Exploring Mother-Child Co-Regulation Across Interaction Contexts in At-Risk Mother-Child Dyads: Associations and Predictions to Child Externalizing Behavior Problems

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Abstract

Exploring Mother-Child Co-Regulation Across Interaction Contexts in At-Risk Mother-Child Dyads: Associations and Predictions to Child Externalizing Behavior Problems

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Psychosocial risk factors such as poverty and adversity negatively impact parent-child interactions, which are foundational for children's socio-emotional development. Parenting stress and need for support, common in at-risk environments, also affect these interactions and have been linked to higher rates of externalizing behaviours in children. This study examined co-regulation, a dynamic process through which parent and child mutually influence each other's emotions, cognitions, and behaviours, in psychosocially at-risk mother-child dyads. Participants were 111 mother-child dyads from the Concordia Longitudinal Research Project. Dyads were observed during three tasks: a puzzle task, a compliance-based command task, and an interference task simulating maternal unavailability. Five types of co-regulation from the Revised Relational Coding System were coded: symmetrical, unilateral, unengaged, asymmetrical, and disruptive. It was found that dyads engaged in more symmetrical co-regulation during the puzzle and command tasks, and more unengaged and unilateral co-regulation during the interference task. Moreover, more time spent in symmetrical co-regulation during the puzzle task was associated with greater externalizing behaviours in children. In contrast, more unilateral co-regulation was associated with fewer externalizing behaviours in middle childhood. Maternal parenting stress was also a predictor of behavioural problems. Findings highlight the context-dependent nature of co-regulation; dyads engaged in different types of co-regulation depending on the task. Further, in at-risk dyads, symmetrical co-regulation may reflect mutual dysregulation, rather than adaptive coordination, while disengagement may be protective. Results have implications for promoting adaptive dyadic regulation in at-risk families through parenting interventions and prevention programs.

There is no such thing as a baby. There is a baby and someone.

D. W. Winnicott

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Contribution of authors

My supervisor, Dr. Dale M. Stack, and I are responsible for the conceptualization of the research study presented in this master's thesis. Dr. Stack and I formulated the research questions, hypotheses, and analyses plans. The data used in this study were collected through the Concordia Longitudinal Research Project (Concordia Project), originally under the direction of Drs. Jane Ledingham and Alex E. Schwartzman. The project is currently under the direction of Drs. Lisa A. Serbin and Dale M. Stack at Concordia University. Observational coding for this study was completed by me (puzzle and command tasks), Cassandra St-Roch, Elizabeth Leong, and Olivia Lazimbat (interference task) in Dr. Stack's Infant and Child Studies Laboratory. I completed data entry, data cleaning, and data analyses using statistical software. I wrote all components of this thesis. Dr. Stack provided feedback throughout various drafts, including revisions and edits to the text, all along the way.

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Exploring Mother-Child Co-Regulation Across Interaction Contexts in At-Risk Mother-Child Dyads: Associations and Predictions to Child Externalizing Behavior Problems

Mother-child interactions are foundational for children's cognitive, social, and emotional development (Fogel, 1993; Lobo & Lunkenheimer, 2020). Positive parent-child interactions are characterized by consistency, sensitivity, responsiveness, and warmth, whereas negative parent-child interactions are characterized by harsh, authoritarian, and inconsistent parenting practices (Eshel et al., 2006; Knerr et al., 2013). Supportive, sensitive parent-child interactions have been shown to positively influence children's cognitive, social, and emotional development (Bernier et al., 2016; Bornstein et al., 2018). Flexibility in parent-child interactions has also been associated with better child outcomes and functioning (Grumi et al., 2022). Responsive and sensitive parenting may also mitigate risks related to poverty, violence, and social disadvantage (Black et al., 2017; Knerr et al., 2013; Morris et al., 2017; Neuhauser, 2018). On the other hand, parent-child interactions with low levels of supportiveness, high rigidity and coercion have been linked with behaviour problems, emotion regulation problems, and problems with peers (Bocknek et al., 2009; Davenport & Bourgeois, 2008; Patterson, 2002; Scaramella & Leve, 2004). Thus, these interactions provide the basis for a child's behavioural, social, and emotional development and well-being.

According to Dynamic Systems Theory, it is crucial to view mother-child interactions as dynamic, rather than static, processes (Fogel & Garvey, 2007). Indeed, no interaction occurs in isolation but rather through the constant adjustment of each partner (e.g., mother and child), which is influenced by individual and environmental factors (Fogel & Garvey, 2007). One way to operationalize mother-child interactions in a dynamic (i.e., ongoing and constantly changing) manner, rather than a one-time static measure, is through Fogel and Garvey's (2007)

conceptualization of co-regulation. Co-regulation refers to dynamic interactions during which parent and child attempt to reach a coordinated state of communication by adjusting their behaviour to the other's cues and mutually regulating their emotions, cognitions, and behaviours (Fogel, 1993). This construct can be used to describe mother-child interactions in line with Dynamic Systems Theory, which posits that the behaviour of mother and child constantly impacts the way they interact with each other (Fogel & Garvey, 2007). Parents (in the present study, mothers) and children are always engaging in co-regulation during interactions; however, the nature of this co-regulation can vary from moment to moment. Fogel and colleagues identified five co-regulation types present in parent-child communication: symmetrical, asymmetrical, unilateral, unengaged, and disruptive (Fogel et al., 2003). These types describe the extent to which dyads are co-regulating within an interaction (Fogel et al., 2003). In symmetrical co-regulation, dyads are fully co-regulating, as they both share a common point of interest and mutually contribute and adjust to the interaction through novel input. In asymmetrical co-regulation, while both partners still share a joint point of interest, only one is actively contributing to the interaction, while the other passively observes. Unilateral co-regulation also describes a situation where only one partner is actively contributing to the interaction; however, in this case, the other partner is fully disengaged from it. In unengaged co-regulation, neither partner contributes to the interaction, and both members are focused on themselves or other points of interests. Finally, disruptive co-regulation occurs when one member disrupts the activity of the other and is unable to adapt their behaviours to address the disrupted partner's expressions of displeasure (Fogel et al., 2003).

Apart from Fogel and colleagues' classification, research on co-regulation has been conceptualized differently and has used different related constructs to measure and understand

mother-child interactions (Provenzi et al., 2018). One similar construct is synchrony, which describes face-to-face interactions that are emotionally, behaviorally, or physiologically coordinated between mother and child to help the child regulate (Li & Lunkenheimer, 2025). Neural synchrony, during which the brain activity of both individuals in an interaction is temporally linked, has been associated with behavioural synchrony (Alonso et al., 2024). Synchronous interactions are characterized by responsiveness, reciprocity, engagement, mutual focus, and shared affect (Criss et al., 2003). This construct is similar and may capture one aspect of co-regulation, namely symmetrical co-regulation, while asymmetrical and unilateral co-regulation would be described as asynchronous types of co-regulation within this framework. Co-regulation and its related constructs have been studied in relation to different child outcomes to better understand their influence on child development and potentially inform interventions.

Symmetrical co-regulation has been associated with positive outcomes, including a secure mother-child attachment, cognitive and psychomotor development and positive mother-child relationship quality in infants (Evans & Porter, 2009; Leong et al., 2024). The related construct of synchrony has also been linked with positive cognitive, emotional, and behavioural child outcomes (Birk et al., 2022; DePasquale, 2020; Harrist & Waugh, 2002; Leclere et al., 2014; Lobo & Lunkenheimer, 2020). For example, higher dyadic synchrony has been shown to be linked to cognitive outcomes, such as language acquisition and executive functioning, as well as socio-emotional outcomes, including secure attachment, emotion regulation skills, and fewer behavioural problems and negative affectivity (Provenzi et al., 2018). Further, in a recent systematic review, Verhagen et al. (2024) found that behavioural and emotional co-regulation characterized by dyadic synchrony, mutual responsiveness, and mutual engagement during challenging tasks is linked to better child self-regulation skills, suggesting that synchronous co-

regulation (or symmetrical) might be especially important when mother-child dyads are engaging in specific types of tasks.

However, these findings are more complicated when at-risk dyads are studied. Indeed, more neural synchrony has been observed in high socioeconomic risk samples, and these higher levels of synchrony have then been associated with poorer child self-regulation outcomes (DePasquale, 2020; Suveg et al., 2016; Wass et al., 2024). Further, Doiron and colleagues (2023) found that symmetrical co-regulation was associated with internalizing and externalizing behaviours in psychosocially at-risk dyads. Extensive research has explored how individual, dyadic, and environmental risk factors can impact mother-child interactions. However, studies have only recently begun to investigate how co-regulation specifically is influenced by external factors, such as parenting or environmental conditions. Further research is therefore needed to clarify the links between these various risk variables and co-regulation.

Mother-Child Interactions in the Context of Risk

Mother-child interactions are influenced by a variety of factors that might disrupt them and lead to dysfunctional or negative interactions (Bailey et al., 2012; Fuchs et al., 2015; Ehrensaft et al., 2015; Greene et al., 2020; Lovejoy et al., 2000; Lyons-Ruth & Black, 1996). Bronfenbrenner's (1977) social-ecological model proposes that a child's development is nested within various interacting systems and environments, ranging from immediate settings, such as the home and parent-child interactions, to broader contexts, such as socioeconomic disadvantage. Importantly, these factors also influence one another, such that broader socioeconomic conditions impact parenting, which in turn shapes the quality of parent-child relationships. For example, known risk factors such as histories of adversity and psychosocial risk (Ehrensaft et al., 2015; Leite Ongilio et al., 2022; Stack et al., 2012) and parenting stress (Negi & Sattler, 2025;

Neuhauser, 2018; Ward & Lee, 2020) have been shown to impact mother-child interactions. Stack and colleagues (2012) found that intergenerational psychosocial risk has cascading effects on children's socioemotional development and, more specifically, that mothers with childhood histories of aggression and social withdrawal, as well as socioeconomic disadvantage, interacted with their children with higher levels of hostility. Their children, in turn, were less responsive toward their mothers, indicating that psychosocial risk may lead to disruptive and more negative mother-child interactions. A recent systematic review also found that maternal childhood adversities negatively impacted mother-child interactions, leading to less maternal displays of affection, emotional availability, sensitivity, mother-child communication and bonding (Leite Ongilio et al., 2022).

Parenting stress is also an important risk factor for the development of maladaptive parent-child interactions and adverse child outcomes. More specifically, parents of younger children and those with lower incomes may be more likely to experience higher levels of parenting stress because the novel demands of parenting, combined with the constraints on their time and resources, are more emotionally taxing (Abidin, 1990; Deater-Deckard, 1998; Leigh & Milgrom, 2008). One study investigating parenting stress and its effects on parenting behaviours found that parenting stress predicted harsh parenting, which in turn predicted less adaptive social behaviour in children and more internalizing behaviours (Negi & Sattler, 2025). Another study found that parenting stress was negatively associated with parents' responsiveness to their toddlers, and that mothers' lower responsiveness was associated with less child prosocial behaviour and more child behavioural problems (Ward & Lee, 2020).

Histories of psychosocial risk and parenting stress also directly affect children's socioemotional outcomes, including externalizing behaviours. Indeed, parenting stress has been

found to be directly linked to preschoolers' social competence, internalizing behaviours, and externalizing behaviours, regardless of its negative impact on parenting behaviours (Anthony et al., 2005). Further, difficult parent-child relationships brought on by parenting stress have been associated with externalizing problems and less prosocial behaviour in preschoolers, highlighting the importance of adaptive parent-child interactions in children's socioemotional development (Ruiz Ortiz & Barnes, 2019). Reciprocal associations have been found between parenting stress and externalizing behaviours in early and middle childhood, such that higher levels of parenting stress predict child behaviour problems (Jiang et al., 2022; Neece et al., 2012), and one recent meta-analysis has shown that parenting stress is more strongly related to the development of externalizing behaviours than internalizing behaviours (Barroso et al., 2018).

One established protective factor or resilience factor against the negative effects of parenting stress is social support (Masten et al., 2021; Negi & Sattler, 2025). Indeed, what might exacerbate parenting stress are additional stressors such as economic hardships or lack of support (Jiang et al., 2022). That is why social support is crucial as a buffer against parenting stress and may promote better parent-child interactions and foster socioemotional development. Social support is defined as the support that an individual receives from their social network, such as family and friends (Negi & Sattler, 2025). It has already been shown to be a promotive factor, providing some protection from psychological distress, poor parenting practices, and poor child outcomes, especially among parents experiencing distress due to economic hardship (Arikan et al., 2019; Negi & Sattler, 2025; Radey, 2018). Indeed, in a longitudinal study examining parenting stress, social support, parenting practices, and their effect on child outcomes among low-income mothers and children, higher levels of social support was found to influence both responsive and harsh parenting, such that it predicted more responsive and less harsh parenting

(Negi & Sattler, 2025). Furthermore, higher maternal support and lower parenting stress have been associated with better mother-child relationship quality (Stack et al., 2012). Indeed, mothers who were more sensitive to their child's needs and less hostile were those who had more social support and lower levels of stress (Stack et al., 2012): Furthermore, the same study found that more appropriate maternal structuring during tasks and more child responsiveness were also associated with higher levels of support and lower levels of stress, overall contributing to more harmonious mother-child interactions (Stack et al., 2012). In addition to parenting, social support has also been shown to influence numerous child outcomes such that higher levels of social support have been associated with more adaptive social behaviour and less externalizing and delinquent behaviours in children and adolescents (Arikan et al., 2019; Ghazarian & Roche, 2010; Negi & Sattler, 2025).

Overall, these factors interact to influence mother-child interactions and subsequently, children's socioemotional development. However, more research is warranted on the links between mother-child interactions in early childhood, conceptualized as co-regulation, and child behavioural outcomes in the context of psychosocial risk. Indeed, according to Dynamic Systems Theory, it is crucial to conceptualize mother-child interactions as dynamic, yet few studies have utilized the co-regulation framework to investigate the links between mother-child interactions and socioemotional outcomes.

Effects of Contextual Factors on Co-regulation and Socioemotional Outcomes

Various factors have been demonstrated to specifically influence co-regulation, rather than broader parent-child interactions, including psychosocial risk, parenting stress and support, and different interaction contexts. In turn, co-regulation has been shown to influence children's socioemotional outcomes, such as externalizing behaviours.

Some studies have examined the influence of psychosocial risk and parenting stress on co-regulation. It has been found that higher levels of parenting stress are associated with more time spent in disrupted or discordant co-regulation (Doiron & Stack, 2017; Li & Lunkenheimer, 2025). Moreover, a consistent link exists between parental stress and lower levels of physiological synchrony (Alonso et al., 2024; Azhari et al., 2019, 2022; Nguyen et al., 2020). Similarly, greater sociodemographic risk has been linked with lower levels of mother-child synchrony (Azhari et al., 2019; Hoyniak et al., 2021; Leclere et al., 2014). It has also been found that psychosocially at-risk dyads spent more time in asymmetrical and disruptive co-regulation in a study comparing full-term, VLBW preterm, and psychosocially at-risk mother-infant dyads (Doiron et al., 2022). However, mothers with higher levels of parenting stress in the psychosocially at-risk groups spent less time in asymmetrical co-regulation with their infants (Doiron et al., 2022). Similarly, in the brain synchrony literature, it has been found that synchrony is not linked to better interaction quality or child functioning in families at high socioeconomic risk, indicating that in these situations of higher-risk, synchrony might be acting as a risk factor, rather than as an adaptive interaction type (DePasquale, 2020). A recent systematic review has also shown that whether physiological or behavioural synchrony is associated with positive or negative outcomes depends on various contextual factors such as parent psychopathology, negative parenting behaviours, and exposure to trauma (Birk et al., 2022). These findings indicate that further research is needed on the links between parenting stress and co-regulation types, especially in at-risk samples.

While environmental factors, such as parenting stress and psychosocial risk, are associated with the development of behavioural problems on their own, there is still limited research on the role of co-regulation in externalizing behaviours in the context of psychosocial

risk and increased parenting stress. Broadly, parent-child interactions characterized by reciprocity, mutual responsiveness, shared affect, and synchronicity have been associated with higher levels of social skills, more positive relationships with peers, fewer conduct problems, and fewer externalizing behaviours (Feldman et al., 2013; Lindsey et al., 1997; Harrist et al., 1994; 2002; Mize & Pettit, 1997; Ravindran & McElwain, 2024). In the co-regulation literature, it has been shown that positive and well-regulated parent-child interactions, characterized by dyadic flexibility and positive affect, are linked with lower levels of behaviour problems in young children (Lunkenheimer et al., 2011). Several other studies have echoed this finding, suggesting that physiological and behavioural synchrony are linked with fewer externalizing behaviours (Lunkenheimer et al., 2013, 2018; Quinones-Camacho et al., 2020, 2022; Verhagen et al., 2024).

However, in psychosocially at-risk samples, the associations are not as clear. There have been studies showing positive associations between parent-child behavioural synchrony and lower levels of antisocial behaviours and externalizing problems in low-income families (Criss et al., 2003; Herbers et al., 2014). Further, as noted above, while asynchronous forms of co-regulation have been associated with negative mental health outcomes in low-risk dyads, discordant findings have been observed in at-risk dyads, where asynchronous types of co-regulation might be protective. Indeed, in a longitudinal study of psychosocially at-risk mother-preschooler dyads, it was found that there were positive associations between parenting stress and child internalizing and externalizing problems when dyads engaged in less asymmetrical and unilateral co-regulation and more symmetrical co-regulation (Doiron et al., 2023). These effects were maintained when children were followed longitudinally at the age of 7 years (Doiron et al., 2023). While psychosocial risk and parenting stress have been investigated in a few studies on co-regulation, there have been no studies, to our knowledge, examining the links between co-

regulation and the potential protective factor of social support. This was a factor considered worthwhile to explore, as findings show that parenting social support can buffer the effect of parenting stress on externalizing behaviours; however, the role of co-regulation in these associations remains unexplored.

In addition to these environmental factors, the context in which an interaction occurs is important. Results from various studies have demonstrated that co-regulation is context-dependent (Alonso et al., 2024; Aureli et al., 2018; Lunkenheimer et al., 2018). For example, in a study where mother-infant dyads engaged in play with and without toys, it was found that interactions involved mostly symmetrical co-regulation when the dyads were playing with toys and mostly unilateral co-regulation when there were no toys, suggesting that the context in which dyads are interacting has an effect on which type of co-regulation they predominantly use (Aureli et al., 2018). In a study examining parent-child physiological synchrony, it was found that engaging in a structured teaching task during which parent-preschooler dyads completed difficult puzzles was linked with less physiological synchrony (Lunkenheimer et al., 2018). However, for preschoolers with higher levels of externalizing problems, that teaching task was associated with more synchrony while free play and clean-up tasks were associated with less synchrony (Lunkenheimer et al., 2018). In another study of physiological synchrony, engaging in a cooperative task (completing a tangram puzzle) was associated with greater neural synchrony and higher behavioural reciprocity in mother-preschooler dyads (Nguyen et al., 2020). In a study using Fogel's classification of co-regulation, it was found that mother-infant dyads at 4 months of age engaged in more disrupted co-regulation following brief perturbation periods where dyads were either separated briefly (but still close by) or the mother kept a still-face (Leong et al., 2024). These contradictory findings point us to the variations in types of co-regulation

predominantly used by mother-child dyads during different types of tasks. Whereas a stress-inducing task, such as completing a difficult puzzle, led to less synchrony, a cooperative one was associated with more neural and behavioural synchrony (Lunkenheimer et al., 2018; Nguyen et al., 2020). Furthermore, although neural synchrony can approximate behavioural conceptualizations of co-regulation, Fogel and colleagues' classification allows for varying levels of synchrony to be observed, ranging from completely synchronous (i.e., symmetrical) interactions to various forms of asynchronous or disengaged interactions (i.e., asymmetrical, unilateral, or unengaged). Moreover, many co-regulation studies have employed a free play or teaching task procedure (Leclere, 2014; Verhagen et al., 2024). However, these tasks encourage largely symmetrical (or synchronous co-regulation) and may not provide enough opportunity to investigate variations in types of co-regulation used in different everyday contexts that mother-child dyads experience, such as periods of maternal unavailability or compliance type tasks. Therefore, an investigation into how co-regulation differs depending on tasks of varying levels of structure and demand was warranted.

Moreover, few studies have examined mother-child interactions and co-regulation beyond infancy and toddlerhood, and into the preschool years when children acquire greater communication skills, cognitive functions, agency, and ability to engage in interactions as opposed to infancy (Aureli et al., 2022; Birk et al., 2022; Doiron et al., 2022; Harrist & Waugh, 2002; Leong et al., 2024). Indeed, studies have found that the type of co-regulation mother-child dyads engage in changes as children age, with an increase in symmetrical co-regulation and a decrease in unilateral co-regulation from infancy to toddlerhood (Aureli et al., 2022; Doiron et al., 2022), suggesting that a developmental trajectory may emerge throughout childhood in terms of co-regulation.

Finally, the links between types of co-regulation in different interaction contexts and externalizing behaviours remain understudied. One systematic review found that parent-child co-regulation in response to a challenging task, such as a conflict discussion or a difficult puzzle, was linked with better child socioemotional outcomes, although familial risk (e.g., poverty, maltreatment) might have an inverse and adverse effect (Verhagen et al., 2024). Examining the way these variables interact (co-regulation, interaction context, psychosocial risk, and child outcomes) is crucial, as it might allow us to more deeply understand mother-preschooler interactions and their effects on concurrent and longer-term outcomes.

The Present Study

The present study was designed to address gaps in the co-regulation literature by examining mother-preschooler interactions in various contexts and their associations with known risk and protective factors, such as parenting stress and social support, as well as socioemotional or behavioural outcomes such as externalizing behaviours. These associations were also examined longitudinally to determine the impact of co-regulation in the preschool years on outcomes in middle childhood.

There were two objectives. The first objective was to determine the differences in time spent in three types of co-regulation (symmetrical, unilateral, and unengaged) across three tasks: a structured teaching task (puzzle task), a compliance task (command task), and a task mimicking periods of maternal unavailability (interference task) where child plays on a mat in close proximity to the mother who is completing a questionnaire. It was expected that mother-child dyads would spend a greater amount of time in symmetrical and asymmetrical co-regulation during the puzzle task, as it requires either collaborating on the puzzle or teaching the child and demonstrating how to do it. During the command task, it was expected that dyads

would mainly engage in symmetrical co-regulation when the children complied with the mothers' requests and unilateral co-regulation when they ignored them. For the interference task, it was expected that dyads would spend a greater amount of time in 1) unengaged co-regulation, as each member of the dyad would be occupied with their own task, 2) in unilateral co-regulation, as the child would attempt to engage with their mother and seek her attention, or 3) in disrupted co-regulation as maternal unavailability might disrupt the child's play.

The second objective (2a, 2b) was to examine the concurrent and longitudinal associations between co-regulation, parenting stress and support, and children's externalizing behaviours. While it may be reasonable to think more symmetrical co-regulation would be linked with less externalizing behaviours, in light of the discordant findings presented above, it was hypothesized that higher levels of externalizing behaviours would be linked with greater time spent in symmetrical co-regulation. This hypothesis is based on previous findings showing that in psychosocially at-risk dyads with higher parenting stress, synchronous forms of co-regulation might be less adaptive and lead to negative socioemotional outcomes. Further, based on Doiron and colleagues' (2023) findings, it was also expected that higher levels of externalizing behaviours would be associated with less time spent in asymmetrical and unilateral co-regulation. These associations would hold even when controlling for known factors associated with externalizing behaviours, such as parenting stress and need for social support.

Results from this study were expected to contribute to the co-regulation literature and the broader mother-child interaction literature by examining mother-child interactions conceptually framed in co-regulation in a systematic and dynamic way, and considering the dyad as a whole, across various tasks mimicking naturalistic everyday situations in the home. It also considered crucial risk and protective factors that might be impacting mother-child interactions and how the

subsequent types of co-regulation would be associated with externalizing behaviours, both in early childhood and middle childhood, allowing for a deeper and more complete understanding of mother-child interactions, and co-regulation in particular, in psychosocially at-risk populations.

Methods

Participants

The participants in this study were a subset of the Concordia Longitudinal Research Project (henceforth Concordia Project), a prospective, longitudinal, and intergenerational study that began in Montreal in 1976 (Schwartzman et al., 1985; Serbin et al., 1998; Stack et al., 2017). This study recruited children in grades 1, 4, and 7 from francophone schools in disadvantaged neighbourhoods by screening them for psychosocial risk (maladaptive peer relations, socioeconomic disadvantage). A sample of 1,774 participants was followed from adolescence to adulthood and into parenthood. In this study, a subsample of 175 mothers from the first generation of participants were observed with their offspring, the second generation of participants, as preschoolers (Time 1). This same subsample was followed up with when the children were 9 to 13 years old (Time 2), and 119 families agreed to participate again. The participants spoke mostly French.

Procedure

The mother-child dyads were visited at home twice when the children were between 1 and 6 years old (Time 1) and once again when the children were between 9 and 13 years old (Time 2) for the second wave of data collection. During each visit, research assistants explained the study procedures and obtained informed consent from the mothers (see Appendix A). They

completed questionnaires and engaged in various tasks meant to mimic everyday interactions, including a puzzle task, a command task, and an interference task at Time 1. During the puzzle task, the mothers were instructed to complete age-appropriate puzzles with their children for 4 minutes for children 12 to 36 months old and 7 minutes for children older than 36 months. During the command task, the mothers were instructed to ask their children to perform various simple tasks listed on a piece of paper, such as picking up toys or turning the pages of a book, for a period of 3 minutes. Only children over 24 months of age completed the command task. During the interference task, mothers completed questionnaires for 3 minutes while the child played on the mat nearby with toys, which was meant to simulate situations of maternal unavailability.

These interactions were videotaped for later observational coding. Ten dyads were excluded due to missing video recordings, sound quality issues, or the dyads being unable to complete the tasks because of behavioral issues at the time of the visit, or it was disclosed that the child had a neurodevelopmental diagnosis. Due to the nature of the analyses, only the dyads who completed all three tasks were included in this study. Therefore, the final preschool sample comprised 111 dyads, and the final middle childhood sample consisted of 73 children (see Table 1 for detailed demographic information). The mothers' mean age was 30.31 (*SD* = 3.34), and their mean level of education was 11.75 years (*SD* = 2.41). The children's mean age at Time 1 was 4.13 (*SD* = 1.31), and there were 53 boys and 58 girls. At Time 2, the middle childhood sample consisted of 35 boys and 38 girls with a mean age of 11.13 (*SD* = 0.80).

Measures

Observational Measures

Co-Regulation. Time spent in each type of co-regulation was coded using the Revised Relational Coding System (RRCS; Fogel et al., 2003). The RRCS consists of five overarching communication types that describe dyadic interactions: symmetrical, asymmetrical, unilateral, unengaged, and disrupted. A "no code" category was added for instances where at least one of the members of the dyad was not visible in the video. Coding is based on vocalizations, touch, gaze, affect, and general body language cues. This coding system requires observing the dyad as a whole. Consequently, categorization into each co-regulation type is based on how one member of the dyad responds to cues from the other partner (see Table 2).

Symmetrical co-regulation describes interactions during which both members of the dyad are engaged with each other or a shared point of interest. They also continuously build on each other's contributions to the interaction through various means (e.g., vocalization, movement, or body language). During asymmetrical co-regulation, the dyad also shares a joint point of interest, but only one member contributes to the interaction, while the other observes passively. Unilateral co-regulation occurs when one member of the dyad is actively engaged in the interaction, while the other remains unengaged. In unengaged co-regulation, both members of the dyad are unengaged in the interaction. Finally, disruptive co-regulation occurs when one member of the dyad disrupts the activity of the other and does not attempt to repair the ensuing expression of displeasure (see Table 2 for examples).

Observational coding was performed using the Mangold INTERACT computer software, allowing for live, second-by-second behaviour coding. Only interactive behaviours lasting 2 seconds or more were coded.

The primary coder was trained by establishing reliability with a more experienced coder (senior research assistant) who coded 25% of the sample. The kappa coefficients for each co-

regulation type ranged from 0.80 to 0.96 in the puzzle task and 0.79 to 0.93 in the command task, suggesting high inter-rater reliability (see Table 2 for all Kappa values). The second coder, another research assistant and graduate student coded the interference task. The kappa coefficients for this task as well as a series of tasks coded alongside it ranged from 0.79 to 0.94.

In the current study, asymmetrical and disruptive co-regulation were excluded from analysis due to low frequency (< 5% of the time).

Questionnaire Measures

Demographic Information Questionnaire. The Demographic Information Questionnaire (DIQ) is a self-report measure of sociodemographic information that mothers complete. This questionnaire has been used in previous research with the Concordia Project to collect participants' demographic information effectively (Doiron et al., 2017; 2022; Briscoe et al., 2017; Mantis et al., 2014).

Parenting Stress Index. Mothers completed the Parenting Stress Index (PSI; Abidin, 1995), a self-report measure that assesses psychological distress associated with parenting and measures stress in the parent-child system. The current study employed the short form of the PSI, which comprises 36 items rated on a five-point Likert scale (*1 = strongly disagree to 5 = strongly agree*). The 36 items load onto three subscales: Parental Distress, Difficult Child Characteristics, and Dysfunctional Parent-Child Interaction. The Parental Distress subscale assesses factors that affect parenting practices such as competence, parental conflict, support, and depression. The Parent-Child Dysfunctional Interaction subscale measures the extent to which parents feel satisfied with their child and their interactions with them. The Difficult Child subscale captures how the parent perceives their child, in terms of the child's self-regulation and

behavioural difficulties. Examples of items include "*I often have the feeling that I cannot handle things very well*" and "*I feel trapped by my responsibilities as a parent*". A total score can also be computed to quantify overall parenting stress, with higher scores indicating greater stress associated with parenting. Internal consistency in a normative sample was excellent, with Cronbach's alphas for subscales and the total above .80 (Abidin, 1995). Internal consistency in this sample was also excellent, with a Cronbach's alpha of 0.91 for the total score at Time 1 and of 0.92 at Time 2.

Parenting Social Support Index. A modified version of the Parenting Social Support Index (PSSI; Telleen, 1985), geared to include mothers of toddlers and preschoolers rather than just infants, was administered to the mothers. It is a self-report measure that assesses levels of parenting social support through seven forms of support that parents may receive. Three total scores are generated (total perceived need for support, total network size, and total support satisfaction). Example of items include "*During the past month, how much did you need advice and information about the care of your child?*" and "*During the past month, how satisfied were you with the helpfulness of the advice that you were given?*". To reduce the numbers of predictors given the sample size, only the total perceived need for support was analyzed as higher levels of social support has been shown to be linked with behaviour problems in children (Arikan et al., 2019; Ghazarian & Roche, 2010; Negi & Sattler, 2025). Therefore, higher need for support might be related to more externalizing behaviours. The PSSI has been found to have good internal reliability and concurrent validity (Telleen, 1985). In this sample, internal consistency was 0.70 in the preschool sample and 0.74 in the middle childhood sample.

Child Behaviour Checklist. The Child Behaviour Checklist (CBCL) is a parent-report screening measure of children's behavioural and emotional problems (Achenbach, 1991). One of

two versions was given to the mothers at Time 1 and was included in the analyses to assess externalizing behaviours. One version targets children aged two to three years (CBCL/2-3; Achenbach, 1992), and the other targets children aged four to eighteen years (CBCL/4-18). The CBCL/2-3 consists of 99 items where the parent is asked to rate how true or untrue the statements are regarding their child on a 3-point Likert scale (*0 = absent to 2 = often*). The scale yields nine scores, including a total score, an internalizing problem score, and an externalizing problem score. The child's externalizing behaviour score is the sum of the aggressive and destructive behaviour subscales. Higher scores indicate the presence of more externalizing behaviours. Internal consistency for the externalizing scale was excellent in this sample, with a Cronbach's alpha of 0.91. The CBCL/4-18 consists of 113 items and yields eight scores, including an externalizing problems scale, which is the sum of the aggressive behaviour and delinquent behaviour subscales. Internal consistency for the externalizing problems scale was 0.93 in a sample of boys and girls aged 4-11 (Achenbach, 1991). It was 0.80 in the current sample at Time 1 and 0.91 at Time 2. At Time 1, the total externalizing behaviours scores for both questionnaires (2-3 and 4-18) were converted to z-scores to create a single variable to use in statistical analyses. Example of items across both scales include "*Argues a lot*", "*Disobedient at school*", "*Physically attacks people*", "*Defiant*", and "*Gets in many fights*".

Analysis

Data Preparation

Percent durations were used to operationalize co-regulation. Percent duration represents the percentage of time over the total length of the interaction for each dyad spent in a specific type of co-regulation. The percent duration data and the questionnaire data were screened for normality and outliers and to verify the assumptions associated with repeated-measures

ANOVAS and regression analyses. Percent durations of all the codes were converted to z-scores to identify outliers and achieve normality. Outliers, defined as z-scores greater than 3 standard deviations (SD) from the mean, were converted to the next most extreme score within 3 *SD* (Kline, 2009). After converting outliers, skewness and kurtosis values were within an adequate range (skew < 3, kurtosis < 10; Cain et al., 2016). The assumption of sphericity for the ANOVA analysis was violated according to Mauchly's test of sphericity. Therefore, Greenhouse-Geisser corrections were used for all ANOVA results. Assumptions for all hierarchical regressions (multicollinearity, linearity, homoscedasticity, normality of residuals, independence of errors) were checked and all assumptions were met. There were three multivariate outliers in the T2 regressions, which were removed from the longitudinal analyses only. All statistical analyses were conducted using IBM SPSS Statistics (Version 29).

Analytic Approach

A repeated-measures ANOVA was used to assess the differences in time spent in each type of co-regulation across the three tasks. The tasks (i.e., puzzle, command, and interference) and co-regulation type (i.e., symmetrical, unilateral, and unengaged) were the within-subject factors, and the percent duration of time spent in each co-regulation type was the dependent variable. Sidak corrections were used for post-hoc pairwise comparisons to account for multiple comparisons (Sidak, 1967).

Multiple hierarchical regressions were used to assess the associations between co-regulation types, parenting stress, parenting social support, and children's externalizing behaviours both concurrently and longitudinally. In each regression, sex was controlled for and entered in the first step. Since age was not found to be a significant predictor in any of the regressions, it was removed from the analyses to reduce the number of predictors. Parenting

stress and social support were controlled for and entered in the second step. Finally, each type of co-regulation was entered in the last step as the independent variable. All hierarchical regressions were conducted separately for each type of co-regulation (symmetrical, unilateral, and unengaged) in each task (puzzle, command, interference). For all analyses, only significant results are presented in the text.

Results

Descriptive Statistics

Time spent in each type of co-regulation varied across tasks. Dyads engaged mostly in symmetrical co-regulation, followed by unengaged, then unilateral co-regulation (see Table 3). Dyads rarely engaged in asymmetrical or disruptive co-regulation and as a result these two co-regulation types were excluded from further analysis. Correlations between all variables were examined to determine that the variables were not too highly correlated before running the regression analyses (See Tables 4-7 for descriptive statistics and correlations).

Objective 1: Comparison of co-regulation type across tasks

To test for the effect of task on the amount of time (as percent duration) spent in each co-regulation type, a 3 (task) x 3 (co-regulation type) repeated measures ANOVA was conducted.

A statistically significant main effect of co-regulation was found, F (2, 109) = 1838.88, p <.001, ηp^2 = .971). Sidak-corrected simple effects indicated that, across all three tasks, dyads spent significantly more time in symmetrical co-regulation (M = 68.46, SD = 37.46) compared to unilateral co-regulation (M = 7.35, SD =10.80) and unengaged co-regulation (M = 23.61, SD = 3.19; all ps < .001). The difference in time spent in unengaged co-regulation vs. unilateral co-

regulation was also significant ($p < .001$), with dyads spending significantly more time in unengaged co-regulation across the three tasks (see Figure 1).

A statistically significant interaction between task and co-regulation was found, F (4, 107) = 498.28, $p < .001$, $\eta p^2 = .949$; that is, the amount of time mother-child dyads spent in each type of co-regulation differed significantly across the three tasks. Sidak-corrected simple effects and pairwise comparisons were run to explore the differences between tasks.

When comparing co-regulation across tasks, it was found that dyads spent significantly more time in symmetrical co-regulation in the puzzle ($M = 93.71$, $SD = 9.23$) and command tasks ($M = 93.26$, $SD = 7.67$) compared to the interference task ($M = 18.41$, $SD = 17.34$; all ps $< .001$). Conversely, dyads spent significantly more time in unilateral co-regulation in the interference task ($M = 14.37$, $SD = 14.39$) compared to the puzzle ($M = 3.25$, $SD = 5.12$) and command tasks ($M = 4.44$, $SD = 6.46$; all ps $< .001$). Similarly, dyads spent significantly more time in unengaged co-regulation in the interference task ($M = 66.19$, $SD = 22.92$) than in the puzzle ($M = 2.52$, $SD = 4.95$) and command tasks ($M = 2.13$, $SD = 3.32$; all ps $< .001$).

When comparing co-regulation within each task, dyads in the puzzle task spent significantly more time in symmetrical co-regulation than both unilateral and unengaged co-regulation (ps $<.001$), with no significant difference between unilateral and unengaged co-regulation ($p = .490$). In the command task, dyads spent significantly more time in symmetrical co-regulation than both unilateral and unengaged co-regulation (ps $< .001$) and spent significantly more time in unilateral co-regulation than unengaged co-regulation ($p = .003$). In the interference task, dyads spent significantly more time in unengaged co-regulation than both symmetrical and unilateral co-regulation (ps $< .001$), with no significant difference between symmetrical and unilateral co-regulation ($p =.188$).

Objectives 2a and 2b: Concurrent and longitudinal associations between types of co-regulation, parenting stress, social support, and externalizing behaviours

To examine the associations between types of co-regulation and externalizing behaviours, each type of co-regulation across the three tasks was regressed on mother-reported child externalizing behaviour scores either at the same timepoint (Time 1) or at a later timepoint in middle childhood (Time 2).

Concurrent associations.

When sex, mothers' parenting stress and need for social support, and symmetrical co-regulation in the puzzle task were regressed on externalizing behaviours, the final model accounted for 46.6% (44% adjusted) of the total variance. There was a significant positive association between symmetrical co-regulation and externalizing behaviours, such that children from dyads who spent more time in symmetrical co-regulation exhibited more externalizing behaviours (b = .019, t = 2.10, p = .039). In the final model, there was also a significant association between mothers' parenting stress and externalizing behaviours (b = .034, t = 6.89, p < .001), such that mothers who experienced more parenting stress had children who exhibited more externalizing behaviours. In all the other models, mothers' parenting stress was significantly associated with externalizing behaviours (*betas* ranging from 0.034-0.035, ts ranging from 6.89-7.00, ps all <.001; see Tables 8-16 for detailed statistics)

Longitudinal associations.

In the longitudinal associations, baseline externalizing behaviours were controlled for and entered in the first step. The number of predictors per participant in these regressions was just

under the threshold suggested by Tabachnick and Fidell (2001; 10 participants per predictor), and all the hierarchical regression assumptions were met, suggesting that the models were acceptable.

When sex, mothers' parenting stress and need for support, children's baseline externalizing behaviours, and unilateral co-regulation in the command task were regressed on externalizing behaviours, the overall model accounted for 82.9% (68.8% adjusted) of the total variance. Children in dyads who spent more time in unilateral co-regulation in the command task exhibited fewer externalizing behaviours in middle childhood (b = -.254, t = -2.21, p = .032) even after controlling for mothers' parenting stress, need for social support, and children's baseline externalizing behaviours. In the final model, children of mothers who experienced more parenting stress (b = 0.20, t = 4.91, p < .001) exhibited more externalizing behaviours in middle childhood. Furthermore, externalizing behaviours in early childhood was positively associated with externalizing behaviours in middle childhood (b = 2.24, t = 2.89, p = .006).

In all the models, the association between mothers' parenting stress and externalizing behaviours was significant (*beta*s ranging from 0.14-0.20, *t*s ranging from 4.52 – 5.00, *p*s all < .001). Similarly, in all the models, the associations between baseline externalizing behaviours and externalizing behaviours at Time 2 were significant (*betas* ranging from 2.24-4.46, *t*s ranging from 2.89-5.70, *p*s ranging from <.001-.006; see Tables 17-25 for detailed statistics)

Discussion

The present study aimed to examine types of co-regulation across three different interaction contexts in mother-preschooler dyads and in association with various psychosocial variables. The results supported the hypotheses that time spent in different types of co-regulation differed across interaction tasks. This is a novel finding with regard to this age group and to the

various tasks examined. Indeed, most co-regulation research has focused on infants, and to a lesser extent, toddlers, and on free play tasks or, to a lesser extent, challenging puzzle tasks (Leclere et al., 2014; Verhagen et al., 2025). Therefore, our findings highlight the importance of considering contextual differences when studying mother-child co-regulation. Beyond the interaction context, our study examined dyads from a psychosocially at-risk sample and measured various potential risk and protective factors, such as parenting stress and social support, as well as child externalizing behaviours. As anticipated, certain types of co-regulation were associated with externalizing behaviours even after controlling for parenting stress and need for social support.

The first objective was to examine differences in types of co-regulation across the three interaction tasks. As hypothesized, mother-child dyads engaged in primarily symmetrical co-regulation during the puzzle task. However, contrary to predictions, asymmetrical co-regulation was not frequently observed and consequently was excluded from analyses. This might be explained by the task consisting of age-appropriate puzzles that the dyads could complete together and did not require that the mother teach or demonstrate how to do it. A previous study investigating mother-child synchrony while engaging in a cooperative puzzle task also found that it led to greater neural synchrony and behavioural reciprocity (Nguyen et al., 2020). Another study found that mother-child dyads exhibited more neural synchrony during a challenging timed task requiring them to complete puzzles too difficult for the child's age and a decrease in synchrony in the subsequent period during which dyads could engage in free play (Quinones-Camacho et al., 2020). These two studies suggest that when dyads work together to complete a task, they exhibit more behavioural and physiological synchrony. However, very few studies have examined differences in levels of synchronous interactions across tasks and contrasted

synchronous and asynchronous ways of interacting within a task using a dynamic coding system comprised of many interaction behaviours, making our findings a novel contribution to the co-regulation literature.

Furthermore, our predictions regarding the command task were also supported. Dyads mainly engaged in symmetrical co-regulation as the children were following the instructions that their mothers were giving them or were negotiating with their mothers on them or were displeased by them, which would all be captured by symmetrical co-regulation. As suspected, a subset of children ignored their mothers' directives and engaged in unilateral co-regulation. Indeed, dyads spent significantly more time in unilateral co-regulation than unengaged co-regulation in this task, as opposed to the puzzle task, where there was no difference between unilateral and unengaged co-regulation. The predominance of symmetrical co-regulation in the puzzle and command tasks speaks to the specific demands these tasks place on mother-child dyads: i.e., of collaborating on a puzzle or engaging in an exchange following a directive that was given by the mother. This aligns with the findings that as infants age and attain toddlerhood and the preschool years, they become more capable of being active partners in interactions due to their developing cognitive and language abilities (Lunkenheimer et al., 2018; Provenzi et al., 2018). Furthermore, results from two longitudinal studies have shown that symmetrical co-regulation increases after 2 years old while unilateral co-regulation decreases (Aureli et al., 2022; Doiron et al., 2022), which is reflected in the present findings with preschoolers.

During the interference task, as expected, mostly unengaged co-regulation was observed as mothers and children were each occupied with their own activity. Contrary to hypotheses, dyads did not spend a significant amount of time in unilateral and disruptive co-regulation, although previous studies have shown a greater amount of time spent in disruptive co-regulation during

periods of maternal unavailability (Leong et al., 2024). This might be explained by the fact that the children in the present study were older and perhaps better able to self-regulate when their mother was unavailable, as opposed to 4-month-old infants who might be more disrupted by maternal unavailability. Moreover, the length of the task was briefer and the type of unavailability was different in the Leong and colleagues (2024) study, as in one of the two interaction periods the mothers physically left their child (secured in their seat) to hide behind a curtain very close by, whereas in the present study's task, the mothers were still physically present but emotionally unavailable. Although dyads spent more time in unilateral co-regulation during this task than the previous two, which might be capturing children's attempts to get their mother's attention, there was no difference between unilateral and symmetrical co-regulation.

Overall, these findings underscore the fact that types of co-regulation differ across tasks and deepen our understanding of co-regulation as a context-dependent and dynamic process. Different tasks require that dyads use different types of co-regulation, which suggests that no one type of co-regulation can be considered adaptive or maladaptive on its own. Rather, the broader context must be considered, both in terms of the interaction taking place but also of the parent, child, and environmental factors impacting the interaction. While symmetrical co-regulation might seem the most desirable, it might not always be, depending on the demands of the task.

The second objective was to examine the concurrent and longitudinal associations between different types of co-regulation across the three tasks with externalizing behaviours, while accounting for parenting stress and need for support. As hypothesized, higher levels of externalizing behaviours were associated with greater time spent in symmetrical co-regulation, specifically in the puzzle task. This finding suggests that in psychosocially at-risk dyads, symmetrical co-regulation might be maladaptive, capturing mutual dysregulation or children's

problematic behaviours during mother-child interactions. Our hypothesis that higher levels of externalizing behaviours would be associated with less asymmetrical and unilateral co-regulation was not supported by the results in the concurrent analyses. This hypothesis was based on Doiron and colleagues' (2023) finding that less time spent in asymmetrical and unilateral co-regulation were linked to more externalizing problems in the context of higher parenting stress. This finding might not have been replicated due to the nature of the tasks used being different across both studies, which led to different types of co-regulation being observed and different associations with externalizing behaviours. This study used structured tasks where specific instructions were given to the mother whereas Doiron and colleagues' study used a free play period that is more unstructured and allows dyads to act more freely. Future research should continue to explore co-regulation across different interaction tasks and their links with socioemotional outcomes such as externalizing behaviours.

In the longitudinal analyses, we found that more time spent in unilateral co-regulation during the command task was associated with lower levels of externalizing behaviours, suggesting that disengaging from interactions might be protective for at-risk dyads where less positive or negative parenting behaviours might be more common (Neuhauser, 2018; Savage et al., 2019). Since mothers experiencing more parenting stress and at psychosocial risk interact with higher levels of hostility (lower levels of non-hostility) and lower levels of sensitivity with their children (Leite Ongilio et al., 2022; Stack et al., 2012), one of the dyadic partners being more passive during interactions may be beneficial to children, especially in stressful situations. Furthermore, these findings are in line with Doiron and colleagues' (2023) finding that in psychosocially at-risk dyads, less time spent in unilateral co-regulation was associated with fewer externalizing problems when parenting stress was elevated. These results further confirm

the idea that no type of co-regulation is necessarily adaptive or maladaptive but rather depends on the interaction context and broader psychosocial factors that impact the dyad. Birk and colleagues (2022) also suggested that physiological synchrony may lead to negative child outcomes, especially when dyadic and environmental risk factors are present. It appears that for psychosocially at-risk dyads in which mothers experience more parenting stress, more reciprocal interactions such as symmetrical co-regulation may be less adaptive, and disengagement from the interactions by one member of the dyad may be protective.

Feldman (2007) has suggested that the ability to shift between synchronous and asynchronous types of regulation might be more adaptive than being in constant synchrony. This view is echoed in recent literature examining emotion regulation in both children and adults which has suggested that emotion regulation strategies are also neither adaptive or maladaptive but rather are beneficial depending on the individual and situations and emphasizing flexibility in regulation strategies (Aldao et al., 2015; Atkinson et al., 2021; Bonanno & Burton, 2013). The finding that symmetrical co-regulation during the puzzle task was associated with more externalizing behaviours, while unilateral co-regulation during the command task was associated with less, suggests that perhaps these tasks may have elicited frustration in the child as they attempted to complete the puzzle with their mothers or follow their directives. This frustration could manifest in both the constructs of symmetrical co-regulation and externalizing behaviours, and disengagement from the task might have been a way to decrease frustration and arousal. This might be especially true in psychosocially at-risk dyads, where mothers experiencing parenting stress, linked with less sensitive and more hostile parenting (Carapito et al., 2020; Stack et al., 2012), may struggle to interact and support their children effectively during challenging tasks and the children might contribute less to interactions following a history of less sensitive and

more hostile maternal responses. While the puzzles in this study were age-appropriate, they might still have represented a challenge for some of the dyads and the co-regulation of emotion and behaviours during challenges is especially important to study as it contributes to the development of the child's self-regulation (Coburn et al., 2015; Verhagen et al., 2024).

Across both concurrent and longitudinal analyses, mothers' parenting stress emerged as a robust predictor of externalizing behaviours, echoing previous findings showing a consistent link between parenting stress and externalizing behaviours (Anthony et al., 2005; Barroso et al., 2018; Neece et al., 2012).

Strengths, Limitations, and Future Directions

One of the present study's major strengths was that it used observational methods to systematically measure co-regulation in mother-child interactions in a naturalistic home environment. Furthermore, the dyads were observed in various contexts designed to mimic everyday mother-child interactions, allowing us to investigate differences in co-regulation across various tasks, which has rarely been done before. Moreover, to our knowledge, this is only the second study to examine co-regulation past toddlerhood and with preschoolers (Doiron et al., 2023). Most research to date has only examined co-regulation in infancy and early toddlerhood (Aureli et al., 2018; 2022, Aureli & Presaghi, 2010; Doiron & Stack, 2017; Evans & Porter, 2009; Hsu & Fogel, 2001, 2003; Porter et al., 2022). The preschool period is especially important to study as children become increasingly agentic and able to engage in varied interactions as they develop greater cognitive and language skills (Provenzi et al., 2018). This is also the period where externalizing behaviours first appear and can be observed by parents (Campbell et al., 2000), providing us with the opportunity to investigate the links between co-regulation and externalizing behaviours.

However, as with any study, there were a few limitations. While this study considered some key risk variables associated with parent-child relationships and children's socioemotional outcomes, there are others that may also play a role in mother-child co-regulation, such as child characteristics (e.g., temperament). Indeed, temperament has been shown to impact parenting practices, parent-child interactions, and co-regulation specifically (Dalimonte-Merckling & Brophy-Herb, 2019; Porter et al., 2022). Furthermore, while a strength of our study was its longitudinal design, co-regulation was only measured at the first time point. It would be informative to also measure co-regulation longitudinally to explore how it evolves over time and in relation to various psychosocial variables. Two longitudinal studies have investigated how co-regulation changes from infancy to toddlerhood and from toddlerhood to early childhood, and have found important types of stability and change, indicating that the type of co-regulation mother-child dyads engage in evolves over a child's development (Aureli et al., 2022; Doiron et al., 2022). However, there are very few studies examining mother-child co-regulation in older children, none to our knowledge with this coding system, and we do not know how these types of co-regulation continue to evolve. It would be informative if future research integrates longitudinal designs to examine mother-child co-regulation in middle childhood and adolescence.

This study relied solely on mothers' reports of their own parenting stress and need for support, as well as their child's externalizing behaviours, which could be subjective or biased. However, research has indicated that using mothers' reports of their children's mental health in early childhood is effective, even in mothers who are also experiencing psychopathology (Olino et al., 2021). Furthermore, the observational and longitudinal nature of the study provided us with valuable information on co-regulation in a naturalistic setting and its relationship with child

socioemotional outcomes over time, particularly in a psychosocially at-risk sample. Nonetheless, the use of multiple informant reports in future research, such as parents, children, and teachers, could help us better identify the links between co-regulation and various child mental health outcomes.

The sample size and attrition at Time 2 may have posed an issue in the statistical analyses, limiting our ability to detect associations between co-regulation and externalizing behaviours, especially in the interference task. We had to limit predictors to maximize power, some of which could have been potential controls (e.g., demographic factors, or other subscales of our parenting stress and support measures). However, in this study we still captured a variety of interaction tasks, going beyond most co-regulation research, which has largely focused on free play and teaching tasks (Leclere, 2014; Verhagen et al., 2024). It also included several measures of psychosocial risk and child externalizing behaviours over time, and the dynamic measurement of co-regulation was also a novel contribution.

Future research on co-regulation could also examine children's interactions with other dyadic partners, such as siblings, peers, and fathers. Indeed, studies have shown that interactions between siblings and friends can affect one another, and the quality of these relationships has implications for problematic behaviours (Hazel et al., 2022; Kramer & Kowal, 2005; McElwain & Volling, 2005). Similarly, this study only examined mothers during interactions, even though we know that fathers' interactions with their children are as crucial for their development, and differences have been observed in patterns of synchronous interactions used by infant-mother and infant-father dyads (Feldman, 2003). Future research could also consider including other risk or protective factors when studying co-regulation, as well as more socioemotional outcomes, such as internalizing behaviours, psychopathology, and measures of social competence. Indeed,

research findings have already shown that parent-child interactions predict later social interactions and socioemotional adjustment (Feldman et al., 2013; Gilbert & Gilbert, 2013; Negi & Sattler, 2025; Ward & Lee, 2020). However, these studies have not examined the social variables in association with co-regulation, which allows us to capture interactions in a dynamic manner rather than as a static one-time measure.

Implications and Conclusions

The results from this study contribute to our understanding of mother-child interactions across interaction contexts and their implications for children's externalizing behaviour problems. Furthermore, the results may also have clinical implications with regard to improving adaptive mother-child relationships and decreasing children's externalizing behaviours. Indeed, disruptive behaviour disorders are a major public health concern, and children with disruptive behaviour disorders are likely to have impairments in multiple life domains (e.g., social, academic, etc.; Lambert et al., 2001). They are also more likely to have chronic symptoms that continue beyond their childhood years, making this an issue throughout development (Lambert et al., 2001; Moffitt, 1993; Paré-Ruel et al., 2024). Finally, disruptive behaviour problems increase susceptibility to criminal or delinquent behaviours (Aebi et al., 2014; Schaeffer et al., 2003; Sourander et al., 2006). Therefore, investigating their developmental origins through mother-child relationships in at-risk contexts is crucial.

Furthermore, parent-child relationships have been consistently shown to have associations with both child and parent mental health (Borji et al., 2018; Kim & Cicchetti, 2004) and are therefore a target for many interventions for socioemotional problems in children (Suldo & Fefer, 2013). For example, Parent-Child Interaction Therapy (PCIT) for externalizing behaviours aims to increase positive interactions between parent and child by showing parents

strategies to be better attuned and sensitive to their children (Cooley et al., 2014; Lieneman et al., 2017). More specific to co-regulation, one study used changing patterns of co-regulation (measured using state space grid (SSG)) analysis, a graphical approach that quantifies observational data according to a map constructed from two observed variables) as markers of treatment effectiveness in family interventions for child aggression (Granic et al., 2007). Indeed, this study found that changes in parent-child interaction patterns, such as increases in emotional flexibility and repair skills following conflict discussions, distinguished improvers from non-improvers in family intervention (Granic et al., 2007). These findings point to co-regulation as a promising avenue for use in interventions to prevent and treat children's socioemotional problems, including externalizing behaviours.

Taken together, results from our study provide evidence for the large differences in types of parent-child interactions across interaction contexts, highlighting the context-dependent nature of co-regulation. Furthermore, results from this study provides continued evidence that types of co-regulation should not be simply dichotomized as adaptive or maladaptive but rather should be seen as flexible adaptations to the demands of the environment. For at-risk dyads, certain types of co-regulation typically seen as adaptive might be deleterious and lead to negative socioemotional outcomes in children, such as externalizing behaviours. That is why it is crucial to continue to study parent-child interactions, conceptualized as co-regulation and dynamically measured, to better understand the variables that might be impacting it as well as its impact on children's mental health outcomes and well-being. Co-regulation is constantly occurring in human interactions, and because mother-child interactions are among the most formative for children's socioemotional development, studying them across contexts is essential for understanding and supporting children's well-being.

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Figure 1

Percent Duration of Type of Co-regulation for the Puzzle, Command, and Interference Tasks

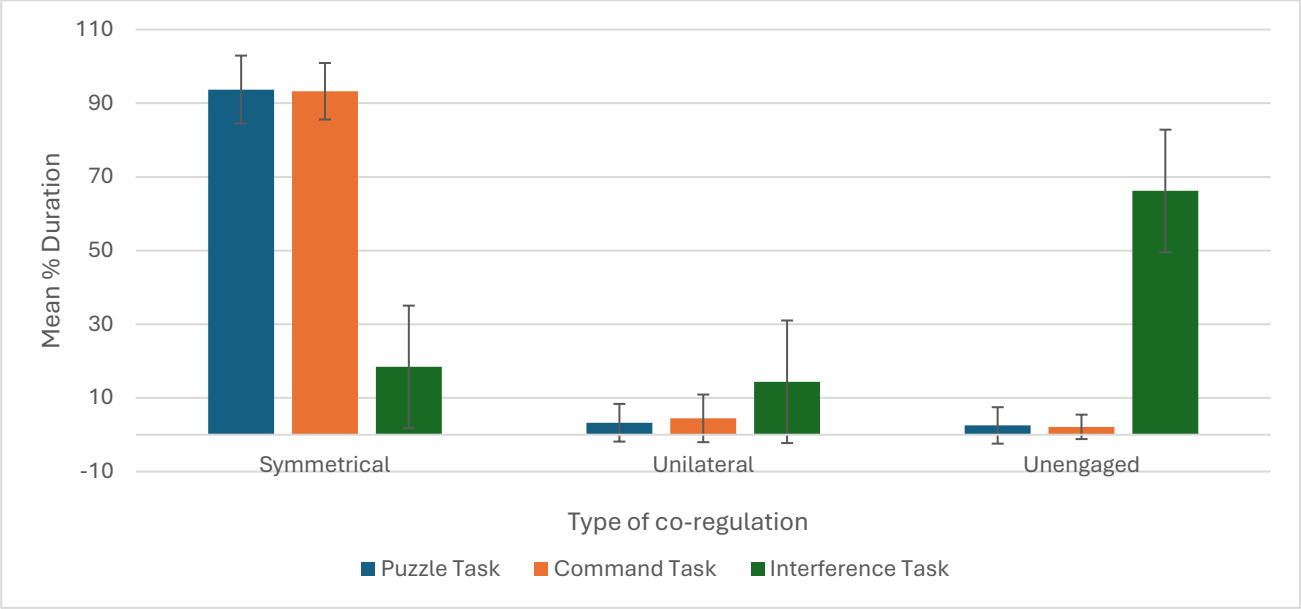

Table 1.

Participants' Demographic Information

	M	*SD*
Age of Child T1 (N = 111)	4.13	1.31
Age of Child T2 (N = 73)	11.13	0.80
Maternal Age	30.31	3.34
Paternal Age	32.17	3.87
Maternal Age at birth of first child	24.82	3.67
Maternal Education	11.75	2.41
Family Income	43 986.21	24 413.79
Maximum Occupational Prestige (SIOP)	40.53	10.60
Income-to-Needs T1	1.62	0.98
Income-to-Needs T2	1.92	0.96
	% of *N*	*n*
Sex of Child T1 (N = 111)		
Male	47.75	53
Female	52.25	58
Sex of Child T2 (N=73)		
Male	47.94	35
Female	52.05	38

Table 2.

Brief Operational Definitions, Examples, and Kappas (κ) for The Revised Relational Coding System (Fogel et al., 2003)

Type	Operational Definition	Example	Kappas Puzzle Task	Kappas Command Task	Kappas Interference Sequence
Symmetrical	Both members are engaged and contributing to the interaction. They modify their behaviours based on their interpretation of the cues of the partner.	The mother gives an instruction to the child, and s/he follows it.	0.96	0.93	0.85
Asymmetrical	Both members are engaged with a joint point of interest. Only one member of the dyad is actively contributing to the interaction, while the other passively observes.	The child watches the mother complete the puzzle while she explains to child how the pieces fit.	0.92	0.90	0.83
Unilateral	One member is engaged in the interaction. Their partner does not contribute to the interaction or ignores them.	The child works on the puzzle while the mother looks elsewhere.	0.91	0.92	0.82
Unengaged	Neither partner is engaged with the other.	The child plays on their own while the mother	0.88	0.85	0.88

		completes questionnaires			
Disruption	One member disrupts the activity of the other and fails to act in a manner that addresses the other member's expressions of displeasure.	The child does not want to do the puzzle and attempts to leave the play mat. The mother forcibly brings the child back while child becomes disrupted.	0.80	0.79	0.85

Table 3.

Means and Standard Deviations for Co-regulation Types in the Puzzle, Command, and Interference Tasks

Co-regulation Type	Puzzle Task	Command Task	Interference Task
	M(SD)	M(SD)	M(SD)
Symmetrical	93.71 (9.23)	93.26 (7.67)	18.41 (17.34)
Unilateral	3.25 (5.12)	4.44 (6.46)	14.37 (14.39)
Unengaged	2.52 (4.95)	2.13 (3.32)	66.19 (22.92)

Table 4.

Descriptive Statistics for Parenting Stress, Parenting Social Support, and Externalizing Behaviours at T1 and T2

Measure	M (SD)	Range
PSI Total T1	66.14 (17.77)	36.00-140.00
PSI Total T2	63.71 (20.58)	38.00-133.00
CBCL 2-3 Externalizing T1 (n = 45)	13.02 (7.22)	1.00-34.00
CBCL 4-18 Externalizing T1 (n = 48)	12.10 (6.88)	0.00-31.00
CBCL 4-18 Externalizing T2 (n = 70)	10.24 (8.13)	1.00-45.00
PSSI - Need for Social Support T1 (n = 106)	17.85 (5.16)	7.00-32.00
PSSI - Need for Social Support T2 (n = 68)	16.01 (4.87)	8.00-30.00

Table 5.

Correlations Between Co-regulation During the Puzzle Task, Parenting Stress, Parenting Social Support, and Externalizing Behaviours

Co-regulation Type	PSI – Total T1	PSSI – Need for Support T1	CBCL 2-3 – Externalizing T1	CBCL 4-18 – Externalizing T1	PSI – Total T2	PSSI – Need for Support T2	CBCL 4-18 Externalizing T2
Symmetrical	.020	-.242*	.020	.218	-.032	-.282*	.042
Unilateral	.014	.275**	-.052	-.097	.007	.268*	-.013
Unengaged	-.025	.052	.184	-.256	.037	.273*	-.055

*p <. 0.05, **p < .01, ***p < .001

Table 6.

Correlations Between Co-regulation During the Command Task, Parenting Stress, Parenting Social Support, and Externalizing Behaviours

Co-regulation Type	PSI – Total T1	PSSI – Need for Support T1	CBCL 2-3 – Externalizing T1	CBCL 4-18 – Externalizing T1	PSI – Total T2	PSSI – Need for Support T2	CBCL 4-18 – Externalizing T2
Symmetrical	.000	.029	-.141	.236	.030	.000	.083
Unilateral	-.018	-.028	.087	-.085	-.075	-.024	-.115
Unengaged	-.075	-.025	-.032	-.347*	-.070	.040	-.074

*p <. 0.05, **p < .01, ***p < .001

Table 7.

Correlations Between Co-regulation During the Interference Task, Parenting Stress, Parenting Social Support, and Externalizing Behaviours

Co-regulation Type	PSI – Total T1	PSSI – Need for Support T1	CBCL 2-3 – Externalizing T1	CBCL 4-18 – Externalizing T1	PSI – Total T2	PSSI – Need for Support T2	CBCL 4-18 – Externalizing T2
Symmetrical	.066	.027	.107	-.054	.069	.141	-.098
Unilateral	.018	-.051	.111	.019	-.018	-.059	-.084
Unengaged	-.118	-.008	-.215	.025	-.086	-.063	.096

*p <. 0.05, **p < .01, ***p < .001

Table 8.

Sex, Parenting Stress, Need for Support and Symmetrical Co-regulation During the Puzzle Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.466	.028	.440				
Sex				-.320 (.167)	-.157	-1.917 (83)	.059
PSI Total				.034 (.005)	.584***	6.894 (83)	<.001
PSSI – Need for Support				.020 (.017)	.098	1.155 (83)	.251
Symmetrical				.019 (.009)	.173*	2.097 (83)	.039

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 9.

Sex, Parenting Stress, Need for Support and Unilateral Co-regulation During the Puzzle Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495(86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.456	.019	.430				
Sex				-.330 (.169)	-.162	-1.947 (83)	.055
PSI Total				.034 (.005)	.589***	6.907 (83)	<.001
PSSI – Need for Support				.019 (.017)	.096	1.117 (83)	.267
Unilateral				-.027 (.016)	-.144	-1.707 (83)	.091

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 10.

Sex, Parenting Stress, Need for Support and Unengaged Co-regulation During the Puzzle Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.451	.014	.425				
Sex				-.287 (.168)	-.141	-1.706 (83)	.092
PSI Total				.035 (.005)	.598***	7.001 (83)	<.001
PSSI – Need for Support				.012 (.017)	.061	.727 (83)	.469
Unengaged				-.025 (.017)	-.119	-1.467 (83)	.146

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 11.

Sex, Parenting Stress, Need for Support and Symmetrical Co-regulation During the Command Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.441	.004	.414				
Sex				-.296 (.170)	-.145	-1.737 (83)	.086
PSI Total				.035 (.005)	.605***	7.019 (83)	<.001
PSSI – Need for Support				.012 (.017)	.062	.729 (83)	.468
Symmetrical				.008 (.011)	.064	.781 (83)	.437

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 12.

Sex, Parenting Stress, Need for Support and Unilateral Co-regulation During the Command Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.437	.000	.410				
Sex				-.291 (.172)	-.143	-1.696 (83)	.094
PSI Total				.035 (.005)	.602***	6.967 (83)	<.001
PSSI – Need for Support				.012 (.017)	.060	.702 (83)	.484
Unilateral				-.001 (.013)	-.005	-.059 (83)	.953

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient.

Table 13.

Sex, Parenting Stress, Need for Support and Unengaged Co-regulation During the Command Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.457	.020	.431				
Sex				-.250 (.169)	-.123	-1.474 (83)	.144
PSI Total				.035 (.005)	.593***	6.974 (83)	<.001
PSSI – Need for Support				.013 (.017)	.067	.804 (83)	.424
Unengaged				-.042 (.024)	-.142	-1.726 (83)	.088

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 14.

Sex, Parenting Stress, Need for Support and Symmetrical Co-regulation During the Interference Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.438	.001	.411				
Sex				-.292 (.171)	-.144	-1.711 (83)	.091
PSI Total				.035 (.005)	.602***	6.965 (83)	<.001
PSSI – Need for Support				.012 (.017)	.059	.702 (83)	.485
Symmetrical				.002 (.005)	.026	.312 (83)	.756

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 15.

Sex, Parenting Stress, Need for Support and Unilateral Co-regulation During the Interference Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711 (84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.440	.003	.413				
Sex				-.284 (.170)	-.140	-1.667 (83)	.099
PSI Total				.035 (.005)	.600***	6.956 (83)	<.001
PSSI – Need for Support				.012 (.017)	.061	.716 (83)	.476
Unilateral				.004 (.006)	.054	.661 (83)	.511

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 16.

Sex, Parenting Stress, Need for Support and Unengaged Co-regulation During the Interference Task Predicting Externalizing Behaviours at Time 1

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.067	.067	.057				
Sex				-.528 (.212)	-.260*	-2.495 (86)	.015
Step 2	.437	.370	.417				
Sex				-.290 (.170)	-.143	-1.711(84)	.091
PSI Total				.035 (.005)	.602***	7.009 (84)	<.001
PSSI – Need for Support				.012 (.017)	.060	.706 (84)	.482
Step 3	.441	.003	.414				
Sex				-.291 (.170)	-.143	-1.709 (83)	.091
PSI Total				.035 (.005)	.596***	6.884 (83)	<.001
PSSI – Need for Support				.012 (.017)	.060	.708 (83)	.481
Unengaged				-.003 (.004)	-.058	-.706 (83)	.482

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 17.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Symmetrical Co-regulation During the Puzzle Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.660	.005	.623				
Sex				-1.831 (1.344)	-.126	-1.362 (46)	.180
Externalizing Behaviours T1				2.212 (.832)	.313	2.660 (46)	.011
PSI Total T2				.189 (.041)	.514***	4.562 (46)	<.001

PSSI – Need for Support T2	.167 (.139)	.110	1.198 (46)	.237
Symmetrical	.052 (.067)	.073	.786 (46)	.436

Table 18.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Unilateral Co-regulation During the Puzzle Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.656	.001	.618				
Sex				-1.766 (1.369)	-.122	-1.290 (46)	.203

Externalizing Behaviours T1	2.343 (.816)	.332**	2.869 (46)	.006
PSI Total T2	.185 (.041)	.504***	4.474 (46)	<.001
PSSI – Need for Support T2	.154 (.143)	.102	1.077 (46)	.287
Unilateral	-.036 (.117)	-.029	-.309 (46)	.759

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 19.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Unengaged Co-regulation During the Puzzle Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.668	.013	.632				
Sex				-1.799 (1.317)	-.124	-1.366 (46)	.178

Externalizing Behaviours T1	2.172 (.812)	.307	2.676 (46)	.010
PSI Total T2	.190 (.041)	.516***	4.648 (46)	<.001
PSSI – Need for Support T2	.177 (.136)	.117	1.299 (46)	.200
Unengaged	-.147 (.110)	-.119	-1.338 (46)	.187

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 20.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Symmetrical Co-regulation During the Command Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.675	.020	.639				
Sex				-1.748 (1.301)	-.121	-1.344 (46)	.186

Externalizing Behaviours T1	2.285 (.792)	.324**	2.885 (46)	.006
PSI Total T2	.198 (.041)	.540***	4.836 (46)	<.001
PSSI – Need for Support T2	.167 (.133)	.110	1.254 (46)	.216
Symmetrical	.157 (.095)	.145	1.662 (46)	.103

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 21.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Unilateral Co-regulation During the Command Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.688	.033	.654				
Sex				-2.148 (1.291)	-.148	-1.664 (46)	.103

Externalizing Behaviours T1	2.239 (.776)	.317	2.885 (46)	.006
PSI Total T2	.195 (.040)	.530	4.909 (46)	<.001
PSSI – Need for Support T2	.173 (.130)	.114	1.328 (46)	.191
Unilateral	-.254 (.115)	-.187*	-2.206 (46)	.032

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 22.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Unengaged Co-regulation During the Command Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.656	.001	.618				
Sex				-1.761 (1.371)	-.121	-1.285 (46)	.205

Externalizing Behaviours T1	2.378 (.815)	.337**	2.920 (46)	.005
PSI Total T2	.184 (.042)	.502***	4.441 (46)	<.001
PSSI – Need for Support T2	.139 (.136)	.092	1.022 (46)	.312
Unengaged	.056 (.196)	.025	.284 (46)	.777

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 23.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Symmetrical Co-regulation During the Interference Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.660	.005	.623				
Sex				-1.430 (1.361)	-.099	-1.051 (46)	.299

Externalizing Behaviours T1	2.375 (.808)	.336**	2.939 (46)	.005
PSI Total T2	.188 (.041)	.513***	4.561 (46)	<.001
PSSI – Need for Support T2	.161 (.137)	.107	1.174 (46)	.246
Symmetrical	-.032 (.038)	-.075	-.833 (46)	.409

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 24.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Unilateral Co-regulation during the Interference Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.682	.027	.647				
Sex				-1.659 (1.286)	-.114	-1.290 (46)	.203

Externalizing Behaviours T1	2.390 (.782)	.338**	3.056 (46)	.004
PSI Total T2	.195 (.040)	.532***	4.868 (46)	<.001
PSSI – Need for Support T2	.131 (.131)	.087	1.006 (46)	.320
Unilateral	.082 (.042)	.166	1.967 (46)	.055

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Table 25.

Sex, Parenting Stress, Need for Support, Externalizing Behaviours at Time 1 and Unengaged Co-regulation During the Interference Task Predicting Externalizing Behaviours at Time 2

Predictor	R^2	ΔR^2	Adjusted R^2	*b (SE)*	β	*t (df)*	*p*
Step 1	.467	.467	.445				
Sex				-1.794 (1.609)	-.124	-1.115 (49)	.270
Externalizing Behaviours T1				4.458 (.784)	.631***	5.690 (49)	<.001
Step 2	.655	.188	.626				
Sex				-1.676 (1.324)	-.116	-1.265 (47)	.212
Externalizing Behaviours T1				2.365 (.805)	.335**	2.937 (47)	.005
PSI Total T2				.185 (.041)	.505***	4.521 (47)	<.001
PSSI – Need for Support T2				.140 (.134)	.093	1.042 (47)	.303
Step 3	.658	.003	.621				
Sex				-1.839 (1.359)	-.127	-1.354 (46)	.182

Externalizing Behaviours T1	2.338 (.812)	.331**	2.879 (46)	.006
PSI Total T2	.185 (.041)	.504***	4.486 (46)	<.001
PSSI – Need for Support T2	.126 (.137)	.083	.915 (46)	.365
Unengaged	-.018 (.029)	-.056	-.622 (46)	.537

Note. R^2 = amount of variance explained by the model in the current step, ΔR^2 = change in amount of variance accounted for by the model in comparison with the previous step, b = unstandardized regression coefficient, SE = standard error, β = standardized regression coefficient. *p <. 0.05, **p < .01, ***p < .001

Appendix A

Participants' Consent Form

"L'INDIVIDU DANS SON MILIEU: Les parents et leurs enfants"

Directeurs du projet: - Lisa A. Serbin, Ph.D.
- Dale M. Stack, Ph.D.
- Alex E. Schwartzman, Ph.D.

FORMULAIRE DE CONSENTEMENT

Je,_____, m'engage volontairement avec mon enfant, _____, à participer à l'étude "L'individu dans son milieu: Les parents et leur enfant" de l'Université Concordia. Les buts du projet m'ont été expliqués. L'étude comprend une série de questionnaires, une évaluation du fonctionnement intellectuel de mon enfant, ainsi que trois périodes de jeux lors desquelles nous serons observés et filmés. L'étude comporte deux sessions d'une durée maximale de 3 heures chacune et une rémunération totale de $50.00 me sera allouée aussitôt que les questionnaires seront remis. En signe de courtoisie, les résultats sommaires de l'évaluation de mon enfant me seront communiqués par téléphone. De plus, les chercheurs seront prêts à effectuer une ou deux visites additionnelles, au besoin, pour terminer l'évaluation, discuter de résultats problématiques, ou m'offrir un service de référence.

Je comprends que toutes les informations que nous fournissons, qu'elles soient écrites ou filmées, sont strictement confidentielles et qu'elles ne serviront qu'à des fins de recherche. Dans toutes les circonstances, je suis assuré(e) que l'anonymat sera conservé. Cependant, selon la loi sur la protection de la jeunesse, toute information indiquant de l'abus physique ou sexuel devra être divulguée à l'Office de la Protection de la Jeunesse.

Je comprends aussi que je suis libre de cesser notre participation à n'importe quel moment. Comme le projet "L'individu dans son milieu" est à long terme, je comprends que je pourrais être appelé(e) dans l'avenir pour participer à d'autres étapes de ce projet. Je me réserve le droit de décider, à ce moment, de donner suite ou non à la demande de participation.

Signature:_____

Nom:_____ Date:_____

Assistant(e) de recherche:_____