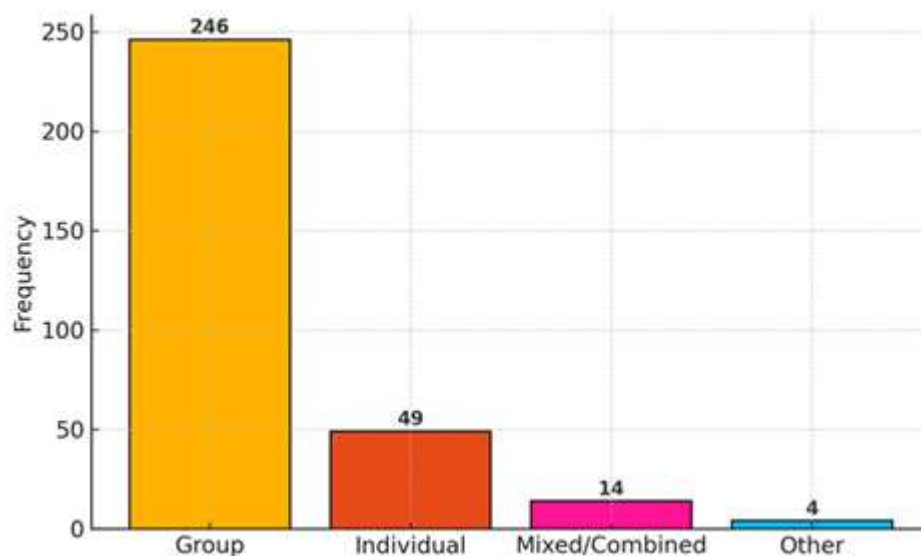


Figure 9

Frequency of Delivery Method (in groups or individually)



Mode of delivery/ Provider

We also explored how the intervention was provided, in the sense of who was the provider when working with the intervention groups. There were various combinations of providers observed in the different studies (See Table 3 and Figure 10). For ease of reporting, we categorized these into five larger categories. The most frequently observed category was that of the intervention being delivered by the teacher in a total of 52% of the studies. This included the cases where the teacher was delivering the intervention together with the use of task materials (25%) such as specific activities or games designed for the purposes of the intervention (e.g., in the Colagrossi study, these would be cards with activities targeting a skill area), the teacher delivering the intervention (23%), the teacher working together with the parent to deliver the intervention and the teacher working with the researcher (both at

approx. 2%). The second most frequent mode of delivery was through task materials (21%). The third was the researcher delivering the intervention (21%). Out of the latter, 10% were delivered by the researcher together with task materials, and the other 10% were delivered by the researcher with/or research assistants. Finally, approximately 4% of interventions were delivered by an external instructor.

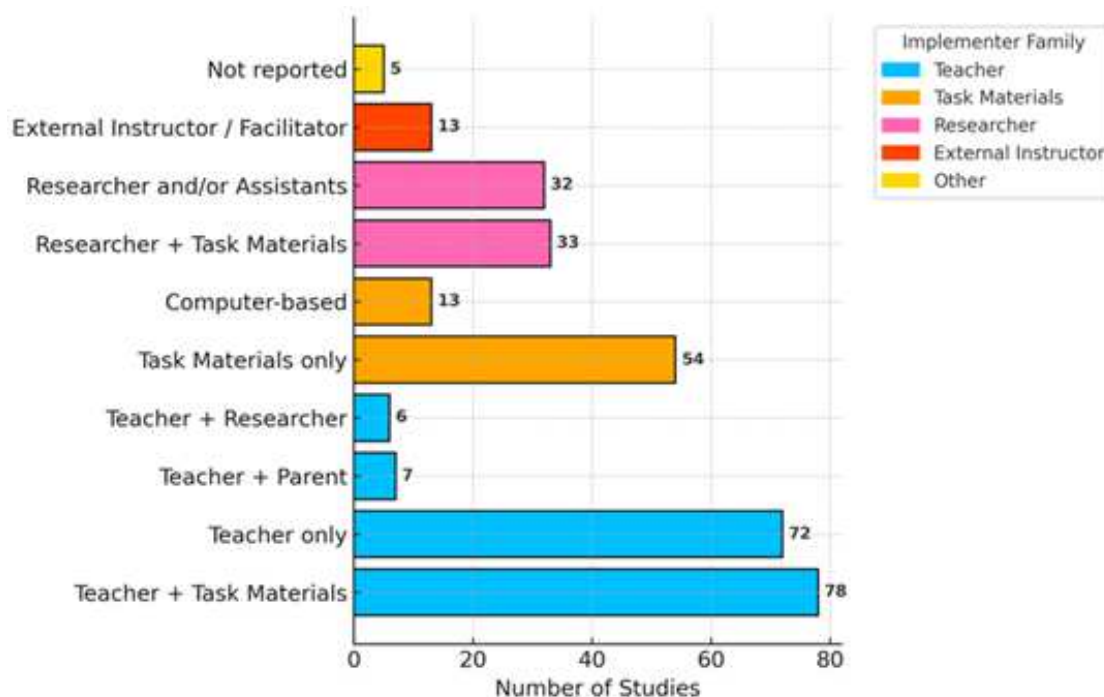
Table 3

Frequency of Provider of intervention

Mode of delivery	Specific mode/provider	Count	Percentage
Teacher	TOTAL	163	52.1%
	Teacher + Parent	7	2.2%
	Teacher + Researcher	6	1.9%
	Teacher + Task Materials	78	24.9%
	Teacher only	72	23.0%
Task Materials	TOTAL	67	21.4%
	Computer-based	13	4.2%
	Task Materials only	54	17.3%
Researcher	TOTAL	65	20.8%
	Researcher + Task Materials	33	10.5%
	Researcher and/or Assistants	32	10.2%
External Instructor	TOTAL	13	4.2%
	External Instructor / Facilitator	13	4.2%
Other	TOTAL	5	1.6%
	Not reported	5	1.6%

Figure 10

Frequency of Provider of intervention



Measurement tools

It is also useful to look at the tools used to measure the outcomes of the studies (Table 4). A variety of measurement tools were used to assess SR /EF outcomes. The vast majority of the studies (68%) used task-based measures. Examples of task-based measures are the Head-Toes-Knees-Shoulders Task (HTKS) where children perform certain movements with their body according to the instructions, or tablet/computer tasks where children follow the instructions to complete playful tasks. The next most frequently used measurement tools was a combination of task-based tools and behaviour rating questionnaires (15%) and behaviour rating questionnaires only (14%).

Table 4

Frequency of Measurement tools

Measure Type (AP)	Count	Percentage
Task-based	210	68.0%
Combination of task-based & behaviour rating questionnaires	46	14.9%
Behaviour rating questionnaires	42	13.6%
Other*	5	1.6%

Observation plus task-based measures	5	1.6%
Observation supplemented by questionnaires	1	0.3%

*Other: interviews only or observation only.

Which were the high efficacy studies that could inspire interventions in England?

For the purposes of this study, it was essential to identify the most effective interventions. To identify the most effective out of all interventions, we scored for intervention efficacy which combines quality assessment scores and effect sizes for results. In essence, '*high efficacy*' was defined as: studies which had a high quality-assessment score (higher than Mean + 1SD) and had at least one significant positive EF/SR outcome of moderate effect size. Fifteen studies, presented in Table 5, fulfilled all the above criteria.

Table 5

High efficacy studies

Title of study	Author and Year
Adaptation and Efficacy of a Social-Emotional Learning Intervention (SEL Kernels) in Early Childhood Settings in Southeastern Brazil: A Quasi-Experimental Study	Colagrossi et al., 2024
A kind mind: Enhancing socio-emotional skills in German preschool children through the mindfulness-based kindness curriculum.	Jansen et al., 2024
Summer Preschools for Syrian Refugee and Host Community Children in Turkey: A Model of Contextually Sensitive Early Intervention	Erdemir, 2022
Examining heterogeneity in the impacts of socio-emotional curricula in preschool: A quantile treatment effect approach.	Shea et al., 2021
Training effects of attention and EF strategy-based training 'Nexxo' in school-age students.	Rossignoli-Palomeque et al., 2020
Evaluating a board game designed to promote young children's delay of gratification.	Anzman-Frasca et al., 2020
Evaluating a board game designed to promote young children's delay of gratification (study 2).	Anzman-Frasca et al., 2020
Preschool intervention can promote sustained growth in the executive-function skills of children exhibiting early deficits.	Sasser et al., 2017
Boost your brain, while having a break! The effects of long-term cognitively engaging physical activity breaks on children's executive functions and academic achievement.	Egger et al., 2019

Mindfulness plus reflection training: Effects on executive function in early childhood.	Zelazo et al., 2018
Investigating teacher and student effects of the Incredible Years Classroom Management Program in early elementary school.	Murray et al., 2018
Improving Young Children's Social and Emotional Competence: A Randomized Trial of the Preschool PATHS Curriculum	Domitrovich et al., 2007
Effect of the Children's Health Activity Motor Program on Motor Skills and Self-Regulation in Head Start Preschoolers: An Efficacy Trial	Robinson et al., 2016
Using block play to enhance preschool children's mathematics and executive functioning: A randomized controlled trial	Schmitt et al., 2018
Evaluation of a teacher training program to enhance executive functions in preschool children	Walk et al., 2018

From these 15 studies, we excluded two studies: the paper by Shea et al. (2021), as they only reported significant results for children who already had high emotional knowledge scores and/or high problem solving, so it was not beneficial to all children, and the study by Rossignoli-Paloma et al. (2020), as they describe a study in children aged 6-9 (mean age 7.5), but they only report significant results for the children who are in the 8-9 age group, so above our study's early childhood target group.

What are the high efficacy interventions' characteristics?

The 13 high efficacy interventions' characteristics are presented in Table 6. As is evident, the high efficacy interventions had some characteristics in common. Population-wise, the majority of these interventions (8) took place in the US, with 3 taking place in Europe, one in Brazil and one in Turkey. In terms of specific intervention characteristics, nearly half (6) targeted self-regulation, 4 targeted EF and 3 targeted both. Most (10) were directly intervening on self-regulation and executive function, 2 were indirectly intervening (through training the teacher) and 1 combined direct and indirect intervention. Most (11) took place in school settings out of which: 10 were classroom based and 1 took place outdoors, while two interventions were lab-based. Therefore, the majority took place in a naturalistic environment. All interventions were delivered face to face (13), and at group level (not individually).

Table 6

Characteristics of high efficacy studies (population characteristics and intervention characteristics)

Study	Total sample size	Mean age (years)	Sample sex (% of Female)	Participant SES	Country	Intervention name	Intervention Approach	Intervention approach categorisation	Directly or Indirectly intervening on SR/EF	Setting
Colagrossi et al., 2024	314	NA	47.8	not reported	Brazil	SEL Kernels (adapted)	SEL program	SEL	Directly and indirectly	School
Jansen et al., 2024	69	5.3	56.52	diverse	Germany	Mindfulness-based Kindness Curriculum	Mindfulness	SEL	Directly	School
Erdemir, 2022	711	5.46	48	low	Turkey	Summer Preschools intervention	Curricula	Curricula and Pedagogy	Directly	School
Anzman-Frasca et al., 2020	56	4.79	32.1	diverse	USA	Gem Heroes board game	Mediated structured play	Play	Directly	Laboratory
Anzman-Frasca et al., 2020	53	4.01	49.1	diverse	USA	Gem Heroes board game	Mediated structured play	Play	Directly	Laboratory
Sasser et al., 2017	356	4.59	54	low	USA	Head Start Research-Based, Developmentally Informed (REDI) preschool intervention	SEL program	SEL	Directly	School
Egger et al., 2019	142	7.91	54.9	not reported	Switzerland	Cognitively engaging physical activity breaks	Physical Activity	Non-routine activities	Directly	School

Zelazo et al., 2018	218	4.75	53.67	low	USA	Mindfulness + Reflection intervention	Mindfulness	SEL	Directly	School
Murray et al., 2018	1192	6.17	48.4	diverse	USA	The Incredible Years® Teacher Classroom Management Program (IY-TCM)	Multicomponent training	Curricula and Pedagogy	Indirectly	School
Domitrovich et al., 2007	246	4.28	51.22	low	USA	Promoting Alternative Thinking Strategies (PATHS) curriculum	SEL program	SEL	Directly	School
Robinson et al., 2016	113	4.33	50.5	low	USA	The Children's Health Activity Motor Program (CHAMP)	Physical Activity	Non-routine activities	Directly	School
Schmitt et al., 2018	59	4.6	56	diverse	USA	Block Play	Semi-structured creative play	Play	Directly	School
Walk et al., 2018	133	4	44	diverse	Germany	EMIL: A training program for preschool teachers to enhance preschooler's EF	Multicomponent training	Curricula and Pedagogy	Indirectly	School

What intervention approaches were employed in high efficacy studies?

The interventions were categorised as to their approach in three categories inspired by Takacs and Kassai (2019) and previously adopted in the systematic literature review by Muir et al. (2023). The four overarching intervention categories are i) Play; ii) Social emotional; iii) Curricula and Pedagogy and iv) Non-routine activities. Within each of these categories, the below interventions approaches were coded.

Play: Engaging children in enjoyable activities that promote EF and/or SR, including:

- (i) *mediated structured play*
- (ii) *semi-structured creative play*

Social emotional (SEL): Enhancing children's self-awareness and their connectedness with others, through:

- (iii) *mindfulness*
- (iv) *social-emotional learning (SEL) programs*

Curricula and Pedagogy: Helping teachers embed EF and SR training into learning contexts, using:

- (v) *curricula*
- (vi) *multicomponent training (teacher and child)*
- (vii) *music*
- (viii) *mathematics*
- (ix) *language training*
- (x) *integrated arts programming*

Non-routine activities: Involving novel or adapted tasks designed to foster EF and SR

- (xi) *digitalised task training*
- (xii) *non-digitalised task training*
- (xiii) *physical activity*

In the 13 studies, a variety of intervention approaches were adopted. These are presented in Table 6. In terms of the intervention approaches adopted, 5 implemented an SEL program, 3 of the interventions were based on the implementation of Curricula and Pedagogy, 3 adopted a Play intervention, and 2 non-routine activities.

What high efficacy interventions would we recommend for England?

In order to recommend interventions for implementation in the England, we focus on the studies which had beneficial results for broad aspects of self-regulation and executive functions. We present these below.

Before doing so, we would like to stress that five studies stood out for their results on very specific elements of self-regulation and/or executive functions, namely: delay of gratification, cognitive flexibility and emotional competencies related to secondary emotions. In the case that stakeholders identify these three areas as areas for improvement for the children they are working with, then the below three studies had exceptional results on delay of gratification, one study had excellent results on cognitive flexibility, one on secondary emotions and could be considered for implementation in populations that struggle specifically with these skills. Namely, for delay of gratification, the two separate interventions reported in the paper by Anzman-Frasca et al. 2020, involving mediated structured play through an age-appropriate board game designed to promote delay of gratification, and the intervention by Robinson et al. (2016) who implemented the Children's Health Activity Motor Program (CHAMP) had significant and positive effects. For cognitive flexibility, the intervention by Egger et al. (2019) involved physical activity, and the group which experienced a combination of high cognitive engagement and physical activity performed significantly better than the group which experienced physical activity only (in the form of aerobics). For emotional competencies strictly related to secondary emotions (pride, guilt, shame), the study by Jansen et al (2024) employed the Mindfulness-based Kindness curriculum and had significant positive results.

For more widespread results on more overarching aspects of SR/EF, the below 8 interventions stood out in terms of their results: Colagrossi et al. (2024), Walk et al. (2018), Domitrovich et al. (2007), Erdemir (2022), Sasser et al. (2017), Schmitt et al. (2018) , Zelazo et al., (2018), and Murray et al. (2018). The latter six interventions could prove particularly promising for stakeholders aiming to work with a predominantly low SES or ethnically diverse populations, as this was the participating sample of the specific studies. These six interventions are presented in detail in the second part of this report, which focuses on disadvantaged and ethnically diverse populations. For targeting a variety of SES populations and a range of backgrounds, we would recommend the former two interventions.

Interventions which could inspire work in England: a description and their results

For targeting a variety of SES and a range of backgrounds, two studies stand out which present the results of interventions we would recommend for implementation in England.

Study 1, Colagrossi et al. (2024):

The intervention adopted by Colagrossi et al. (2024) was an SEL program and their approach can be inspirational for English settings. Colagrossi et al. adapted the SEL Kernels intervention, implemented it in early childhood settings in Brazil (age range: 3-6), and reported significant improvements in behaviour problems and emotion regulation. The SEL Kernels intervention was originally developed based on 25 leading programs in the US and employs activities and practices around emotional, interpersonal, cognitive, mind-set and character skill areas (Bailey et al., 2019). The original SEL Kernels set consisted of 21 cards, each featuring a strategy or activity aligned with one of five core skill areas: **Feelings Power**, which focuses on identifying, expressing, and managing emotions (e.g., *Feelings Thermometer*); **Friendship Power**, which supports respectful and positive interactions with others (e.g., *Peace Powers*); **Brain Power**, which strengthens executive functioning and self-regulation skills (e.g., *Brain Games*); **Attitude Power**, which encourages positive

mindsets and gratitude (e.g., *Thankful Thoughts*); and **Citizen Power**, which emphasizes community awareness and helping others (e.g., *Community Circle*). Each card includes a theory of change describing how the kernel supports students, step-by-step instructions for implementation, suggestions for adaptation, and explicit alignment with the local national curriculum. Collagrossi et al. adapted this approach for use in the Brazilian contexts. It is important to state that the adaptation involved (apart from translating into the local language) a multi-step, participatory process which included stakeholder meetings with educators and staff, school-based meetings with parents and caregivers, and five months of classroom field testing of 21 Kernels in early childhood settings. Based on feedback and usage data, the materials were refined into a final set of 16 Kernels and teaching tip cards, featuring simplified instructions, visual supports, links to the local curriculum, inclusive strategies, and integration with academic and sustainability content. School personnel were then trained on how to implement this approach, and the research team visited each school monthly and had conversation circles with all teachers. This study is an exceptional example of how settings in England could also implement the SEL Kernels approach, after first adapting it in consultation with all relevant stakeholders, an approach which ensures relevance for the given context and teacher buy-in and implementation.

This study reported improvements in children's behaviour problems and emotion regulation (both as reported by their teachers). Specifically, the results reported a significant effect on reduction in teacher-reported conduct problems, hyperactivity, peer problems, total SDQ (Strengths and Difficulties Questionnaire) score, greater increase in prosocial behavior, and a significant effect of the intervention on greater reduction in Liability/Negativity and improvements in emotional regulation scores and total ERC (Emotion Regulation Checklist) score. In terms of effect sizes, the SDQ results were of medium to high effect sizes, and the ERC results had large effect sizes.

Study 2, Walk et al. (2018):

Walk et al. 2018, adopted a Curricula and pedagogy approach, and, more specifically, multicomponent training. This study took place in Germany but could be valuable for settings in England. The research team implemented EMIL (Stiftung, 2016), a training program for German preschool teachers that was designed to enhance EF skills of preschoolers (Aged 3-6). It consists of a teacher training program (eight sessions, 28.5 hours) and its implementation in preschools. Out of the 8 sessions with teachers, 5 sessions took place with all teachers, and the last 3 sessions were conducted with each preschool team individually. The sessions comprised presentations on the definition, conceptualization, development, and training of executive functions (EFs). Preschool teachers were introduced to key aspects of children's cognitive and social-emotional development, with a particular focus on the developmental trajectory of EFs and their relevance for social competence and academic achievement. The sessions also addressed evidence-based strategies for promoting EFs within the preschool context. Teachers engaged in reflective discussions on how task demands on EFs could be adapted and how EF-supportive practices could be integrated into everyday preschool routines. In addition, various methods and activities shown to enhance EFs such as physical activity, mindfulness-based practices, and role-play were presented and practiced. Finally, participants were provided with materials to support

the transfer of acquired knowledge and strategies into practical application within their own preschool settings.

Although the teacher training program was delivered according to a predetermined structure with predefined content, the way teachers incorporated these concepts into their daily professional practice was left to their discretion. Teachers were expected to identify relevant situations and opportunities within their preschool settings based on examples discussed during the training sessions and to provide individualized support to children according to situational demands. In this way, EMIL was designed to be flexibly integrated into diverse preschool curricula and adapted to the varying needs of different preschools, children, and organizational structures.

In terms of results, the children in the intervention group showed significant gains in independently assessed (i.e., not teacher-reported) child level measures. Specifically, they showed significant gains three out of seven EFs, namely behavioral inhibition (large effect size), visual-spatial working memory (medium effect size), and combined EFs (small effect size). Additionally, post hoc tests for children with low initial EFs scores (EF score below the 50th percentile) revealed that participation in the intervention led to significant gains in inhibitory control (high effect size), visual-spatial working memory (high effect size), and phonological working memory (medium effect size), as well as a marginally significant difference for combined EFs (medium effect size).

Question 2: Out of the interventions applied in ethnically diverse or disadvantaged communities, what characteristics typified those interventions that appeared to be most effective in ethnically diverse or disadvantaged communities?

For stakeholders aiming to work with a predominantly low SES or/and ethnically diverse sample, we have identified the interventions that have proved promising in similar populations in the past. These are presented in detail in this part.

In order to respond to this research question, we focused only on interventions that targeted low SES and/or diverse ethnicity populations. To find the most effective out of these interventions, we scored for intervention efficacy which combines quality assessment scores and effect sizes for results. In essence, '*high efficacy*' was defined as: studies which had a high quality-assessment score (higher than Mean + 1SD) and had at least one significant positive moderate effect for at least one measured EF/SR outcome. Eight studies fulfilled all the above criteria and are henceforth termed 'the high efficacy studies'.

While presenting the characteristics of these eight high-efficacy studies, we juxtapose the results with the analysis from the '*relatively high in efficacy*' studies. The latter were all the studies (61) that focused on disadvantaged and/or diverse ethnicity populations, which were higher in quality assessment than the average quality score and had at least one significant positive outcome. This enables the reader to have a picture about all the relatively high in efficacy studies (61), with more details provided for the high efficacy studies (9).

Which are the interventions with ethnically diverse or disadvantaged communities that stand out as high efficacy?

Below we present the 9 studies that were the most effective in ethnically diverse or disadvantaged communities (Table 7). After introducing these studies, the remainder of this section is framed around 3 further questions which look at the characteristics of these studies:

- What are the population characteristics of high efficacy interventions?
- What are the intervention characteristics of high efficacy studies?
- What intervention approaches were employed in high efficacy studies? What were their results?

Table 7

High efficacy studies with low SES and/or diverse ethnicity and/or disadvantaged populations

Title	Authors
Summer Preschools for Syrian Refugee and Host Community Children in Turkey: A Model of Contextually Sensitive Early Intervention	Erdemir, E. (2022)
Evaluating a board game designed to promote young children's delay of gratification.	Anzman-Frasca et al. (2020)
Evaluating a board game designed to promote young children's delay of gratification (Study 2).	Anzman-Frasca et al. (2020)
Preschool intervention can promote sustained growth in the executive-function skills of children exhibiting early deficits.	Sasser et al. (2017)
Mindfulness plus reflection training: Effects on executive function in early childhood.	Zelazo et al. (2018)
Investigating teacher and student effects of the Incredible Years Classroom Management Program in early elementary school.	Murray et al. (2018)
Improving Young Children's Social and Emotional Competence: A Randomized Trial of the Preschool PATHS Curriculum	Domitrovich et al. (2007)
Effect of the Children's Health Activity Motor Program on Motor Skills and Self-Regulation in Head Start Preschoolers: An Efficacy Trial	Robinson et al. (2016)
Using block play to enhance preschool children's mathematics and executive functioning: A randomized controlled trial	Schmitt et al. (2018)

What are the population characteristics of high efficacy interventions?

The focus here is on studies focusing on disadvantaged or ethnically diverse communities. As is evident in Table 8, five studies had participants of low SES status and four studies had participants of diverse SES status and diverse ethnicity. In the larger sample of relatively high efficacy, 52 of the studies (85%) were focused on low SES populations. This shows that there is evidence that self-regulation interventions can be effective for both low SES populations and ethnically diverse populations.

Table 8

Population characteristics of high efficacy interventions with ethnically diverse or disadvantaged communities

Author and year of publication	Total sample size	Mean age (years)	Age range	Sample sex (Percentages of Female)	Participant SES	Context	Country
Erdemir (2022)	711	5.46	5-6	48	Low	lower SES, Syrian refugees (50%)	Turkey
Anzman-Frasca et al. (2020)	56	4.79	4-5	32.1	Diverse	diverse SES and ethnicity	USA
Anzman-Frasca et al. (2020)	53	4.01	4-5	49.1	Diverse	diverse SES and ethnicity	USA
Sasser et al. (2017)	356	4.59	4-5	54	Low	low SES, diverse ethnicity	USA
Zelazo et al. (2018)	218	4.75	3.92-5.25	53.67	Low	Not reported	USA
Murray et al. (2018)	1192	6.17	kindergarten to 2 nd grade	48.4	Diverse	diverse SES, diverse ethnicity	USA
Domitrovich et al., (2007)	246	4.28	3-4	51.22	Low	disadvantaged	USA
Robinson et al. (2016)	113	4.33	preschoolers	50.5	Low	low SES, mostly African American	USA
Schmitt et al. (2018)	59	4.6	3.2-5.8	56	Diverse	Mixed SES (Separate focus: low SES)	USA

The total number of participants in the 9 high efficacy studies were 3,004 and the sample size ranged from 53 participants to 1,192 participants. All these high efficacy studies, bar one exception, took place in the last decade (from 2016 onwards). This is an interesting result when compared to the relatively high in efficacy studies which took place during a broader range, from 2007 to 2024. This result might indicate that the most recent studies have a tendency to be more efficacious and thus we could consider focusing on them as inspiration for future interventions.

The mean age of participants was 4.8 and ranged from 3 to 6 years of age. It is important therefore to note that all high efficacy studies had participants in the 3-6 years age group. The relatively high in efficacy group of studies also had a mean age of participants at 4.6. This suggests that, while causality cannot be determined, most of the particularly efficacious studies were targeting children at around the age of 4. Further studies could benefit from this insight.

It is also interesting to note that all but one of the 9 studies were based in the USA, while one was based in Turkey. This result is similar to the result from the relatively high efficacy group where 43 of the studies (70%) took place in the USA. This highlights the potential value of more high efficacy research taking place in the rest of the world, potentially with scope to learn from those programmes conducted in the USA. Importantly, when we looked at the studies (N=61) which focused on disadvantaged and ethnically diverse populations and performed at least higher than average in terms of quality assessment, none of them took place in the UK. This is a significant gap in the UK knowledge base that could be addressed through future research.

What are the intervention characteristics of high efficacy studies?

Below (Table 9) we present the intervention characteristics for the high efficacy studies in terms of type of intervention activity and setting.

- Most (5) of the high efficacy interventions with disadvantaged and ethnically diverse populations targeted self-regulation. Two interventions targeted executive functions and two targeted both self-regulation and executive functions. This is broadly similar to the relatively high in efficacy group of studies, where 48% targeted self-regulation, and 34% targeted executive functions. Interestingly, in the total sample of studies in this systematic literature review, only 31% targeted SR. It is possible to infer from this that there are a number of effective SR interventions that could potentially be adapted to the UK context for disadvantaged and ethnically diverse populations.
- The majority of the high efficacy studies (8) also directly intervened on self-regulation or executive functioning. That is, the intervention involved working directly with children (and not with teachers). The only exception to this was the study by Murray et al. (2018). Very similar again were the results for the relatively high in efficacy group where 80% of the studies were directly working with the children. This is aligned with the overall picture from all interventions of this systematic literature review.
- Except for two studies, which took place in the controlled environment of a laboratory, all other studies took place in schools, mostly in classrooms (one outdoors), in a naturalistic environment. This is aligned with the results of the relatively high in

efficacy studies, where 87% took place in classroom environments. These results are important because they demonstrate that interventions can very beneficially occur in the naturalistic environment of classrooms, and thus more easily implemented than, for example, visiting a laboratory.

Table 10 presents the intervention characteristics for the high efficacy studies in terms of format of intervention, delivery method, provider of intervention and group size the intervention was delivered to.

- All the interventions were delivered through a face-to-face approach, in a group setting, though group sizes varied, with four interventions being delivered to small groups (e.g. groups of three children), one intervention delivered to large groups, and four delivered to the whole class.
- Provider/mode of delivery also varied. Five of the interventions were delivered by teachers (three of which were accompanied by task materials), two by external facilitators/instructors and two by a research assistant and task material. This is similar to the trend observed in the relatively high in efficacy studies, where 62% of studies were delivered by teachers.
- Intensity, in terms of number of sessions, frequency and duration was reported in different ways by different studies and it is not possible to compare. Intensity varied from a total duration of one hour (4 x 15-minute sessions in Anzman-Frasca et al., 2020) to one school year (one PATHS lesson per week in Sasser et al., 2017).

Table 9*Intervention characteristics of high efficacy studies with ethnically diverse or disadvantaged communities (i)*

Author and year of publication	Intervention on EF, SR or Both	Directly or indirectly intervening on SR/EF	Type of activity (Classroom based, lab-based, etc)	Setting (school, out of school, etc)	Highly controlled environment or naturalistic environment
Erdemir (2022)	SR	Directly	classroom based	school	naturalistic
Anzman-Frasca et al. (2020)	SR	Directly	lab based	laboratory	controlled
Anzman-Frasca et al. (2020)	SR	Directly	lab based	laboratory	controlled
Sasser et al. (2017)	EF	Directly	classroom based	school	naturalistic
Zelazo et al. (2018)	Both	Directly	classroom based	school	naturalistic
Murray et al. (2018)	SR	Indirect	classroom based	school	naturalistic
Domitrovich et al. (2007)	Both	Directly	classroom based	school	naturalistic
Robinson et al. (2016)	SR	Directly	Outdoors	school	naturalistic
Schmitt et al. (2018)	EF	Directly	classroom based	school	naturalistic

Table 10*Intervention characteristics of high efficacy studies with ethnically diverse or disadvantaged communities (ii)*

Author and year of publication	Format	Delivery method	Provider/Mode of delivery	Group size	Intensity
Erdemir (2022)	face to face	group	teacher and task material	whole classroom	50 days
Anzman-Frasca et al. (2020)	face to face	group	research assistant and task material	small groups of 3	20 min x 4 sessions
Anzman-Frasca et al. (2020)	face to face	group	research assistant and task material	small groups of 3	15-min x 4 sessions
Sasser et al. (2017)	face to face	group	teacher and task material	whole classroom	One school year
Zelazo et al. (2018)	face to face	group	teacher and task material	small groups	24 min daily sessions over 6 weeks
Murray et al. (2018)	face to face	group	teacher (after training)	whole classroom	Curriculum
Domitrovich et al. (2007)	face to face	group	teacher	whole classroom	30 lessons (1/week)
Robinson et al. (2016)	face to face	group	trained instructors and task material	large group	15 40-min sessions over 5 weeks
Schmitt et al. (2018)	face to face	group	Interventionist	small group	14 sessions x 15-20', 7 weeks

What intervention approaches were employed in high efficacy studies? What were their results?

The interventions were categorised as to their approach in three categories inspired by Takacs and Kassai (2019) and previously adopted in the systematic literature review by Muir et al. (2023). The four overarching intervention categories are i) Play; ii) Social emotional; iii) Curricula and Pedagogy and iv) Non-routine activities.

In Table 11, we present the intervention approaches for each high efficacy intervention adopted with disadvantaged and/or ethnically diverse populations.

- The intervention categories that appeared the most frequently were Play (3 interventions), and Social-Emotional learning (3 interventions).
 - The play interventions included mediated structured play in the form of board games (Anzman-Frasca et al. 2020, 2 separate interventions) and semi-structured creative play in the form of block play (Schmitt et al., 2018).
 - In the Social-emotional learning interventions, Sasser et al. (2017) implemented a Social-Emotional learning program (REDI) employing the preschool Promoting Alternative Thinking Strategies (PATHS) curriculum with enhanced social-emotional and language-literacy components. Zelazo et al. (2018) implemented a mindfulness and reflection intervention. Domitrovich et al. (2007) adopted PATHS: Promoting Alternative Thinking Strategies curriculum, which is a universal, teacher-taught social-emotional curriculum.
- The next most frequent intervention approach was Curricula and pedagogy (2 interventions). In the curricula and pedagogy interventions, Murray et al. (2018) implemented multicomponent training in the form of the Incredible Years® Teacher Classroom Management Program (IY-TCM). Erdemir (2022) implemented the Summer Preschools intervention, which is a skills-based curriculum.
- Lastly, the intervention by Robinson et al. (2016) used non-routine activities in the form of physical activities.

The above results are similar to the results of the group of studies with relatively high efficacy. The most frequently observed categories of intervention in the latter were curricula and pedagogy (33%) and socio-emotional learning programmes (33%), with play coming third at 21%. This indicates that there were a range of intervention approaches in the studies which performed exceptionally well in terms of efficacy. This result could provide insights for future interventions targeting disadvantaged and ethnically diverse populations. The high efficacy and relatively higher efficacy studies suggest the value of looking at play, socioemotional approaches and curricula and pedagogy approaches as interventions, whilst non-routine activities performed least well in both groups. This suggests that interventions which focus on children's every day, routine experiences, in a range of contexts, may be most likely to support higher efficacy.

Table 11

Information about interventions and intervention approaches in high efficacy studies with ethnically diverse or disadvantaged communities

Author and year	Intervention name	Brief Description of Intervention	Intervention approach and categorisation
Erdemir (2022)	Summer Preschools intervention	skill-based curriculum with five domains of cognitive, language, socioemotional, physical and self-care	Curricula; Curricula and pedagogy
Anzman-Frasca et al. (2020)	Gem Heroes board game	age-appropriate board game designed to promote delay of gratification	Mediated structured play; Play
Anzman-Frasca et al. (2020)	Gem Heroes board game	age-appropriate board game designed to promote delay of gratification. Based on learnings from Study 1 and the literature: (1) a pre-game simulation, (2) the use of psychological distancing, and (3) additional incremental challenges.	Mediated structured play; Play
Sasser et al. (2017)	Head Start Research-Based, Developmentally Informed (REDI) preschool intervention	focused on promoting social-emotional learning in preschool with the preschool Promoting Alternative Thinking Strategies (PATHS) curriculum with enhanced social-emotional and language-literacy components	Social-Emotional learning program; SEL
Zelazo et al. (2018)	Mindfulness + Reflection intervention	mindfulness and relaxation practices adapted for children, along with three EF challenging games, HTKS, Bear/Dragon/Simon Says, and Mother May I? while encouraged to discuss their thoughts and emotions.	Mindfulness; SEL
Murray et al. (2018)	the Incredible Years® Teacher Classroom Management Program (IY-TCM)	comprehensive series of interventions including parent, child, and teacher training components that were designed to prevent and treat aggressive behaviour and conduct problems in young children	Multicomponent training; Curricula and pedagogy
Domitrovich et al. (2007)	Promoting Alternative Thinking Strategies (PATHS) curriculum	a universal, teacher-taught social-emotional curriculum. The curriculum is divided into thematic units that include lessons on compliments, basic and advanced feelings, a self-control strategy, and problem solving.	SEL program; SEL
Robinson et al. (2016)	the Children's Health Activity Motor Program, CHAMP	used as mastery climate approach to provide children the opportunity to navigate a developmentally appropriate movement environment	Physical Activity; Non-routine activities

Schmitt et al. (2018)	Block Play	children given a set of wooden unit blocks comprising a variety of shapes with prompts to build things	Semi-structured creative play; Play
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What were the results of these high efficacy studies?

Before examining the results of the high efficacy studies, it is important to note that most (8) of the high efficacy interventions adopted an RCT study design, a percentage of 89%. The only exception was Erdemir (2022) who adopted a quasi-experimental design. This result of high percentage of RCTs was reflected in the relatively high in efficacy group, where 82% were RCT studies. By contrast, in the total sample of interventions, only 61% of the studies were RCTs. Future research with diverse and disadvantaged participants could therefore consider adopting RCT approaches. Additionally, all studies used robust standardised assessments to assess children's SR and EF, in the form of task-based assessments and in the form of behaviour rating questionnaires.

We present the results according to the intervention approach. In the Play interventions, the two studies by Anzman-Frasca et al. (2020) measured self-regulation, by looking at delay of gratification. In these two studies during the intervention game, there was a significant increase in the likelihood of delaying gratification from Session 1 to 2. In the first study only, the intervention group were significantly more likely to increase their wait time at the Marshmallow test. Both these studies reported moderate effect sizes. The study by Schmitt et al. (2018) found a significant interaction effect for EF flexibility and global EF, with small to moderate effect sizes, when focusing on children of parents at the lower end of parental education. This means that children of parents with low educational attainment benefited the most from the intervention with an improvement in their executive functions generally and their cognitive flexibility specifically.

In Socio-emotional learning programmes, Sasser et al. (2017) found an intervention effect on children (followed for 5 years from age 4) with low EF trajectories compared to the control group. For children with low EF trajectories, the intervention group exhibited higher 3rd grade EF scores than the control group. This means that the intervention improved EF scores in third grade significantly more for these children. The results had small to moderate effect sizes. Zelazo et al. (2018) in their Mindfulness and Reflection intervention found significant effects on EF and aspects of SR, with small to large effect sizes. The results of Domitrovich et al.'s (2007) study suggest that after exposure to PATHS, intervention children had higher emotion knowledge skills and were rated by parents and teachers as more socially competent compared to peers. Further, teachers rated intervention children as less socially withdrawn at the end of the school year compared to controls.

In the Curricula and pedagogy interventions, Erdemir (2022) found significant changes in favour of the control group in emotion regulation, social competence, internalising and externalising behaviour problems with large effect sizes. Murray et al. (2018) found a significant interaction between risk status and the intervention for outcomes of prosocial behavior and inattention. Specifically, at-risk students in the intervention had higher prosocial behavior scores and lower inattention than at-risk controls at post-test, with moderate effect sizes. Finally, Robinson et al. (2016) who employed non-routine activities through Children's Health Activity Motor Program reported a significant time x group interaction, with the

intervention group maintaining their self-regulation levels while the control group had a decrease, with a moderate effect size.

Implications and recommendations for policy, practice and research

This project aimed to identify self-regulation interventions that have been carried out with young children up to the age of 8, to record their characteristics and outcomes, and perform quality assessment. Self-regulation is considered the foundation for lifelong functioning in a wide range of domains, from academic achievement to emotional well-being, and physical and mental health. While self-regulation is currently receiving increasing attention in England, practitioners do not always have a clear understanding of self-regulation or how to promote its development.

The main objectives of the project were two:

- 1) to describe the characteristics of self-regulation interventions carried out with young children up to the age of 8, and identify high efficacy studies that could inspire interventions in England
- 2) to focus on the interventions applied in ethnically diverse or disadvantaged communities and describe what characteristics typified those interventions that appeared to be most effective in ethnically diverse or disadvantaged communities

Our results can support researchers, practitioners and policymakers in either identifying the most promising intervention(s) to translate research into practice or could form the basis of the design of a new intervention, incorporating successful elements from existing interventions.

Characteristics of self-regulation interventions carried out with young children up to the age of 8

What have we learnt?

A total of 313 studies were identified as describing self-regulation interventions carried out with children up to the age of 8, all carried out between 2000 and 2024. Almost half of them took place in the last five years. This reflects the increasing interest in self-regulation in the last years and perhaps the increased understanding of the importance of self-regulation.

In terms of population characteristics of the intervention studies, the majority of these studies took place in the USA (32%) and only 11 of the identified studies (3.5%) took place in the UK. This finding indicates that there is perhaps scope for more self-regulation intervention research in the UK. Additionally, the highest percentage of studies (30%) worldwide focused on populations with low SES. This could be because current evidence from the literature indicates that interventions can make more of a difference for children coming from disadvantaged backgrounds. Despite all the evidence, and despite the high percentage of interventions targeting low SES children in our systematic literature review, when we looked at the studies (N=61) which focused on disadvantaged and ethnically diverse populations and performed at least higher than average in terms of quality assessment, *none* of them took place in the UK. This is a very important gap which indicates that there is scope for a high-quality intervention study focused on disadvantaged and/or ethnically diverse

populations to take place in the UK. There is a lot to be learned from a study of this nature, which could inform both policy and practice.

In terms of specific intervention characteristics, it is important to note that the overwhelming majority of studies were classroom-based rather than lab- or computer-based, took place in school -mostly naturalistic- settings, followed a face-to-face approach and were delivered to groups of children rather than individually. Furthermore, more than half of the studies were delivered by the teacher, rather than task materials or by a researcher/external facilitator. These results are important because they demonstrate that interventions can take place in classrooms and, thus, they can be more easily implemented.

Which high efficacy studies could inspire interventions in England?

We identified 13 interventions which fulfilled the criteria to be considered as high efficacy, which are presented in brief in Table 12 below. The high efficacy interventions had some characteristics in common. Population-wise, the majority of these interventions (8) took place in the US, with 3 taking place in Europe, one in Brazil and one in Turkey. In terms of specific intervention characteristics, nearly half (6) targeted self-regulation, 4 targeted EF and 3 targeted both. Most (10) were directly intervening on self-regulation and executive function, 2 were indirectly intervening (through training the teacher) and 1 combined direct and indirect intervention. Most (11) took place in school settings out of which: 10 were classroom based and 1 took place outdoors, while two interventions were lab-based. Therefore, the majority took place in a naturalistic environment. All interventions were delivered face to face (13), and at group level (not individually). In terms of the intervention approaches adopted, 5 implemented an SEL program, 3 of the interventions were based on the implementation of Curricula and Pedagogy, 3 adopted a Play intervention, and 2 non-routine activities.

From these studies, five had results on very specific elements of self-regulation and/or executive functions, namely: delay of gratification (Anzman-Frasca et al. 2020, 2 studies; Robinson et al., 2016), cognitive flexibility (Egger et al., 2019) and emotional competencies related to secondary emotions (Jansen et al., 2024). In the case that stakeholders identify these three areas as areas for improvement for the children they are working with, then the above five studies could be considered. However, for this report, we are more interested to present interventions with more widespread results on more overarching aspects of SR/EF. The remaining 8 interventions stood out in terms of their results: Colagrossi et al. (2024), Walk et al. (2018), Domitrovich et al. (2007), Erdemir (2022), Sasser et al. (2017), Schmitt et al. (2018), Zelazo et al., (2018), and Murray et al. (2018). The latter six interventions can prove particularly promising for stakeholders aiming to work with a predominantly low SES or ethnically diverse populations, as this was the participating sample of the specific studies. These six interventions are presented in detail in the second part of this report (and described in the next section of conclusions), which focuses on disadvantaged and ethnically diverse populations.

For targeting a variety of SES populations and a range of backgrounds while aiming for improvements in more overarching aspects of SR/EF we would recommend the two interventions by Colagrossi et al. (2024) and Walk et al. (2018).

Table 12*High efficacy interventions: population and intervention characteristics*

Study	Mean age (years)	Participant SES	Country	Intervention name	Intervention Approach	Intervention approach categorisation	Directly or Indirectly intervening on SR/EF	Setting
Colagrossi et al., 2024	NA	not reported	Brazil	SEL Kernels (adapted)	SEL program	SEL	Directly and indirectly	School
Jansen et al., 2024	5.3	diverse	Germany	Mindfulness-based Kindness Curriculum	Mindfulness	SEL	Directly	School
Erdemir, 2022	5.46	low	Turkey	Summer Preschools intervention	Curricula	Curricula and Pedagogy	Directly	School
Anzman-Frasca et al., 2020	4.79	diverse	USA	Gem Heroes board game	Mediated structured play	Play	Directly	Laboratory
Anzman-Frasca et al., 2020	4.01	diverse	USA	Gem Heroes board game	Mediated structured play	Play	Directly	Laboratory
Sasser et al., 2017	4.59	low	USA	Head Start Research-Based, Developmentally Informed (REDI) preschool intervention	SEL program	SEL	Directly	School
Egger et al., 2019	7.91	not reported	Switzerland	Cognitively engaging physical activity breaks	Physical Activity	Non-routine activities	Directly	School
Zelazo et al., 2018	4.75	low	USA	Mindfulness + Reflection intervention	Mindfulness	SEL	Directly	School

Murray et al., 2018	6.17	diverse	USA	The Incredible Years® Teacher Classroom Management Program (IY-TCM)	Multicomponent training	Curricula and Pedagogy	Indirectly	School
Domitrovich et al., 2007	4.28	low	USA	Promoting Alternative Thinking Strategies (PATHS) curriculum	SEL program	SEL	Directly	School
Robinson et al., 2016	4.33	low	USA	The Children's Health Activity Motor Program (CHAMP)	Physical Activity	Non-routine activities	Directly	School
Schmitt et al., 2018	4.6	diverse	USA	Block Play	Semi-structured creative play	Play	Directly	School
Walk et al., 2018	4	diverse	Germany	EMIL: A training program for preschool teachers to enhance preschooler's EF	Multicomponent training	Curricula and Pedagogy	Indirectly	School

Study 1, Colagrossi et al. (2024): The intervention adopted by Colagrossi et al. (2024) was an SEL program and their approach could potentially be inspirational for English settings. They adapted the SEL Kernels intervention which was initially developed for US settings, implemented it in early childhood settings in Brazil, and reported significant improvements in behaviour problems and emotion regulation. The SEL Kernels consists of a set of brief, evidence-informed activities designed to promote children's emotional, interpersonal, cognitive, and character-related skills within everyday classroom practice. The original SEL Kernels set consisted of 21 cards, each featuring a strategy or activity aligned with one of five core skill areas. Each card includes a theory of change describing how the kernel supports students, step-by-step instructions for implementation, suggestions for adaptation, and explicit alignment with the local national curriculum. Importantly, the adaptation by Colagrossi et al. (2024) involved a rigorous, participatory process with educators, families, and school staff, ensuring cultural relevance, feasibility, and strong practitioner buy-in.

Building on this intervention model and its reported outcomes, several implications and recommendations emerge for practice, policy, and future research. For practice, the study illustrates the value of adopting flexible, evidence-informed SEL approaches that can be embedded into everyday classroom routines rather than delivered as stand-alone programmes. In fact, this study is an exceptional example of how settings in England could also implement the SEL Kernels approach, after first adapting it in consultation with all relevant stakeholders, an approach which ensures relevance for the given context and teacher buy-in and implementation. The structured yet adaptable nature of the SEL Kernels, alongside clear theories of change and practical guidance, makes them particularly well suited to early years settings in England, where curriculum time is often constrained. The participatory adaptation process further highlights the importance of engaging educators and families to support relevance, ownership, and sustained implementation. For policy, the findings reinforce the need to position SEL as a core component of high-quality early childhood education rather than an optional add-on. Policymakers in England could consider supporting scalable, low-cost SEL models that align with national curriculum priorities and invest in workforce training and ongoing implementation support. Finally, for research, this study points to the importance of UK-based evaluations of adapted SEL Kernels approaches, including the use of multi-informant outcome measures and longer-term follow-up to assess sustainability of effects. Future research should also examine implementation processes and contextual influences to inform effective scale-up across diverse English early years settings.

Study 2, Walk et al. (2018): Walk et al. 2018 implemented EMIL (Stiftung, 2016), a training program for German preschool teachers that was designed to strengthen preschoolers' (aged 3-6) EF skills. This intervention had positive effects on children's behavioural inhibition, visual-spatial working memory and combined EFs, and there were similar significant effects specifically for children who started with low EF scores. While this study took place in Germany, it could potentially be inspirational for settings in England. It consists of a teacher training program (eight sessions, 28.5 hours) and its implementation in preschools. EMIL focuses on building educators' understanding of the development and importance of EFs in early childhood and equipping them with evidence-based strategies, such as adapting task demands, embedding EF-supportive practices into daily routines, and using activities including physical movement, mindfulness, and role-play. Delivered through

an intensive teacher training model and flexibly implemented within preschools, EMIL was intentionally designed to align with existing curricula and to allow teachers professional autonomy in applying strategies in contextually appropriate ways. Although implemented in Germany, this approach offers valuable insights for early years settings in England, where a practitioner-led, curriculum-integrated intervention might be preferred.

Building on this intervention and its reported outcomes, several implications and recommendations can be drawn for practice, policy, and research. For practice, the findings highlight the central role of high-quality professional development in supporting children's executive functioning, particularly when training combines theoretical grounding with practical, reflective application. The emphasis on teacher autonomy and contextual adaptation suggests that EF-focused interventions may be more sustainable and impactful when educators are empowered to embed strategies within everyday interactions rather than follow rigid programmes. This is especially relevant for English early years settings, where diverse pedagogical approaches and organisational structures are common. For policy, the results support greater investment in structured, evidence-informed professional development targeting cognitive and self-regulatory skills as part of early childhood education. Policymakers could consider prioritising EF development within early years workforce standards and funding models, recognising its established links to later academic achievement and social competence. For research, the differential effects observed, particularly stronger gains among children with initially lower EF skills, underscore the need for further studies exploring for whom and under what conditions such interventions are most effective. Future UK-based research should examine long-term outcomes, implementation fidelity, and scalability of teacher-led EF interventions like EMIL, as well as their potential to reduce developmental inequalities in early childhood.

Taken together, Colagrossi et al. (2024) and Walk et al. (2018) point to a set of coherent and mutually reinforcing conclusions about how early years interventions may most effectively support children's self-regulatory development. Early years interventions are most effective when they are evidence-informed, flexible, and embedded within everyday practice, rather than delivered as rigid, stand-alone programmes. Both the SEL Kernels and EMIL demonstrate that meaningful improvements in children's self-regulation skills and executive functioning can be achieved through approaches that align with existing curricula and empower educators through teacher autonomy, professional judgement, and contextual adaptation. A key implication for English early years settings is the central role of high-quality professional development, with both studies showing that investing in educators' understanding, reflective practice, and ownership is critical for sustainable implementation and positive child outcomes. From a policy perspective, the findings support positioning SR and EF development as core components of high-quality early childhood education, alongside investment in workforce training and scalable, low-burden models. Finally, the evidence, particularly the stronger effects for children with lower initial skills, highlights the potential of such interventions to reduce early developmental inequalities, underscoring the need for UK-based research examining long-term outcomes, implementation processes, and scalability within diverse early years contexts.

Interventions applied in ethnically diverse or disadvantaged communities: What do we learn from the characteristics of the most effective interventions?

Out of the interventions applied in ethnically diverse and disadvantaged communities, we focused on those that had very high-quality assessment scores and had at least one significant positive moderate effect (named 'high efficacy studies'). Nine studies fulfilled these criteria: Erdemir (2022), Anzman-Frasca et al. (2020, two studies), Sasser et al. (2017), Zelazo et al. (2018), Murray et al. (2018), Robinson et al. (2016), and Schmitt et al. (2018), which are all presented in Table 12 above. For illustration purposes, we compared the results from this group of nine studies with the results of all studies with disadvantaged or ethnically diverse populations which had a higher-than-average quality assessment score and had at least one positive significant outcome (named 'relatively high in efficacy' studies).

From these nine studies, five fulfilled the criterion of working with a low SES population, while the other four were working with diverse populations but of either ethnically diverse or disadvantaged communities. This differs from the group of relatively high in efficacy studies, where most of the studies focused on low SES populations. The learning point for future studies is that there is evidence that interventions can work with both low SES and ethnically diverse populations. Future research could also focus on more recent studies (from 2016) as inspiration, because almost all of the highly efficacious studies appear to have been conducted in the last decade.

Stakeholders, including practitioners, policy makers, and researchers should note that the mean age of participants for both the high efficacy group and the relatively high in efficacy group was just slightly above 4.5 years, and most of the studies focused on children aged between 3-6. Therefore, this highlights that investing in self-regulation and executive function interventions in the 3-6 age range can be beneficial.

We stress again the point that when we looked at the studies (N=61) which focused on disadvantaged and ethnically diverse populations and performed at least higher than average in terms of quality assessment, *none* of them took place in the UK. This is a significant gap in the UK knowledge base that could be addressed through future research.

In terms of the characteristics of high efficacy self-regulation intervention studies in disadvantaged or ethnically diverse populations, most studies targeted self-regulation (rather than EF or both), a result which was not replicated for the total sample of studies. Therefore, particularly when working with disadvantaged or ethnically diverse populations, interventions targeting self-regulation specifically may hold particular promise for disadvantaged or ethnically diverse communities. Similarly, directly working with the children, in schools, and in naturalistic environments were the prevalent characteristics of high efficacy studies in disadvantaged or ethnically diverse populations, which are all characteristics that could be adopted in future interventions. All high efficacy interventions were offered in a face-to-face mode, in a group setting, and most were delivered by the teachers. This suggests that interventions which are in themselves often most easy to implement (e.g. in classrooms and not in labs) could be adopted with the most valuable results. These results show that interventions that are easy to implement in real classrooms can still achieve high levels of effectiveness, offering strong potential for scalable, evidence-informed practice.

Finally, in terms of the intervention approaches adopted, three of the high efficacy studies employed play interventions, three employed social-emotional learning interventions and two

employed curricula and pedagogy interventions. This suggests that a range of intervention approaches can perform exceptionally high in terms of efficacy in disadvantaged and ethnically diverse populations. The former three approaches may hold particular promise for interventions targeting disadvantaged and ethnically diverse populations. This suggests that interventions which focus on children's every day, routine experiences, in a range of contexts, may be most likely to support higher efficacy.

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