

Curvilinear Relationship Between Kindergarten Teachers' Scaffolding of Make-Believe Play and Children's Executive Functions

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Introduction

In kindergarten the child develops and practices fundamental skills such as executive functions [EFs], which are defined as interdependent higher-order cognitive processes that allow individuals to override automatic thoughts and behaviors in favor of more adaptive and goal-directed responses (Carlson, 2005). Early EFs set the stage for a broad range of developmental outcomes as well as school success (Blair & Razza, 2007); academic achievement (Müller et al., 2008); early literacy and numeracy competencies (Bull et al., 2008); social and emotional skills (Riggs et al., 2006); and physical health (Reinert et al., 2013).

The measurement of EFs in preschool-aged children was scarce until recently and there is a lack of EF tests designed for children (Rato et al., 2018), especially those in natural contexts. However, little is known about **real-life manifestations of EF skills**, which makes the transfer from research into practice highly abstract and complex for both researchers and teachers.

On the other hand, researchers suggest that make-believe play [MBP] contribute to EFs in the classroom (e.g., Lillard et al., 2013). More precisely, is the mature form of MBP that is associated with children's developmental gains (Bodrova & Leong, 2008). For reaching a mature level of play, adult support and scaffolding of make-believe play appear to be critical (Germeroth et al., 2019).

To promote EFs in natural context, relationship between teachers' scaffolding during MBP and children's cognitive skills should also be considered. In fact, while studies have examined the association between mature MBP and EFs in preschool children, few works have explored the impact of teacher support (scaffolding), which can lead to more mature play, on EFs. We believe that teacher's support can play a mediating role on children's EFs (**teacher scaffolding -> higher mature play -> higher EF**).

Results

Executive functions

Inhibition was strongly and positively correlated to **Cognitive flexibility** ($r = .629, p < .01$). **Working Memory** ($r = .567, p < .01$) and **Planning** ($r = .628, p < .01$) also show a significant and strong positive relation between the two dimensions of the MPOT ($r = .674, p < .01$). A significant and negative correlation was observed between **Working Memory** and MPOT-children ($r = -.208, p < .05$).

Make-believe Play

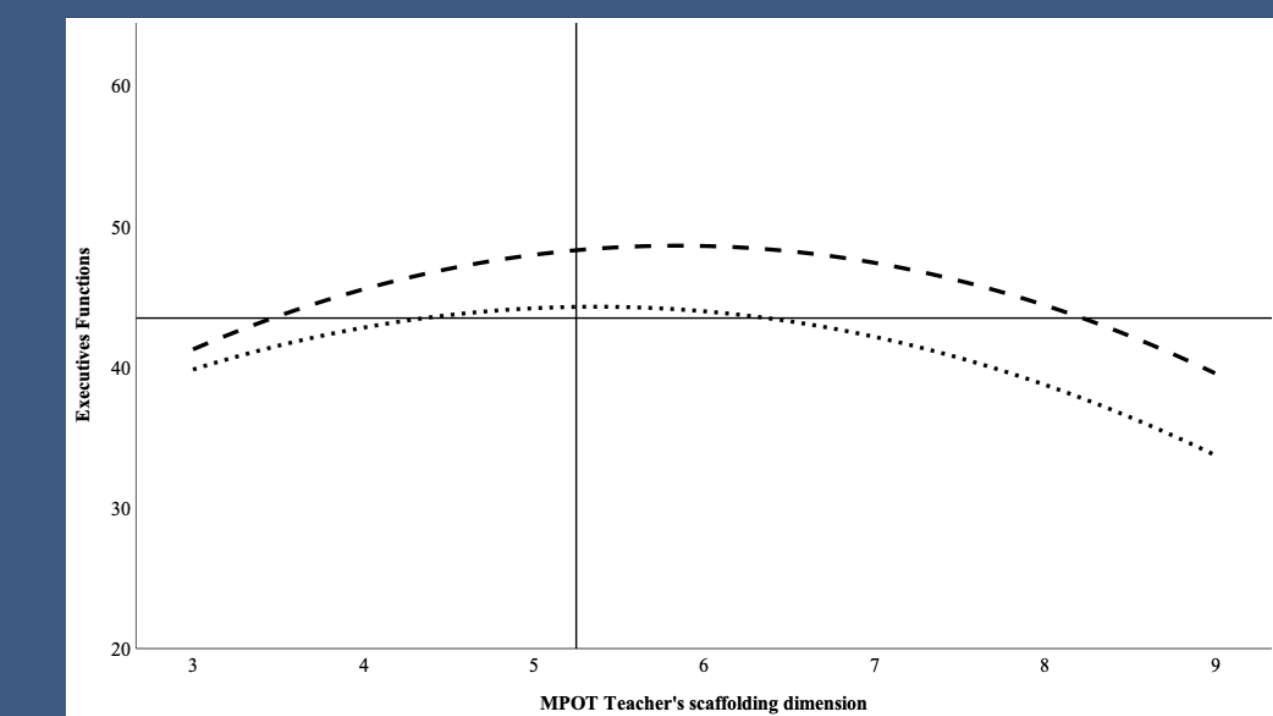
Descriptive statistics showed a **rather mature level of MBP** with a large dispersion among the children. Results showed **low teacher support in MBP**.

Relationship between teacher's scaffolding, MBP and EFs

Results showed a **curvilinear relationship between teacher scaffolding of MBP and the child's EFs**

The negative slope ($b = -.920, p = .000$) indicates that the highest level of observed Total EF was shown in participants who received a moderate amount of teacher scaffolding during MBP.

Data indicated a significant **mediating effect of the context** (classroom's maturity level of MBP) on the curvilinear relationship.



Research Aim : This study examines the mediating relationship between adult support, make-believe play and executive functions [EFs] skills.

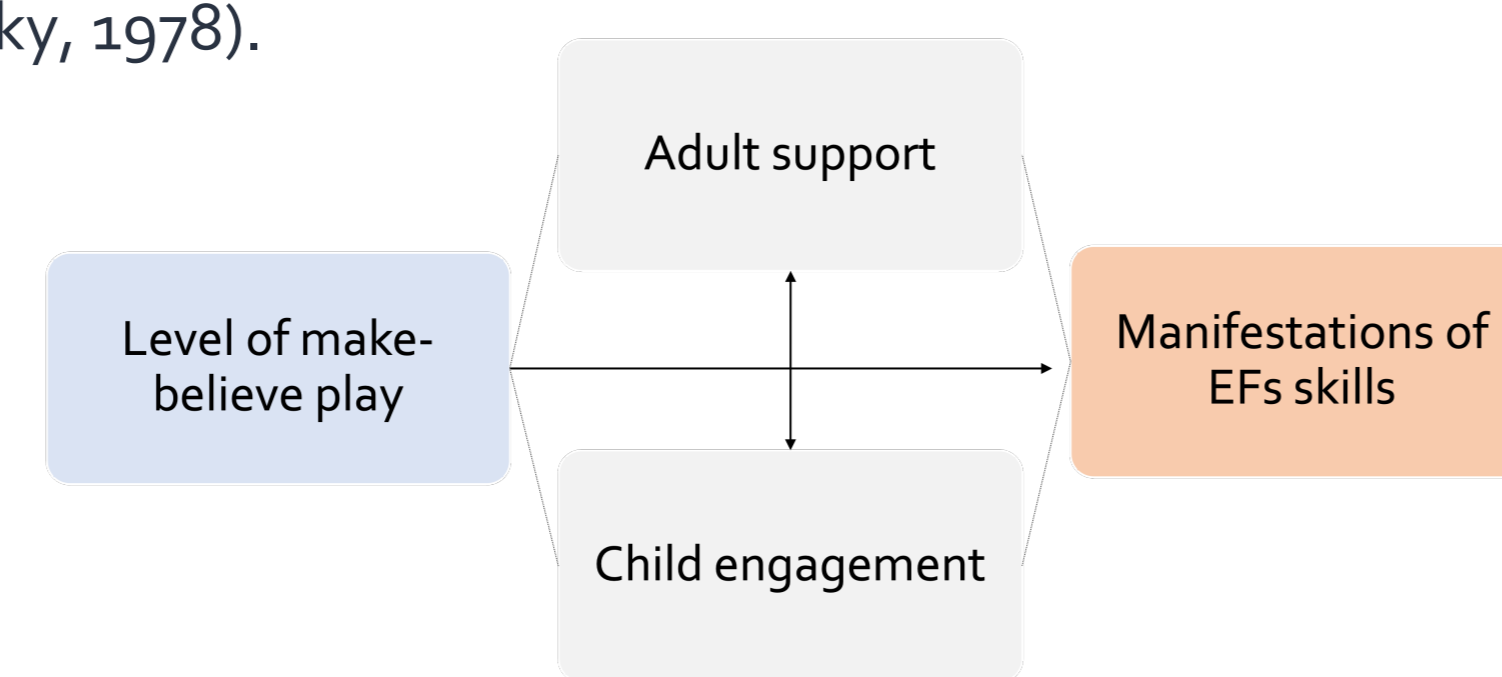
Conceptual Framework

Executive functions skills [EFs] are interdependent cognitive processes that allow overriding automatic thoughts and behaviors in favor of more adaptive and goal-directed responses (Carlson, 2005).

Inhibition	allows the child to control their actions or resist interference from irrelevant external stimuli in a given situation (Wright et al., 2003).
Working memory	allows children to retain information and to use it in an appropriate way in another context (Roberts & Pennington, 1996).
Cognitive flexibility	refers to the ability to shift attention back and forth between two different targets (Thibodeau et al., 2016).
Planning	involves formulating actions in advance and approaching tasks in a strategic, organized, and effective manner (Souissi et al., 2022).

Make-believe play [MBP] refers to an **imaginary situation** in which the child takes on **explicit roles** and uses objects symbolically according to a set of **predetermined rules** (Germeroth et al., 2019). Posited as a natural environment that promotes cognitive development, MBP represents a key tool in developing the child's ability to think about objects and actions that are not present (Vygotsky, 1978).

Scaffolding refers to the teacher's process of gradually offering and withdrawing external support for learning (White & Carlson, 2021).



Discussion

There was a **significant curvilinear association** between the teacher's scaffolding of MBP and child's EFs. This association is **more complex and less straightforward** than we anticipated. We propose discussing these results in light of the **Iterative Reprocessing model** (Zelazo, 2015) :

Neural level	For Zelazo et al. (2017), the inverted U-shaped curve ties neural activity in the prefrontal cortex [PFC] areas to EFs and highlights the interactive or recursive nature between top-down and bottom-up processes : environmental factors (e.g., teacher scaffolding) trigger neural activity in those PFC areas. This creates a feedback loop that maintains neural activity at what can be considered an optimal or effective range according to the ongoing situation (Gunnar & Quevedo, 2007).
Cognitive level	It is hypothesized that when children respond reactively, in a more automatic and less reflexive way, they are more likely to show EF process failures (Zelazo & Carlson, 2017). In a context of high scaffolding/control of the play by the teacher, some children did not have to deploy their own metacognitive/reflective skills.
Behavioural level	From a sociocultural perspective, adult scaffolding is beneficial only if it is adapted to the child's ZPD (Bodrova & Leong, 2007), defined as the distance between the actual developmental level and the potential development level, when problem solving is possible with the guidance of adults or more capable peers (Vygotsky, 1978). Considering that teacher scaffolding of MBP is generally low (i.e., absent or at a level beyond the child's ZPD), we wonder whether the teacher was able to identify the child's level of EFs, which would have to be considered when using intentional interactions such as scaffolding. When mature make-believe play is observed in the classroom, adults may also be less inclined to support children individually, thereby creating a gap between children in terms of EFs and goal-oriented actions.

Paradigm, methodology and methods

Sample

- 160 children ($M_{age} = 69.46, SD_{age} = 4.34$, range = 52–84 months) from 12 kindergarten classrooms in Quebec City (Canada).
- 12 teachers participated to the study. The teachers were exclusively women ($M_{age} = 43.5, SD_{age} = 9.64$, range 27–59 years) with 4 to 32 years of teaching experience in kindergarten ($M_{experience} = 18; SD_{experience} = 9.48$).

Measures

- Children's EFs skills were assessed with the *Executive Functions Observation Tool* (Duval & Montminy, 2021)
- The level of play maturity alongside teachers' level of scaffolding were assessed with the *Mature Play Observation Tool* (Germeroth et al., 2019).

Analysis

As a first step, correlations and plots were considered. Data visualization in SPSS suggested an inverted U-shaped relationship between teacher's scaffolding (MPOT-teacher) and the Total EFs. To test for a curvilinear relationship while accounting for both the child level (step one) and classroom level (step two), linear mixed models [LMM] were chosen as primary analyses. To explore potential explanations for the inverted U relationship between MPOT-teacher and Total EFs, multilevel mediation analyses were conducted in Mplus.

Conclusion

To explore potential explanations for the inverted U relationship between MPOT-teacher and Total EFs, multilevel mediation analyses were conducted, but the overall model was not found to be significant.

The link between teacher's scaffolding and child EFs is therefore probably better explained by **another variable** not considered in the present study (e.g., adults' own EFs; Cuevas et al., 2014). Further studies are thus needed to identify the contextual characteristics that could be key to children's cognitive development and therefore better able to explain how context can be considered to guide interventions and allow children to deploy (or not) their EF skills.

Finally, the observation of EFs skills in class could allow interventions to be more intentional in supporting the child according to their developmental needs. Indeed, our results highlight **the importance of sensitive calibration of the child's developing skills and ZPD** (i.e., not too easy/not too hard), as it would allow them to practice intentional metacognitive and reflective skills, problem solving and planning, and hence contribute to their EFs (Zelazo & Carlson, 2020).

In other words, it seems that **there is a fine balance of adult support when it comes to developing play skills and children's EFs**. To this end, an adult's intentional interventions seem necessary to support the EFs of each child according to their ZPD.

