CAREGIVER-CHILD BEHAVIOURS IN THE IMMUNIZATION CONTEXT: BUILDING UNDERSTANDING THROUGH A PRESCHOOL ATTACHMENT LENS

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ABSTRACT

Research on how caregivers and young children interact during distressing situations through an attachment theory lens demonstrates that less optimal attachment patterns are linked with socio-emotional and biological challenges later in life. Owing to the high pain-related distress from needles, routine pediatric immunization appointments offer a unique opportunity to understand caregiver-child behaviours in an attachment context. To our knowledge, no study has examined both the longitudinal and concurrent relationship between caregiver-child behaviours in the vaccination context and preschool attachment outcomes. The present dissertation encompasses three cohesive studies that examine longitudinal and concurrent predictors of preschool attachment. Study 1 is a systematic literature review and meta-analysis (O'Neill et al., under review) that synthesizes the literature examining the longitudinal and concurrent relationships between a key element of caregiver behaviour during distress (caregiver sensitivity) and preschool attachment. Studies 2 and 3 (O'Neill et al, in press) examine healthy caregiver-child dyads during their 2-month infant (N = 84) vaccination appointments and 4-5 year preschool (N = 117) vaccination appointments (The OUCH Cohort). Study 2 examined the longitudinal relationship between caregiver behaviours (i.e., caregiver sensitivity, proximal soothing) and infant pain-related distress during infants' vaccinations with preschool attachment. Study 3 examined the concurrent relationship between caregiver sensitivity and preschooler pain-related distress during preschoolers' vaccinations and preschool attachment outcomes. In Study 1, both longitudinal and concurrent syntheses identified an overall finding that caregiver sensitivity was greater among caregivers of preschoolers with secure and organized attachments compared to insecure and disorganized attachments, respectively. Study 2 revealed that higher sensitivity across the appointment and greater proximal soothing at 1 minute pre-needle during infants' 2-

month vaccinations were associated with greater preschooler avoidance and less ambivalence, respectively. Moreover, pain-related distress at 2 minutes post-needle was associated with higher preschooler security. In study 3, higher caregiver sensitivity during preschoolers' vaccinations was related to higher preschooler attachment security. Findings from both quantitative studies suggest the acute pain context is an appropriate context to understand preschool attachment. Therefore, the vaccination context is a potential paradigm to implement future screening and intervention in order to promote secure preschool attachments.

DEDICATION

This dissertation is dedicated to all of the children and families who have participated in our research for 7 years. Thank you for your participation in our research and for sharing your lives with us. Your contributions have facilitated learning, growth, and an understanding for which we will forever be grateful.

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PUBLICATION DISCLOSURE

The works submitted in this dissertation are under review for publication (Chapter 2) and in press (Chapter 4). The manuscript citations are provided below.

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DISSERTATION SYNOPSIS

Maladaptive preschool attachments have been linked with development psychopathology outcomes (Groh, Roisman, van IJzendoorn, Bakermans-Kranenburg & Fearon, 2012). While a volume of studies have been conducted to better understand the longitudinal and concurrent factors (i.e., caregiver sensitivity) related to preschool attachment outcomes, no study to date has synthesized the literature. Additionally, in order to identify cost-effective ways to better understand preschool attachment outside of the laboratory, it is necessary to identify new paradigms in which to understand preschool attachment. Accordingly, there were three main objectives of the present dissertation: 1) To systematically review and meta-analyze the literature examining the longitudinal and concurrent association between caregiver sensitivity and preschool attachment; 2) To determine if caregiver and infant behaviours during a naturally occurring distress paradigm (i.e., infants' 2-months routine vaccination appointments) is longitudinally associated with preschool attachment outcomes; and 3) To determine if caregiver and preschooler behaviours during a naturally occurring distress paradigm at the end of early childhood (i.e., preschoolers' 4-5 year vaccination appointments) is concurrently associated with preschool attachment outcomes. A 2-page overview of the primary statistical findings for each of the three studies is provided in Appendix A, to aid in review of the entire dissertation work.

The first study in this dissertation is a systematic literature review and meta-analysis examining the longitudinal and concurrent associations between caregiver sensitivity and preschool attachment. Additionally, the review addresses how the heterogeneity in measurement of caregiver sensitivity impacts its relationship with preschool attachment, assesses the impact of study variability through moderator analyses, and systematically appraises the impact of study quality and statistical outcomes. Overall, the systematic review and meta-analysis revealed that

preschoolers with secure and organized attachments have caregivers with greater sensitivity compared to their respective insecure and disorganized counterparts.

The second and third studies were conducted using data from a longitudinal cohort (The OUCH Cohort) of healthy caregiver-child dyads who were followed during their routine vaccinations appointments across the first year of life and then followed-up at preschool. Data in Study 2 ($N = 84$) included caregiver (i.e., caregiver proximal soothing, caregiver sensitivity) and infant (i.e., infant pain-related distress) behaviours during infants' 2-month routine vaccination appointments who also had preschool attachment data obtained during a separate lab-based assessment at 4-5 years of age. Data in Study 3 ($N = 117$) included caregiver (i.e., caregiver sensitivity) and preschooler (i.e., preschooler pain-related distress) behaviours during preschoolers 4-5 year routine vaccination appointments who also had preschool attachment data. Hierarchical regression analyses were implemented for both Study 2 and Study 3 research aims.

The primary focus of Study 2 was to examine the longitudinal relationship between caregiver-infant behaviours during 2-month vaccinations appointments and preschool attachment outcomes. Results found that higher caregiver sensitivity across the duration of the vaccination appointment was significantly related to higher preschooler avoidance. Additionally, higher amounts of proximal soothing at 1-minute pre-needle during infants' 2-month appointments were associated with lower preschool ambivalence. In terms of infant behaviours, greater levels of pain-related distress at 2-minutes post-needle was related to higher security and lower disorganization and controlling-punitive attachment patterns.

The primary focus of Study 3 was to examine the concurrent relationship between caregiver-preschooler behaviours during the preschool vaccination appointments and preschool attachment outcomes. There was a significant relationship between caregiver sensitivity and

preschool security such that higher caregiver sensitivity during preschoolers' vaccination appointments was related to greater security during the separate lab-based assessment.

Overall, the finding across these three cohesive studies provide a significant contribution to both the broad attachment literature and within a clinical-developmental realm of understanding. For the first time in the literature, the systematic literature review provides a comprehensive understanding of both the longitudinal and concurrent link between caregiver sensitivity and attachment at the preschool age. The findings provide evidence that caregiver sensitivity is a critical point of focus when providing intervention to support healthy caregiver-child relationships. Building on this foundation in the developmental psychology literature, Studies 2 and 3 carefully extended current work in the field of pediatric pain by examining caregiver-child pain-related behaviours (during infancy and preschool) with preschool attachment outcomes. The analyses identified that infant-caregiver behaviours during infant vaccinations and caregiver sensitivity during preschoolers' vaccinations were both related to preschool attachment outcomes. Thus, over the three studies, this dissertation provides compelling evidence to recommend that routine vaccinations provide a valuable opportunity for health care providers to take the temperature of the caregiver-child relationship and use well-child visits to promote screening and early intervention.

Chapter 1: Introduction

Preschoolers' attachment to their primary caregiver is one factor that has been linked to developmental psychopathology outcomes (Groh, Roisman, van IJzendoorn, Bakermans-Kranenburg, & Fearon, 2012; Lecompte & Moss, 2014; Lecompte, Moss, Cyr, & Pascuzzo, 2014; Moss, Rousseau, Parent, St-Laurent, & Saintonge, 1998; Moss, Smolla, Cyr, Dubois-Comtois, & Mazzarello, 2006; O'Connor, Bureau, McCartney, Lyon-Ruth, 2011; Thompson, 2006). The research has identified patterns of attachment as a probable risk factor (i.e., disorganized attachment) or a protective factor (i.e., secure attachment) for the development of maladaptive behaviours (Deklyen & Greenberg, 2008). Deklyen and Greenberg (2008) assert that the narrow focus of ascertaining information through few validated attachment paradigms to inform developmental pathways of psychopathology has somewhat limited the elucidation of mechanisms in which attachment theory may inform our knowledge of psychopathology. As an alternative, the authors (Deklyen and Greenberg, 2008) propose that investigations focus on areas related to attachment (i.e.. early caregiving sensitivity, child emotion regulation) that may further our understanding of the processes involved in the development of later attachment outcomes. In accordance with this line of reasoning, the present dissertation will present a series of three cohesive papers in order to enhance current understandings of the relationship between early developmental factors (i.e., caregiver sensitivity) and preschool attachment through both a broad synthesis of the existing literature and through novel experimental analyses using an acute pain paradigm in which to understand these developmental processes.

Child Attachment

An infant's attachment to their primary caregiver serves the goal of increasing the likelihood of survival through promoting infant-caregiver proximity (Bowlby, 1969/1982). From

an evolutionary perspective, infant proximity to the primary caregiver would promote protection and survival (Bowlby, 1969/1982). When the child is separated from the primary caregiver the attachment system is activated and once the child obtains sufficient proximity the system is deactivated (Cassidy, 2008). Additionally, Bowlby identified two factors which serve to activate the attachment system (i.e., provoke proximity seeking behaviours): 1) child related conditions (i.e., illness, fatigue, hunger, pain); and 2) environmental conditions (i.e., the presence of a threatening or fearful stimuli; Cassidy, 2008). In accordance with the evolutionary roots of attachment, the infant will become attached to the primary caregiver regardless if the caregiver is meeting their needs (Cassidy, 2008). Moreover, the behaviours the child uses to promote proximity are context specific and will be modified with development as the child learns the most effective way to promote proximity at that moment (Cassidy, 2008). Across development, the infant develops 'internal working models' (Bowlby, 1973) which helps shape their ability to anticipate, interpret, and guide the way they behave and interact with their primary caregiver (Bretherton & Munholland, 2008).

Bowlby (1969/1982) identifies four phases in the development of attachment. The first phase is the "Orientation and Signals with Limited Discrimination of Figure" and it occurs approximately between birth and eight to twelve weeks. During phase one, the infant has a minimal ability to discriminate between individuals and is reliant on the caregiver to maintain proximity. The infant will engage in with another individual through orientation, eye tracking, grasping and reaching, and may minimize cries following the presence or voice of the caregiver. The second phase is the "Orientation and Signals Directed towards One (or More) Discriminated Figure" (Bowlby, 1969/1982). Phase two occurs between 12 weeks to six months of age and is marked by the infant's affinity for the primary caregiver (i.e., differentially responding to the

primary caregiver's voice or presence). The third phase is the "Maintenance of Proximity to a Discriminated Figure by means of Locomotion as Well as Signals" (Bowlby, 1969/1982), which occurs during six months until approximately after 1 year of age. Phase three is marked by the increase in discrimination between the primary caregiver and other individuals, as well as, developing a repertoire of responses to separation from the primary caregiver, reunion with the primary caregiver, and using the primary caregiver as a secure base to explore. Additionally, it is during this phase that the infant will become more wary of strangers. It is at this phase where Ainsworth, Blehar, Waters, and Wall (1978) reliability assessed patterns of attachments in infants using the Strange Situations Procedure (Marvin & Britner, 2008).

Finally, the fourth phase, "Formation of a Goal-corrected Partnership" (Bowlby 1969/1982) occurs in preschool (Marvin & Britner, 2008). In this phase, the child is able to have insight to their primary caregiver's feelings and goals (Bowlby 1969/1982), and able to engage in goal-corrected behaviour in order to maintain proximity to the caregiver (Marvin & Britner, 2008). Of note, Marvin (1977) suggests that during this phase there is less importance on physical proximity and more emphasis on maintaining shared goals (as cited in Marvin & Greenberg, 1982). The secure child who is able to maintain shared goals with their caregiver is able to understand the continuity of the relationship with the primary caregiver, regardless of proximity (Marvin & Greenberg, 1982). The fourth phase demonstrates a reorganization of the child's internal working model (Marvin & Britner, 2008) and underlies the sophistication and complexity of attachment patterns in preschoolers.

Phase four of the ontogeny of attachment is what predicates the development of the assessment of attachment in preschool. Akin to the system developed by Ainsworth and colleagues (1978), the Cassidy and Marvin (1992) and Main and Cassidy (1988) coding systems

were developed to reflect the developmental changes in the attachment system that occur in preschool and later childhood. Preschoolers are coded during a series of two separations and two reunions during the preschool separation-reunion procedure (Cassidy & Marvin, 1992), with a focus on how the child responds to their caregiver during the reunions. The Preschool Attachment Classification System (Cassidy & Marvin, 1992) identifies six separate patterns of attachment, each with their own subcategorizations, reflective of the intricate nature of preschoolers' behaviour toward their primary caregiver. Children classified as *secure* show a calm, comfortable, enjoyment at their caregiver's return, using their caregiver as a secure base to explore (Cassidy & Marvin, 1992). Children classified as *avoidant*, engage in behaviours which serve to avoid anything that will draw attention to the relationship with their caregiver (Cassidy & Marvin, 1992). Avoidant behaviours may be physical in nature (i.e., avoiding eye contact, physically turned away from the caregiver) or may be observed through parallel play and impersonal conversations. Children classified as *ambivalent* demonstrate immature behaviours (i.e., whiny, "baby talk", coyness) or direct anger and/or resistance toward the caregiver (Cassidy & Marvin, 1992). Children may also be classified as classified as *behaviourally disorganized/insecure-other*. Children classified as behaviourally disorganized show disordered sequencies, frozen or tense behaviours, incomplete movements, confusion, and depressed affect, whereas children classified as *insecure-other* display several insecure categories (i.e., avoidance and ambivalence) within and across reunions (Cassidy & Marvin, 1992). Children classified as having *controlling-punitive* or *controlling-caregiving* patterns of attachment both demonstrate patterns of role-reversal. The distinction is that children who are controlling-punitive direct hostility and punitive behaviours toward the caregiver, whereas controlling-caregiving children take it upon themselves to help, guide, or "cheer-up" the caregiver (Cassidy & Marvin, 1992).

While there are numerous systems that have been developed to assess attachment in preschool and middle childhood (i.e., Attachment Story Completion Task [Bretherton, Ridgeway, & Cassidy,1990], Preschool Assessment of Attachment [Crittenden, 1992]), the Cassidy and Marvin (1992) and Main & Cassidy (1988) systems are identified as the "gold standard" (Solomon & George, 2016) in which to assess preschool attachment. Of importance, Moss, Lecompte, and Bureau (2015) recently developed the Preschool Attachment Rating Scales (PARS), which is an extension of the Cassidy and Marvin (1992) coding system, through requiring the coder to rate each of the six categorizations of attachment on a scale. Specifically, the PARS (Moss et al., 2015), facilitates the application of a fine-grained continuous rating of preschoolers' attachment patterns to all six of Cassidy and Marvin's (1992) attachment categories (i.e., security, avoidance, ambivalence, behaviourally disorganized/insecure-other, controlling-punitive, controlling-caregiving).

The attachment reunion episodes are critical to assessing the child's relationship with their primary caregiver because it provides introspection as to how the child uses the parent to regulate from their distress, which is the essence of the attachment relationship. Moreover, Deklyen and Greenberg (2008) suggest that examining areas related to attachment may enhance our understanding of processes involved in the development of attachment outcomes. Accordingly, the next section will explore child emotion regulation as it occurs within the attachment relationship.

Child Emotion Regulation

Thompson (1994) defines emotion regulation as the "extrinsic and intrinsic process responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals" (p. 28). Within the context of

attachment theory, whereby a key tenet is that the child attempts to maintain proximity with the attachment figure, Thompson's definition suggests that children would aim to regulate their emotions in order to accomplish the goal of proximity (Cassidy, 1994). Accordingly, children's emotion regulation is informed by their attachment relationship with their primary caregiver through anticipation of the caregiver's sensitivity to their distress (Cassidy, 1994). Therefore, children's regulation behaviours to a distressing stimuli within the context of the child and caregiver dyadic relationship are central to our understanding of the attachment system.

Cassidy (1994) identifies different patterns of emotion regulation which may occur in infancy as they correspond to infant patterns of attachment and the sensitivity of their caregiver. When an infant perceives that they will receive a sensitive response to their distress from their primary caregiver, they are likely to signal their needs to their primary caregiver. Cassidy (1994) identified that infants receiving sensitive caregiving are less likely to express negative affect overall, but when a distressing stimulus it is experienced (i.e., separation in the Strange Situation Procedure) they will demonstrate active, open, and direct emotional expressions to obtain support (i.e., 'honest signalling' as cited in Barr, 1998). In contrast, infants who are classified as avoidant would likely minimize the expression of negative emotions (i.e., anger, sadness, or distress). The rationale for the minimization of emotional expression is based on the premise that the infants' bids for support have been continually ignored and therefore, outwardly expressing distress could risk the result of further proximity from the primary caregiver. Furthermore, it is presumed that the primary caregiver of infants classified as ambivalent have minimally or inconsistently responded to the infant in distress and thus, the infant may demonstrate heightened or exaggerated emotional distress in order to increase the likelihood of attaining attention and proximity to the primary caregiver. While Cassidy (1994) did not discuss emotion regulation in

response to disorganized patterns of attachment, the literature suggests that children with disorganized attachments have unpredictable patterns of emotional expression and difficulty regulating their emotions (Lyons-Ruth & Jacobvitz, 2008).

As described above, caregivers' patterns of sensitivity toward their child's distress shapes the child's expectations about how the caregiver will respond to their distress, informing the attachment relationship. Although both attachment and child emotion regulation are related to developmental psychopathology, caregiver sensitivity is a critical factor often studied as a predictor of the attachment relationship (Atkinson et al., 2000; Deans, 2018; De Wolf & van IJzendoorn, 1997; Goldsmith & Alansky, 1987; Koehn & Kerns, 2018; Zeegers, Colonnesi, Stams, & Meins, 2017) and has been identified as an important factor in better understanding the development of maladaptive attachments (Deklyen and Greenberg (2008). Accordingly, the next section begins to explore caregiver sensitivity as it is a central focus of the present dissertation.

Caregiver Sensitivity

From its inception, the construct termed *maternal sensitivity* has been linked with caregiver-infant attachments (Bretherton, 2013). Ainsworth's initial interest in the behaviour of caregivers began while examining mother-infant interactions through a 9-month study in Uganda (Bretherton, 2013). Although the primary focus of this study was the emergence of infant attachment, Ainsworth noted several patterns of maternal behaviours during interactions with infants (i.e., the quantity of maternal care provided, maternal excellence [mothers who demonstrate interest and attentiveness toward their child], and maternal enjoyment from breastfeeding; Bretherton, 2013; Levine, 1969). After completing her second observational study, Ainsworth began examining the mother-infant interactions in relation to their attachment groupings and the concept of maternal sensitivity emerged (Bretherton, 2013). Eventually,

Ainsworth's Maternal Care Scales were developed (1969), which included four separate scales: 1) sensitivity vs. insensitivity; 2) cooperation vs. interference with infants' ongoing behaviour; 3) physical and psychological accessibility vs. ignoring and neglecting; and 4) acceptance vs. rejection of the infant's needs. Importantly, Ainsworth (1969) identified four key components of maternal sensitivity: 1) awareness of the infant's signals; 2) accurate interpretation of the infants' signals; 3) appropriate responding to those signals; and 4) responding promptly to the infant's signals. Importantly, Ainsworth emphasized that observations of sensitivity were to examine the dyad or the relationship as a whole, as opposed to the mother's behaviour in isolation (Bretherton, 2013). Since the development of the Ainsworth Maternal Care Scales (1969), various measures have been developed to examine maternal and/or caregiver sensitivity and related constructs (Mesman & Emmen, 2013).

With the development of numerous measures to assess caregiver sensitivity, a wealth of literature has examined and identified a relationship between caregiver sensitivity and attachment through both experimental design (i.e. Ainsworth et al., 1978; Barnett, Kidwell, & Leung,1998; Bureau et al., 2014; De Schipper et al., 2012; Dexter, Wong, Stacks, Beeghly, & Barnett, 2013; Dobrova-Krol, Bakermans-Kranenburg, & van Ijzendoorn, 2010; McElwain & Booth-LaForce, 2006; McElwain, Holland, Engle, Wong, & Emery, 2015; Mills-Koonce, Gariepy, Sutton, & Cox, 2008; Moss, Bureau, Cyr, Mongeau, & St-Laurent, 2004; Pederson et al., 1990; Smith & Pederson, 1988; Stevenson-Hinde, Chicot, Shouldice, & Hinde, 2013) and through reviews that synthesize decades of research (Atkinson et al., 2000; Deans, 2018; De Wolf & van IJzendoorn, 1997; Goldsmith & Alansky, 1987; Koehn & Kerns, 2018; Zeegers et al., 2017). Despite the abundance of literature linking caregiver sensitivity to attachment, the literature to date has not synthesized research specifically examining links between caregiver

sensitivity and attachment measured in preschool. As aforementioned, preschool is an important developmental stage related to understanding attachment and links to developmental psychopathology (Groh et al., 2012). Moreover, since the earliest studies linking caregiver sensitivity to attachment outcomes (i.e., Ainsworth et al., 1978), researchers have failed to identify a relationship between caregiver sensitivity and attachment security of the magnitude (i.e., $r = .78$, Cohen's $d = 2.55$; effect sizes cited in Goldman & Alansky, 1987) that Ainsworth and colleagues (1978) identified (Meins, 2013). Meins (2013) proposes that perhaps this is a result of moving away from Ainsworth's original in-home assessment of maternal sensitivity to brief laboratory examinations. This emphasizes the importance of considering more naturally occurring and less-contrived distress paradigms in which to understand the relationship between caregiver sensitivity and preschool attachment.

The first half of this chapter has focused on the broader theory involving child attachment, the relevance of child emotion regulation as it is central to attachment theory, and sensitivity as a key contributing factors to the development of the attachment relationship. Accordingly, the latter half of this chapter will now shift to a different paradigm which this dissertation proposes can be understood within an attachment framework. The chapter now demonstrates how attachment theory supports the use of an acute pain paradigm as a context in which to understand preschool attachment. First, will be a review of attachment theory as it relates to the acute pediatric pain paradigm, and following will be a review of the literature to date examining the relationship between behaviours in the pediatric pain context and attachment outcomes. Finally, the chapter will end with a brief recapitulation of the goals of the current dissertation.

Attachment Theory: The Application to the Acute Pain Paradigm

The attachment paradigm and assessment of related constructs is most often laboratory focused, which for ethical reasons, necessitates the use of a low to moderate distress paradigm. However, Bowlby (1969/1982) identifies that a high or acute distress experience of a child (i.e., pain, illness) are those which are likely to activate the attachment system. Moreover, Deklyen and Greenberg (2008) suggest that examining concepts such as child emotion regulation within the caregiver-child dyad and caregiver sensitivity will elucidate our understanding of the development of attachment and later developmental psychopathology. Paralleling key tenets of attachment theory to the caregiver and child dyadic processes which occur within a naturally-occurring acute distress paradigm (i.e., routine pediatric vaccinations) facilitates the identification of a plausible way to better understand attachment. Linking the potential way in which caregiver and child behaviours during the pediatric acute pain paradigm relate to child attachment outcomes, could facilitate a cost-effective way to implement screening and early intervention for maladaptive child-caregiver relationships during routine well-baby visits.

As aforementioned, attachment theory posits that the attachment system serves the primary goal of increasing proximity to the caregiver during a time of distress in order to promote survival (Bowlby 1969/1982) and the attachment system becomes activated when the child experiences various stressful conditions (i.e., pain, illness, etc.). Within this realm of understanding, an infant's or child's pain incurred by a routine vaccination (i.e., a needle) should induce pain, thereby activating the infant or child attachment system and promoting increasing proximity to the primary caregiver to obtain support.

Similar to the notion that child regulation is a reflection of the infant's or child's patterns of attachment as it demonstrates how the infant or child uses the caregiver to regulate from distress in a reunion episode, infant and child regulation can be examined withing the

vaccination paradigm through examining pain-related distress behaviours that the infant or child uses to obtain support from the primary caregiver. Within the vaccination context researchers (Goubert et al., in press; Pillai Riddell, Racine, Craig, & Campbell, 2013) have differentiated between the phases of reactivity (i.e., the infant's or child's immediate behavioural responses to the needle) and regulation (i.e., subsequent behavioural responses to the needle aimed at bringing the infant or child back to homeostasis). A re-examination of Cassidy's (1994) description of patterns of emotion regulation as they relate patterns of attachment provides some introspection about pediatric regulation within an acute pain paradigm. During the reactivity phase, immediately following the needle, one would not necessarily expect that attachment theory would inform differences in pain expression as this is the phase of the appointment that infants and children may be experiencing peak distress (O'Neill, Ahola Kohut, Pillai Riddell, & Oster, 2019). In contrast, attachment theory may shed light on differences in the regulatory patterns of behaviour during the regulation phase of the appointment. A secure infant or child may engage in pain-related distress behaviours that openly reflect their internal state communicated to the caregiver. Alternatively, an avoidant infant or child may minimize the expression of pain-related distress behaviours in order to prevent further proximity to the caregiver. Moreover, an ambivalent infant or child may overemphasize pain-related distress behaviours in order to increase the probability of obtaining proximity to the caregiver. Finally, infants or children with disorganized patterns of attachment may demonstrate unpredictable patterns of pain-related distress during the regulatory phase.

Additionally, as patterns of regulation and related patterns of attachment do not develop in isolation, it is also important to consider how caregiver factors (i.e., caregiver sensitivity) may relate to the infant's and child's behaviours within the acute pediatric pain paradigm. The

vaccination context facilitates an examination of how the primary caregiver may respond to an infant or child in pain. Using Ainsworth et al.'s (1969) operationalization of caregiver sensitivity as a framework, one can consider the caregiver's awareness of infant's or child's signals of pain (i.e., pain-related distress), the caregiver's accurate understanding of what those pain-related behaviours are signalling, the caregiver's appropriate response to the infant's or child's pain-related distress behaviours, and also the timeliness at which the caregiver responds. Past research findings that caregiver responses are related to infant and child pain-related behaviours within the vaccination context (Campbell, Pillai Riddell, Cribbie, Garfield, & Greenberg, 2018; Pillai Riddell et al., 2011; Racine et al., 2016), support the application of Ainsworth's operationalization of sensitivity to the pediatric paradigm. Moreover, owing to the theory that early child experiences with sensitive versus insensitive caregiver responding may shape a child's internal working models of the world (Bowlby, 1973), caregiver sensitivity during routine vaccination appointments may be an important factor for predicting subsequent attachment outcomes.

A final component of attachment theory which warrants the use of the pediatric acute pain paradigm in order to understand attachment is with regards to Bowlby's (1969/1982) stages of attachment. This discussion will focus on Bowlby's (1969/1982) first and fourth phases as they relate to the phases of development examined in the pediatric pain paradigm (i.e., infants' 2-month vaccinations and preschoolers' 4-5 year vaccinations) for the present dissertation. During the first phase (i.e., "Orientation and Signals with Limited Discrimination of Figure"; Bowlby 1969/1982) the infant minimally discriminates between the caregiver and other individuals, and may reduce cries as a response to the caregiver. However, the infant is largely reliant on the caregiver to maintain proximity (Marvin & Britner, 2008). Reflecting on this stage in relation to

the pediatric pain context, one may expect that the infant will signal to communicate their internal states (i.e., 'honest signalling' as cited in Barr, 1998), but the infant is also highly reliant on the caregiver for proximity. Moreover, during this phase the infant and caregiver relationship is in very early stages of development, and thus the infant may not demonstrate attachment-related patterns of regulation. Furthermore, the caregiver may still be developing a schema of appropriate responses to the infant in distress. The final phase (i.e., "Formation of a Goal-corrected Partnership"; Bowlby 1969/1982) occurs in preschool (Marvin & Britner, 2008) when the child is able to complete goal-corrected behaviours in order to maintain proximity. Similar to infancy, attachment patterns (Cassidy & Marvin, 1992; Main & Cassidy) during this phase may inform patterns of regulation in the pain context, but it is important not to overlook the nuances of these patterns given the sophistication of this developmental stage. With consideration of the Main and Cassidy (1988) and Cassidy and Marvin (1992) attachment categories, children's patterns of regulation examined through pain-related distress may differ compared to that of infancy. Specifically, pain-related distress behaviours may occur in conjunction with other strategies that the child may implement in order to regulate their distress (i.e., verbal communication to the primary caregiver, use of other strategies such as distraction or deep-breathing), as well as behaviours that are impacted by broader psychosocial factors (i.e., temperament, previous experiences of distress during medical procedures, familial expectations about how to behave when in pain; Blount, Bunke, & Zaff, 2000a, 2000b; Blount, Piira, & Cohen, 2003; Manimala, Blount, & Cohen, 2000; Varni, Blount, Waldron, & Smith, 1995). In contrast, with regards to caregiver behaviours (i.e., sensitivity), one would expect that through the strengthening of the caregiver and child relationship overtime, and repeated exposure to the

caregiver responding, sensitivity in the preschool vaccination would have a stronger relationship to child attachment outcomes.

Overall, attachment theory informs the rationale for the examination of caregiver and infant or child behaviours within an acute pain paradigm as it relates to attachment outcomes. As follow-up to this discussion, the subsequent section will examine past research which has examined the relationship between caregiver behaviours and child pain behaviours within a pediatric pain paradigm as they relate to measures of attachment. Examining the relevant literature will identify current knowledge and potential gaps in the literature, informing further direction for research within this dissertation.

Caregiver-Child Behaviours in the Vaccination Context and Attachment: Past Findings

Past research providing evidence for a relationship between infant or child vaccination pain behaviours, caregiver sensitivity, and child attachment offer guidance for the directions of the present dissertation and are reviewed herein (Favez & Berger, 2011; Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996; Hillgrove-Stuart. Pillai Riddell, Flora, Greenberg, & Garfield, 2015; Horton, Pillai Riddell, Flora, Moran, & Pederson, 2015; Horton, Pillai Riddell, Moran, & Lisi. 2016; Pritchett, Minnis, Puckering, Rajendran, & Wilson, 2013; Walsh, McGrath, & Symons, 2008). However, very few studies have examined the relationship between child pain-related distress in the vaccination context and attachment. Most of the literature to date has focused on the relationship between *infant* vaccination pain behaviours and *infant attachment* (Favez & Berger, 2011; Gunnar et al, 1996; Horton et al., 2015).

Infant pain and infant attachment. Several studies have examined the relationship between infant pain in the vaccination context and infant attachment. Gunnar et al. (1996) reported a non-significant relationship between pain behaviours during infants' 2-, 4-, and 6-

month vaccinations and infants' 18-month attachment measured using the Strange Situation Procedure (SSP; Ainsworth & Wittig, 1969). In contrast, when Favez and Berger (2011) developed a specific coding system (Paediatric Attachment Style Indicator) to code infant attachment (i.e., ambivalent, avoidant, and secure categorizations) during toddlers' (15 to 25 months of age) vaccinations, they found that secure infants demonstrated less pain-related distress across the vaccination appointment compared to ambivalent infants. More recently, Horton et al. (2015) investigated the relationship between infants' pain-related distress at their 12-month vaccination and subsequent measures of infant attachment at 12 to 18 months using the SSP (Ainsworth, et al., 1978). Horton and colleagues (2015) reported that, before the needle, avoidant infants exhibited less anticipatory distress than secure infants. However, infants' temperamental fear moderated the relationship between attachment and pain-related distress regulation. When infants had high temperamental fear, avoidant infants exhibited slower pain regulation (i.e., they demonstrated pain for a longer duration) than secure infants. In contrast, when infants had lower temperamental fear, secure infants demonstrated slower pain regulation relative to avoidant and disorganized infants. Although the finding that secure infants demonstrated slower pain-regulation seems counterintuitive, it is understood within knowledge of infant pain research and attachment theory. A key tenet of attachment theory is that a secure infant who has experienced consistent sensitive and responsive caregiving will seek support during times of distress (Bretherton, 2005) and engage in 'honest signalling' (as cited in Barr, 1998). Thus, if the infant continues to experience pain, the signalling should also continue (in normative, healthy child contexts).

Preschool pain and preschool attachment. The research specific to preschool vaccination pain and preschool attachment should also inform the working models of the present

study. To our knowledge, Walsh and colleagues (2008) are the only researchers that have examined the relationship between *preschool* vaccination pain behaviours and *preschool* attachment outcomes. The researchers (Walsh et al., 2008) aggregated several measures (i.e., Separation Anxiety Test [Klagsbun & Bowlby, 1976; Slough & Greenberg, 1990]; Pain and Relationship Task [Walsh, Symons, & McGrath, 2004]; Parent/Child Reunion Inventory [Marcus, 1998]; Emotion Regulation Checklist [Shields & Cicchetti, 1995]) to create overall dimension scores on four categories of preschool attachment (i.e., security, avoidance, ambivalence, and controlling). Walsh et al. (2008) reported that preschoolers with greater levels of ambivalence or controlling attachment had greater behavioural expressions of needle pain. Moreover, preschoolers with greater controlling attachments, demonstrated slower pain regulation following the needle. In contrast, the security and avoidance dimensions of attachment were not significantly related to preschooler vaccination pain behaviours. Although this research provides a foundation to understand the relationship between preschool vaccination pain and preschool attachment, the use of an aggregate measure interferes with the knowledge of which operationalization of attachment is most related to preschoolers' needle pain. Moreover, the overall control category prevents an understanding of how preschooler pain may vary between controlling-punitive and controlling-caregiving patterns of attachment.

Caregiver behaviours in the infant pain context and infant attachment. The relationship between caregiver sensitivity to infants' pain-related distress and infant attachment has also been examined. For example, Gunnar et al., (1996) found that maternal responsiveness during infants' 2-, 4-, and 6-month vaccinations was greater among infants who were secure versus insecure at 18-months. Favez and Berger (2011) found that caregivers of toddlers (15 to 24 months) who were insecure-ambivalent showed more distress promoting behaviours in the

vaccination setting than caregivers of toddlers with secure or insecure-avoidant attachment classifications. Furthermore, Hillgrove-Stuart and colleagues (2015) reported that caregivers of infants with secure or organized attachments, when measured using the SSP (Ainsworth et al., 1978), were more likely to exhibit proximal soothing behaviours for longer amounts of time after their infants' vaccinations.

Caregiver behaviours in the pain context and preschool attachment. In terms of the literature examining caregivers' behaviours toward their children's pain-related distress and attachment in childhood, only one study has been completed to date (Pritchett al., 2013). The authors employed the Manchester Child Attachment Story Task (Green et al., 2000) in order to measure children's (4-8 years) patterns of attachment, and assessed for the presence and absence of caregivers' pain promoting and reducing behaviours during the vaccination (Chambers et al., 2002). The results revealed that caregivers of secure preschoolers were more likely to employ pain reducing behaviours relative to caregivers of insecure preschoolers. Although this study provides a framework to understand the relationship between caregiver sensitivity in the vaccination context and preschool attachment, it is limited by a small sample size (n = 18) and therefore preschoolers were only assigned to one of three categorizations (i.e., secure, avoidant, disorganized).

The Current Dissertation

Although several studies have synthesized the literature examining the relationship between caregiver sensitivity and attachment, no research to date has specifically examined the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment measured using the "gold standard" (Solomon & George, 2016) Cassidy and Marvin (1992) and Main and Cassidy (1988) behavioural coding systems. Moreover, most studies examining

longitudinal and concurrent relationships between caregiver sensitivity and preschool attachment have assessed caregiver sensitivity in a contrived laboratory paradigm with low to moderate stress-inducing tasks (i.e., free play, mild frustration). There are currently no studies that have examined both the longitudinal and concurrent relationship between caregiver sensitivity in an acute pain-related distress paradigm (i.e., routine vaccination) and preschool attachment. Moreover, perhaps partially owed to small sample sizes, studies have not examined the relationship between caregiver-child vaccination behaviours and all six preschool attachment categories, minimizing the sophistication of patterns of attachment in preschool. The implementation of the Preschool Attachment Rating Scales (PARS; Moss et al., 2015), an extension of the "gold standard" (Solomon & George, 2016) Cassidy and Marvin (1992) system, would allow for a fine-grained continuous assessment of preschoolers' attachment on all six of the Cassidy and Marvin (1992) categories.

In addition to examining caregiver sensitivity in this context, the acute pain-related distress paradigm also offers an opportunity to understand the dynamic nature of infant's and child's initial distress and regulation of that distress in relation to a subsequent assessment of preschool attachment. Investigating these novel relationships would not only facilitate an examination of how caregiver and child factors in a naturally occurring acute distress paradigm are longitudinally and concurrently related to preschool attachment, but it would broaden our understanding of the use of routine vaccination appointments as a paradigm in which to provide early screening and intervention to support healthy caregiver-child relationships. Accordingly, three cohesive studies were completed in the current dissertation in order to address these important gaps in the literature.

Study 1 is a systematic literature review and meta-analyses that was conducted in order to synthesize the literature examining the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment measured using the Main and Cassidy (1988) and Cassidy and Marvin (1992) coding systems (Chapter 2; O'Neill et al., under review). Study 2 is a longitudinal examination of the relationship between caregiver-infant behaviours during routine vaccination appointments in early infancy (2-months) and preschool attachment (Chapter 4; O'Neill et al., in press). Study 3 is a concurrent examination of the relationship between caregiver-preschooler behaviours during routine vaccination appointments at the end of early childhood (4-5 years) and preschool attachment (Chapter 4; O'Neill et al., in press).

Of note, Chapter 4 (Study 2 and Study 3) is the author version of the extended manuscript that has been accepted for publication in the journal *PAIN.* For the purpose of this dissertation the studies are referred to as Study 2 and Study 3, but within the accepted manuscript they are identified as Study 1 and Study 2. Chapter 3 is a bridging chapter which links the systematic literature review (Chapter 2) to the analyses paper (Chapter 4), and Chapter 5 provides a final concluding chapter for the overall synthesis of this dissertation. As aforementioned, to support the synthesis of all three studies for readers, Appendix A provides a brief two-page summary of all the main results in the dissertation. Moreover, Appendix B through D provides further information pertaining to the systematic review and meta-analysis (Chapter 2), and Appendix E through F provides further information pertaining to Study 2 and Study 3 (Chapter 4).

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Chapter 2: The Longitudinal and Concurrent Relationship Between Caregiver Sensitivity and Preschool Attachment: A Systematic Review and Meta-Analysis[1]

Introduction

The relationship between preschool attachment and mental health

Mental health disorders occur in approximately 10-20% of children and adolescents across the globe, with 50% of mental health difficulties beginning by early adolescence and 75% occurring by early adulthood [1]. Early prevention and treatment is imperative for improving developmental psychopathology across the lifespan. In order to develop programs targeting early mental health prevention, it is essential to identify and understand potential risk factors of child mental health. Early maladaptive attachment to the primary caregiver is one risk factor that has been linked with psychological disorders in childhood [2,3,4]. However, in order to improve child attachment and accordingly mental health, it is necessary to elucidate how and why these attachment difficulties may develop. A caregivers' sensitivity toward their child is one factor that has been proposed as a potential predictor of child attachment [5]. A review of the literature investigating the intricate relationship between caregiver sensitivity and preschool attachment is necessary to work toward understanding potential mechanisms of improving attachment issues and mental health from childhood through adulthood.

Preschool attachment

Bowlby [6] postulated that early experiences with attachment figures shape children's internal working model of the world. With repeated exposure to a sensitive and responsive attachment figure, children learn to explore the world with confidence and obtain support when

[1] This paper is currently under review in PLOS One and cited below:
O'Neill, M. C., Badovinac, S., Pillai Riddell, R., Bureau, J-F., Rumeo, C., & Costa, S. (under review). The longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment: A systematic review and meta-analysis.

necessary, thereby developing working models of a secure self, a caring attachment figure, and the world as nonthreatening [7]. Alternatively, with repeated exposure to an insensitive caregiver, children see the world as unreliable, and unpredictable.

The Ainsworth, Blehar, Waters, and Wall [8] system of attachment established the classification of infants' attachment to their primary caregiver using the lab-based separation-reunion procedure. Although several measures have been developed to assess attachment in preschool and early childhood, the dominant approach most akin to Ainsworth and colleagues' [8] system is that which assumes stability in attachment from infancy through to childhood [9]. In accordance with this theoretical approach, Main and Cassidy [10] developed the classification system for 6-year-olds, whereas Cassidy, Marvin, and the MacArthur Working Group [11] modified this system for preschoolers (2.5- to 4.5-years-old).

The Cassidy and Marvin [11] and Main and Cassidy [10] coding systems specify that preschoolers and young children may be classified according to one of six attachment classification patterns including; secure, avoidant, ambivalent, disorganized and/or insecure-other, controlling-caregiving, and controlling-punitive [10,11]. Children with a secure attachment pattern demonstrate a calm and comfortable enjoyment with the caregiver, using the caregiver as a secure base to explore their environment [11]. Children with an avoidant attachment pattern demonstrate an attempt to maintain neutrality by avoiding physical and emotional interactions that may bring attention to the child-caregiver relationship [11]. Children classified with an ambivalent attachment pattern may emphasize dependency on the caregiver through immature behaviours (e.g., "baby talk"), or they may demonstrate resistant behaviours through moderate anger, resistance, or avoidance [11]. Children classified with a disorganized and/or insecure-other attachment pattern may demonstrate disordered temporal sequences,

incomplete movements, confusion and apprehension, disoriented expressions, or depressed affect [11]. Children classified with a controlling-caregiving attachment pattern may demonstrate a desire to guide, orient, or cheer-up the parent, whereas children with a controlling-punitive attachment pattern may demonstrate punitive or hostile behaviours toward the parent [11].

Owed to the decades of literature resulting from the development of this system, and only one other existing related review ([12]; focusing solely on maternal depression and preschool attachment) synthesizing these systems, the present review focused exclusively on studies employing the Main and Cassidy [10] and Cassidy and Marvin [11] coding systems. Investigating the relationship between multiple aspects of maternal behaviour and infant attachment, Ainsworth and colleagues [8] first identified maternal sensitivity as the *most important* predictor of infant attachment. Given the available literature almost exclusively explored maternal sensitivity, rather than paternal sensitivity, the current review primarily focused on maternal sensitivity. However, we note a recent surge of studies on father-child attachment [13,14,15], suggesting that reviews focusing more on paternal sensitivity may be warranted in the future.

Operationalizing maternal sensitivity

A construct that has been identified as integral to the development of secure attachment is maternal sensitivity [16,17]. Key tenets of maternal sensitivity include attunement to the infant's signals, correct interpretation of the infant's perspective and communicated needs, and prompt and appropriate responding [16]. Since the development of Ainsworth and colleagues' [16] original sensitivity scale and other Maternal Care scales, additional measures have been developed to assess caregivers' sensitivity toward their infants and young children [18].

In a recent systematic review of behavioural measures developed to assess caregiver sensitivity, Mesman and Emmen [18] completed an in-depth analysis of eight instruments aimed at assessing caregiver sensitivity in comparison to Ainsworth et al.'s [16] original construct. Among the eight measures examined, only three employed a single global rating of sensitivity similar to Ainsworth et al.'s [16] original sensitivity scale [18]. In contrast to Ainsworth et al.'s [16] sensitivity scale which involves a global judgement of sensitivity, the remaining five measures required the summation of several scales to create a combined score representing sensitivity and other related behaviours (e.g., warmth, positive affect). Mesman and Emmen [18] propose that one way to advance our comprehension of the intricacies of maternal sensitivity as a construct, is to examine the contribution of a single global assessment of sensitivity in comparison to a composite assessment of sensitivity and related constructs. Accordingly, the primary focus of the present review was to examine the relationship between sensitivity and preschool attachment, according to whether the reviewed studies implemented caregiver sensitivity as a unidimensional measure (i.e., assessed caregiver sensitivity using a single scale), or a multidimensional measure (i.e., assessed caregiver sensitivity by combining multiple constructs).

Maternal sensitivity and attachment: previous reviews

Since Ainsworth and colleagues' original study [8], several systematic reviews have been completed aiming to synthesize the literature examining the relationship between caregiver sensitivity and attachment [5,19,20,21,22,23].

In the first synthesis of this body of literature, Goldsmith and Alansky [21] identified a small relationship between caregiver sensitivity and infant attachment. In contrast, a decade later, De Wolff and van IJzendoorn [5] updated this literature and identified a medium effect across

studies examining maternal sensitivity and infant attachment. More recent reviews have replicated these findings, again reporting a medium effect for the relationship between sensitivity and infant attachment [19,23]. Moderating effects have also been reported such that the strength of the relationship between maternal sensitivity and infant attachment was greater when infants were from middle class families compared to lower class families, or when infants were older at the time of the attachment assessment [5].

Syntheses have also been completed for the literature examining the relationship between caregiver sensitivity and attachment in children and adolescents [20,22]. However, one of the studies [20] did not complete a meta-analytic synthesis and reviewed a combination of studies involving infant and child attachment. Whereas, the other study [22] completed a meta-analytic review of studies examining sensitivity and attachment from early childhood to adulthood, eliminating the preschool age. A gap in the literature exists in terms of the research specifically examining the relationship between caregiver sensitivity and preschool attachment. Furthermore, with approximately three decades of research since the inception of the Cassidy and Marvin [11] and Main and Cassidy [10] attachment coding systems, there is a wealth of literature to be synthesized in terms of the relationship between caregiver sensitivity and preschool attachment employing these systems. Additionally, given the parallels between Ainsworth et al.'s [8] original classification system and the preschool systems [10,11], it will be important to meta-analytically investigate how the strength of the relationship between caregiver sensitivity and preschool attachment compares to past syntheses of caregiver sensitivity and infant attachment [5,19,21,23]. Moreover, in order to maintain consistency and comparability to the previous related meta-analytic reviews noted above, the present review also implemented several relevant moderator variables (e.g., normative vs. clinical/risk populations, child age, child gender,

socioeconomic status) to determine how these factors may impact the strength of the relationship between caregiver sensitivity and preschool attachment.

The current study

The overarching aim of the present study was to synthesize and meta-analyze the literature examining the concurrent and longitudinal relationship between caregiver sensitivity and preschool attachment measured using the Cassidy and Marvin [11] and Main and Cassidy [10] coding systems. Given the heterogeneity in measurement of caregiver sensitivity, the literature was subdivided by the operationalization of caregiver sensitivity. Specifically, studies were either identified as employing a unidimensional measure of caregiver sensitivity (e.g., examining one aspect of caregiver sensitivity using a single rating of caregiver sensitivity), or a multidimensional measure of caregiver sensitivity (e.g., examining several aspects of the sensitivity of a caregiver by combining multiple ratings such as sensitivity, intrusiveness, warmth, etc.). Additionally, the effect of moderator variables on the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment was examined through meta-regression analyses. Consistent with previous related meta-analyses of caregiver sensitivity and child attachment [5,19,22,23], moderator variables included sample demographics (e.g., normative vs. clinical/risk populations, child age, child gender, socioeconomic status) and study quality.

In accordance with the past literature, we predicted to identify a medium effect between caregiver sensitivity and preschool attachment. Additionally, we predicted that the effect sizes would be relatively larger when caregiver sensitivity was measured proximally closer to the measurement of preschool attachment (e.g., concurrent associations) compared to when caregiver sensitivity was measured at an earlier developmental period in relation to preschool

attachment (e.g., longitudinal associations). Furthermore, owing to the fact that a multidimensional measure of caregiver sensitivity would encompass a greater number of aspects of caregiver sensitivity (e.g., nonintrusiveness, warmth, etc.), we predicted that the association between caregiver sensitivity and preschool attachment would have a relatively smaller effect size for the literature employing a unidimensional measure of caregiver sensitivity versus a multidimensional measure of caregiver sensitivity. In terms of the implemented moderator variables, we predicted that studies with greater age at assessment of attachment, middle/high socioeconomic status, normative samples, and a higher quality would be associated with a stronger relationship between caregiver sensitivity and preschool attachment. We did not have specific predictions for the moderating effect of gender given the lack of evidence for the moderating effect of this variable in previous related meta-analyses [5,22]. However, we chose to include child gender in the moderator analyses due to past associations that have been identified between child gender with both maternal sensitivity and preschool attachment [24].

Methods

Search strategy

A systematic electronic literature search was completed with the assistance of an academic librarian from the Hospital for Sick Children, Toronto, Ontario, Canada. The search was conducted using four different electronic search engines (Medline, Embase, PsycINFO, and CINAHL), and was last updated on April 20, 2020. To facilitate a broad search from inception, there were no initial limitations on language or publication date. Search terms were identified through key terms related to the Preschool Attachment Classification System (PACS; [11]) and key terms within the title and abstracts of relevant articles employing the classification systems for coding preschool attachment [10,11]. Search terms were systematically paired that were

related to the construct of *attachment,* the classification systems for coding preschool attachment [10,11], and children between 2-7 years of age. Search terms and pairings for the electronic search engine are provided in Appendix B.

The present review followed an a priori protocol using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA guidelines; [25]). Review protocol was registered before data extraction on the PROSPERO Website (Registration Number CRD42017073417; [26]).

Inclusion/exclusion criteria

Studies were included if they a) examined caregiver sensitivity, b) examined preschool attachment using the specified preschool attachment classification systems [10,11] among children who were over 2 years and up to 7 years of age, and c) examined the concurrent or longitudinal relationship between caregiver sensitivity and preschool attachment. Abstracts that did not clearly identify either the age at which attachment was measured or the type of measurement used to examine attachment were set aside for full-text review if: 1) they were authored by individuals identified to contribute to the development of the PACS manual [11]; 2) key authors in the field of child attachment; and 3) studies completed using National Institute of Child Health and Development (NICHD) data (see Appendix C).

Studies were excluded if they were not in English or French. Studies were also excluded if they were published pre-1985 because 1985 was the earliest documented reference to the Main and Cassidy preschool coding system [27]. Moreover, studies were excluded if they examined nonhuman attachment, did not examine attachment, examined attachment with children outside of the required age range (i.e., less than or equal to 2 years of age or older than 7 years of age), or if they were review articles, commentaries, abstracts, case studies, or dissertations. Articles

examining attachment with children in the specified age range were excluded if they measured preschool attachment using a different procedure (e.g., Attachment Story Completion Task; [28] or employed a different coding system (e.g., Preschool Assessment of Attachment [PAA]; [29]). The decision to exclude the PAA coding system was based on the low correlation identified between Cassidy and Marvin's [11] and Crittenden's [29] preschool coding systems [30].

Study selection

The systematic electronic literature search yielded a total of 16, 807 abstracts. The lead author and senior author designed the abstract selection criteria. After removing duplicates, the electronic search identified 9, 312 articles. Four independent reviewers screened the titles and abstracts that were included or excluded in accordance with the a priori selection criteria. Thirty-two percent of the abstracts were double-screened, with 88% to 98% of agreement between pairs of reviewers. Any discrepancy in inclusion/exclusion decisions was resolved through consensus. The full-text review yielded a total of 36 articles made up of 21 samples ($N = 3, 847$) that examined the concurrent and/or longitudinal relationship between caregiver sensitivity and preschool attachment measured using the pre-specified coding systems [10,11]. Our initial abstract screening included articles written in French. However, during full-text review it was determined that all of the French articles were drawn from the same samples of English articles by the Moss research group that have been included in the present review. Therefore, all of the French articles were omitted for the present review. The PRISMA Flow Diagram (Fig 1) presents the process of inclusion and exclusion of abstracts from the inception of the search to the final texts examined in the present study.

Data extraction

Four reviewers independently completed the data extraction using a standardized extraction form and corresponding manual developed by the lead authors of this publication. One-hundred percent of the articles were double extracted by the lead author, and any discrepancies were resolved through weekly consensus meetings. The data extraction included publication year, demographic information (i.e., country, ethnicity, sample size, percentage of male children, mean years of age that preschool attachment was assessed, socioeconomic status, and clinical/risk vs. normative sample), methodology (i.e., type of caregiver sensitivity assessed [unidimensional, multidimensional, or both]), and when preschool attachment was analyzed in relation to caregiver sensitivity (i.e., concurrent, longitudinal, or both). Reliability statistics for the measurement of each of the relevant variables (i.e., caregiver sensitivity, preschoolers' attachment) were also extracted in order to obtain the necessary data to calculate the attenuated effect sizes that account for variability in reliability coding across studies [31]. Statistical results were extracted from each study in order to calculate the effect size for differences in caregiver sensitivity as a function of secure-insecure or organized-disorganized preschool attachment. Authors were contacted if an article did not provide enough statistical information to be included in the meta-analyses. In instances where authors did not respond, or were not able to provide the requested statistical information, the article was synthesized qualitatively so as to not completely lose the information provided in that article.

Quality assessment

There is currently no gold-standard measure available for examining the quality of observational studies [32]. Accordingly, the methodological quality of each study included in the present systematic literature review was assessed using a checklist adapted from the National Heart, Lung, and Blood Institute's Quality Assessment Tool for Observational Cohort and Cross-

Sectional Studies [33], Downs and Black [34], and Crombie [35]. See Appendix D for the checklist employed in the present review. Two independent reviewers completed the quality assessment using the 16-item checklist and the overall quality judgment of all of the articles. There were few discrepancies between coders (Percentage agreement = 86%), which were resolved through consensus.

The modified checklist consisted of 16 items which were recorded as "yes" if the article fulfilled the requirement of the item, "no" if the article did not fulfill the requirement of the item, or "not applicable" in the rare case that the item did not correspond with a given article. A total quality score was calculated by determining the percentage of items that the study fulfilled out of the total applicable 16 items. A higher score was indicative of higher quality in a particular study.

In accordance with the NIH recommendations [33], six of the 16 items were identified as essential to determining overall quality judgment of the article (High vs. Low Quality). The items examined to determine overall quality pertained to: sample size and power; clearly defined, valid and reliable implementation of the predictor and outcome variables; coders of preschool attachment were blind to other study variables; > or equal to 80% retention in longitudinal studies; and accounting/controlling for potential confounding variables. Based on the aforementioned factors, each study was assigned an overall "Higher" or "Lower" quality judgment.

Calculation of effect sizes and data analysis

Results were synthesized by first categorizing studies according to whether they examined the longitudinal or concurrent relationship between caregiver sensitivity and preschool attachment. Results were then subcategorized according to the operationalization of the caregiver

sensitivity variable (i.e., unidimensional and/or multidimensional) and then again subdivided according to the preschool attachment outcome variable (e.g., secure vs. insecure and/or organized vs. disorganized). Study articles which reported sufficient statistical information to meta-analyze were included in the quantitative synthesis of the present review. This resulted in eight primary meta-analyses. Studies that did not provide sufficient statistical information to be included in the meta-analysis were synthesized qualitatively.

In instances where multiple studies reported on the same sample, the study that was most comparable to the other studies (e.g., similar operationalization of caregiver sensitivity, completing the analysis with a secure-insecure/organized-disorganized dichotomy rather than using a rating scale, mean years of age that preschool attachment was assessed) was prioritized for quantitative synthesis. If studies were drawn from the same sample and were equal in all aspects, the study with the full (larger) sample size was included. A similar approach was taken for studies that reported multiple statistical tests with the same variables, such that efforts were made to use the full sample and select the test that utilized variables *most* similar to the other studies in the given quantitative synthesis.

Quantitative synthesis.

The standardized mean difference effect sizes were calculated for studies that provided sufficient data to be included in the relevant quantitative synthesis. First Cohen's *d* effect size was calculated and then it was converted to Hedge's *g*, because Hedge's *g* corrects for a slight small sample bias that has been shown in Cohen's *d* [36]. After Hedge's *g* calculations were completed, eight separate meta-analyses were run through random-effects models using the metaphor R package [37] in RStudio (Version 3.6.0). The completed analyses were examined for the overall effect size (Hedge's *g*), significance level, and corresponding 95% confidence

intervals. Based on the assertion that Cohen's [38,39] traditional categorizations for effect sizes are too stringent, new guidelines for interpretation of effect sizes [40] were implemented for interpreting effect sizes in the present review. New recommendations for interpreting effect sizes were previously presented using Pearson's *r* [40], and were therefore converted to Cohen's *d* for adequate interpretation of the present meta-analyses. Recommended categorizations were: very small effect (*r* = .05 or *d* = .10), small effect (*r* = .10 or *d* = .20), medium effect (*r* = .20 or *d* = .40), large effect (*r* = .30 or *d* = .62), and very large effect (*r* = .40 or *d* = .87).

Heterogeneity among the studies was assessed using the *Q*-statistic which indicates if there is a statistically significant amount of heterogeneity between studies, and the I^2-statistic indicates the size of heterogeneity (e.g., small [25%], medium [50%], large [75%]; [36]). An I^2-statstic equal to 100% indicates that all of the variability is due to between study differences, whereas an I^2-statstic of 0% indicates that all of the variability is due to sampling error [36]. Forest plots corresponding to each of the main meta-analyses were completed. Each forest plot illustrates the effect sizes and corresponding confidence intervals for each study included in a given meta-analysis. The center point visually depicts each study's effect sizes (Hedge's *g*) and confidence intervals. A square or bar crossing 0 is indicative of no difference in caregiver sensitivity among the attachment outcome (e.g., secure vs. insecure or organized vs. disorganized). Square points on the right side of 0 are indicative of higher caregiver sensitivity among caregivers who have secure versus insecure, or organized versus disorganized children.

Meta-regression analyses were also conducted in order to examine how potential moderators (e.g., quality score, child gender, child age, sample type [clinical vs. normative], socioeconomic status) moderate the longitudinal and/or concurrent relationship between

caregiver sensitivity (i.e., either unidimensional or multidimensional) and preschool attachment (i.e., either secure vs. insecure or organized vs. disorganized).

Qualitative synthesis

Articles were qualitatively synthesized if insufficient statistical information was provided in the article to be included in the quantitative synthesis, or if the article was drawn from a sample that had already been entered into the relative quantitative synthesis. Qualitative articles were synthesized by reporting the magnitude (i.e., effect size) and direction of the study effects. Moderator variables examined in the quantitative synthesis were also considered in the qualitative synthesis, through consideration of the study characteristics and by examination of any covariates that were included in the analyses in the study articles.

Results

Studies included

The current review included 36 articles and 21 samples (N = 3, 847), with 22 of those articles being included in one of the eight primary meta-analyses. Studies included in the present review are marked with an asterisk within the references section and cited throughout the results section and relevant figures and tables.

Study characteristics

An overview of the study characteristics is presented in Table 1.

Demographics

The majority of the study articles were conducted in the United States (k = 17) and Canada (k = 12), with the remaining studies occurring in Europe (k = 6) and Israel (k = 1). Several of the studies were drawn from the same samples, owing to multiple publications by the same research group: Bureau research group (k = 3), McElwain research group (k = 3), the

Maternal Adversity, Vulnerability and Neurodevelopment research group (k = 2), and the National Institute for Child Development: Study of Early Child Care and Youth Development (NICHD SECCYD; k = 7). Several studies were also completed by the Moss research group, which consisted of studies from an earlier cohort (k = 2) and a later cohort (k = 3), and a study which collapsed the two cohorts (k = 1). Overall, there were a total of 21 samples among all of the studies. Almost half of the studies (k = 15) were drawn from a unique sample in the present review. The majority of the studies were identified as coming from a normative sample (k = 22) and Middle/High socioeconomic status (k = 29). Most of the children were between 2- to 5-years-old when they participated in the modified separation-reunion procedure.

Caregiver sensitivity

Approximately half of the studies (k =17) were identified as operationalizing caregiver sensitivity as a unidimensional measure and half were identified as operationalizing caregiver sensitivity as a multidimensional measure (k = 19). Two of these studies examined the relationship between caregiver sensitivity and preschool attachment through employing both a unidimensional and multidimensional measure of caregiver sensitivity.

Attachment categorizations

Given a priori knowledge that studies varied in their categorizations of preschool attachment outcomes [12], study results were extracted for secure-insecure or organized-disorganized preschool attachments outcomes, or the necessary statistics were extracted to calculate outcomes in terms of these dichotomies (i.e., collapsing means and standard deviations of caregiver sensitivity for A/C/D vs. B, converting the correlation between caregiver sensitivity and a security scale to a mean difference effect size). Of note, studies identified as examining the relationship between caregiver sensitivity and the controlling attachment categories (i.e.,

controlling-caregiving, controlling-punitive) were included within the organized-disorganized quantitative and qualitative syntheses throughout the current review and are referred to as the organized-disorganized dichotomy outcomes herein. Overall, almost all of the studies were interpretable in terms of a secure-insecure dichotomy (k = 33), and most of the studies were interpretable in terms of an organized-disorganized dichotomy (k = 24).

Quality

The mean quality score for the 36 studies was 71.90%. The lowest quality score was 37.50% [30] and the highest quality score was 87.50% [24,41,42,43]. Fig 2 provides a visual depiction of the percentage of studies that fulfilled each of the 16 criteria in the quality assessment that made up the total score. In terms of the six criteria that contributed to the overall quality judgment, 61.1% of the studies provided a power analysis or effect size estimates, 55.6% reported that potential confounding variables were assessed and adjusted for, and 69.4% and 91.7% provided clear, valid, and reliable information about the predictor (caregiver sensitivity) and outcome variables (preschool attachment), respectively. Approximately half (55.6%) of the studies reported that attachment coders were blind to the other study variables. In contrast, few studies (33.3%), reported that retention rate of participants in longitudinal studies was 80% or greater. Approximately half of the studies (k =17) were given a higher quality judgment, and the remaining (k = 19) were given a lower quality judgement.

Quantitative and qualitative syntheses

The following sections present the quantitative and qualitative syntheses for the current review. See Table 2 for a summary of the quantitative and qualitative syntheses.

1. Longitudinal relationship between caregiver sensitivity and preschool attachment

1.1. Longitudinal associations between unidimensional caregiver sensitivity and preschool attachment

Five studies examined the longitudinal relationship between unidimensional caregiver sensitivity and preschool attachment [44,45,46,47,48].

1.1.1. Secure vs. insecure: quantitative synthesis

Three studies were included in the quantitative synthesis examining differences in unidimensional caregiver sensitivity for secure versus insecure children. The weighted mean effect size of differences in unidimensional caregiver sensitivity for children who were secure versus insecure was calculated from a total sample of 448 child-caregiver dyads, that were all from normative samples. Two of the studies had been assigned a higher quality judgment [44,46] and one of the studies had been assigned a lower quality judgment [48]. The meta-analysis revealed a medium effect $g = 0.46$, $p = .002$, 95% CI [0.17, 0.75], indicating higher levels of unidimensional caregiver sensitivity among secure versus insecure children (See Table 3 and Fig 3). There was a moderate degree of true between study heterogeneity ($Q = 4.25$, $p = .12$, $I^2 = 56.62\%$). The result of Egger's regression test [49] for funnel plot asymmetry was non-significant ($p = .13$), suggesting no evidence of publication bias.

Three separate moderator analyses were conducted to determine if the longitudinal relationship between unidimensional sensitivity and secure versus insecure attachment varies as a function of key study variables. There was a significant effect of preschool attachment age ($Q_b = 4.25$, $p = 0.04$), indicating larger between-group differences for unidimensional caregiver sensitivity in samples where children were older ($g = 0.24$). The moderator analyses were non-significant for quality score ($Q_b = 0.75$, $p = 0.38$) and child gender ($Q_b = .16$, $p = 0.68$). Moderator analyses could not be conducted for sample type (clinical vs. normative) and

socioeconomic status (low vs. middle/high) due to lack of variability in the studies (i.e., all samples were normative with a high/middle socioeconomic status).

1.1.2. Secure vs. insecure: qualitative synthesis

Two studies were included in the qualitative synthesis examining differences in unidimensional caregiver sensitivity for secure versus insecure children [45,47]. One of the studies [47] was not included in the quantitative synthesis due to reporting insufficient statistical information for the meta-analysis. The other study [45] was drawn from the same sample as a study [46] that was prioritized for quantitative synthesis.

For the present qualitative synthesis, one study [47] was from a clinical sample and assigned a lower quality judgement, and the other study was from a normative sample [45] and assigned a higher quality judgment. One study [45] examined the longitudinal relationship between caregiver sensitivity and secure versus insecure preschool attachment. Means, standard deviation and sample sizes were pooled to combine secure groups and insecure groups, and the between-group effect size was calculated in order to assess the direction and magnitude of the differences. There was a large overall effect ($g = 0.84$) suggesting that caregiver sensitivity was higher for caregivers of children who were secure compared to insecure. In the study using a clinical sample [47], the longitudinal relationship between caregiver sensitivity and preschool attachment was non-significant, such that caregiver sensitivity did not differ among caregivers of children who were secure versus insecure. It is important to note that, unlike the studies included in the quantitative synthesis, this study controlled for both the child's birthweight and the socioeconomic status of the family.

1.1.3. Organized vs. disorganized: quantitative synthesis

Two studies were included in the quantitative synthesis examining differences in unidimensional caregiver sensitivity for organized versus disorganized children. The weighted mean effect size of differences in unidimensional caregiver sensitivity for children who were organized versus disorganized was calculated from a total sample of 320 child-caregiver dyads drawn from normative samples. One study [46] was assigned a higher quality judgment and one study [48] was assigned a lower quality judgment. The meta-analysis revealed a medium effect $g = 0.51$, $p = .08$, 95% CI [-0.06, 1.09], indicating higher levels of unidimensional caregiver sensitivity among caregivers of organized versus disorganized children (See Table 3 and Fig 4). There was a moderate degree of true between study heterogeneity ($Q = 2.36$, $p = .12$, $I^2 = 57.55\%$). Due to only having two studies included in the meta-analysis, it was not possible to complete Egger's regression test [49] for funnel plot asymmetry. Additionally, because there were only two studies included in the meta-analysis, it was not possible to conduct moderator analyses to determine if the relationship between unidimensional sensitivity and organized versus disorganized attachment varied as a function of key study variables (e.g., quality score, child gender, sample type [clinical vs. normative], socioeconomic status, or age at preschool attachment).

1.1.4. Organized vs. disorganized: qualitative synthesis

Two studies were included in the qualitative synthesis examining differences in unidimensional caregiver sensitivity for organized versus disorganized children [45,47]. One of the studies [47] was not included in the quantitative synthesis due to reporting insufficient statistical information for the meta-analysis. The other study [45] was drawn from the same sample as a study [46] that was prioritized for quantitative synthesis.

For the present qualitative synthesis, one study [47] was from a clinical sample and assigned a lower quality judgement, and the other study was from a normative sample [45] and assigned a higher quality judgment. One study [45] examined the longitudinal relationship between caregiver sensitivity and organized versus disorganized preschool attachment. Means, standard deviations and sample sizes were pooled to combine organized groups in order to compare the organized group with the disorganized group by calculating the between-group effect size to assess the direction and magnitude of the differences. There was a medium overall effect ($g = 0.42$) suggesting that caregiver sensitivity was higher for caregivers of children who were organized compared to disorganized. In the study using a clinical sample [47], the longitudinal relationship between caregiver sensitivity and preschool attachment was non-significant, such that caregiver sensitivity did not differ among caregivers of children who were organized versus disorganized. It is important to note that, unlike the studies included in the quantitative synthesis, this study controlled for both the child's birthweight and the socioeconomic status of the family.

1.2. Longitudinal associations between multidimensional caregiver sensitivity and preschool attachment

Ten studies examined the longitudinal relationship between multidimensional caregiver sensitivity and preschool attachment [24,41,48,50,51,52,53,54,55,56].

1.2.1. Secure vs. insecure: quantitative synthesis

Five studies were included in the quantitative synthesis examining differences in multidimensional caregiver sensitivity for secure versus insecure children. It is important to note that among the five studies, one study was treated as two separate studies and entered twice [51], because separate analyses were run for children with a secure and insecure infant history and the

necessary statistical information to combine these effects to enter it as one study was not available. The weighted mean effect size of differences in multidimensional caregiver sensitivity for children who were secure versus insecure was calculated from a total of 1, 528 child-caregiver dyads, that consisted of three clinical samples [50,51,54] and two [48,53] normative samples. One study [50] had been assigned a higher quality judgment and four studies [48,51,53,54] had been assigned a lower quality judgment. The meta-analyses revealed a small effect $g = 0.34$, $p = .004$, 95% CI [0.11, 0.56], indicating higher levels of multidimensional caregiver sensitivity among secure versus insecure children (See Table 4 and Fig 5). There was a moderate degree of true between study heterogeneity ($Q = 10.52$, $p = .06$, $I^2 = 54.30\%$). The results of Egger's regression test [49] for funnel plot asymmetry was non-significant ($p = .48$), suggesting no evidence of publication bias.

Five separate moderator analyses were conducted to determine if the longitudinal relationship between multidimensional sensitivity and secure versus insecure attachment varies as a function of key study variables. The moderator analyses were non-significant for quality score ($Q_b = 2.39$, $p = 0.12$), child gender ($Q_b = .34$, $p = 0.56$), sample type (clinical vs. normative; $Q_b = 0.80$, $p = 0.37$), child age at attachment ($Q_b = 1.56$, $p = 0.22$), and socioeconomic status ($Q_b = 1.31$, $p = 0.25$).

1.2.2. Secure vs. insecure: qualitative synthesis

Four studies were included in the qualitative synthesis examining differences in multidimensional caregiver sensitivity for secure versus insecure children [24,41,52,55]. All of the studies were drawn from the same sample as a study [53] that was prioritized for the quantitative synthesis.

For the present qualitative synthesis, all studies consisted of a normative sample. Two of the studies were judged to have a higher quality [24,41] and two of the studies were judged to have a lower quality [52,55]. Although all of the studies consisted of the same sample, variations in the methodological quality judgment was due to variability in reporting the required information to be considered as higher versus lower. Between-group effect sizes were calculated to examine the direction and magnitude of the differences in multidimensional caregiver sensitivity among caregivers of children who are secure versus insecure. There were small to medium overall effects in these studies (Hedge's *g* ranging from .32 to .49) suggesting that multidimensional caregiver sensitivity was higher for caregivers of children who were secure versus insecure. Variations in effect sizes across studies drawn from the same sample is likely a result of the variation in sample sizes (see Table 1), and the variation in study provided statistical data used to calculate the effect sizes (e.g., ANOVA, correlation, and pooled means and standard deviations).

1.2.3. Organized vs. disorganized: quantitative synthesis

Three studies were included in the quantitative synthesis examining differences in multidimensional caregiver sensitivity for organized versus disorganized children. The weighted mean effect size of differences in multidimensional caregiver sensitivity for children who were organized versus disorganized was calculated from a total sample of 1, 377 child-caregiver dyads, with one clinical sample [54] and two normative samples [48,53]. All three studies [48,53,54] had been assigned a lower quality judgement. The meta-analyses revealed a small effect $g = 0.39$, $p = .001$, 95% CI [0.16, 0.62], indicating higher levels of multidimensional caregiver sensitivity among caregivers of organized versus disorganized children (See Table 4 and Fig 6). There was a small to moderate degree of true between study heterogeneity ($Q = 2.46$,

p = .29, I^2 = 33.40%). The results of Egger's regression test [49] for funnel plot asymmetry was non-significant (p = .51), suggesting no evidence of publication bias.

Four separate moderator analyses were conducted to determine if the longitudinal relationship between multidimensional sensitivity and organized versus disorganized attachment varies as a function of key study variables. The moderator analyses were non-significant for quality score (Q_b = 2.40, p = 0.12), child gender (Q_b = 2.45, p = 0.12), sample type (clinical vs. normative; Q_b = 2.38, p = 0.12), and child age that preschool attachment was assessed (Q_b = 0.001, p = 0.98). Moderator analyses could not be conducted for socioeconomic status (low vs. middle/high) due to lack of variability in the studies (i.e., all samples were identified as having a high/middle socioeconomic status).

1.2.4. Organized vs. disorganized: qualitative synthesis

Three studies were included in the qualitative synthesis examining differences in multidimensional caregiver sensitivity for organized versus disorganized children [24,55,56]. The studies [24,55,56] were drawn from the same samples of articles [53,54] that were prioritized for the quantitative synthesis.

For the present qualitative synthesis, one study [56] consisted of a clinical sample, and two studies [24,55] consisted of a normative sample. Two of the studies were judged to have a higher quality [24,56] and one of the studies was judged to have a lower quality [55]. Between-group effect sizes were calculated to examine the direction and magnitude of the differences in multidimensional caregiver sensitivity among caregivers of children who are organized versus disorganized. Among the two studies [24,55] drawn from the same sample, one study [55] had a small overall effect (g = .30) and the other [24] had medium overall effect (g = .47), suggesting that multidimensional caregiver sensitivity was higher for caregivers of children who were

organized versus disorganized. Variations in effect sizes across the same sample is likely a result of the variation in sample sizes (see Table 1). Another study [56] had a medium (approaching large) overall effect (g = .61), again supporting the finding that caregiver sensitivity is higher for caregivers of children who are organized relative to disorganized. Of note, the study statistics used to calculate the aforementioned effect size [56], implemented several control variables in the analysis (i.e., child birthweight, child genetic markers, child gender, maternal mental health, maternal demographic variables) and examined caregiver sensitivity as a predictor of organization on a rating scale rather than implementing the organized/disorganized dichotomy.

2. Concurrent relationship between caregiver sensitivity and preschool attachment

2.1. Concurrent associations between unidimensional caregiver sensitivity and preschool attachment

Seventeen studies examined the concurrent relationship between unidimensional caregiver sensitivity and preschool attachment [14,15,30,42,45,46,47,48,57,58,59,60,61,62,63,64,65].

2.1.1. Secure vs. insecure: quantitative synthesis

Ten studies were included in the quantitative synthesis examining differences in unidimensional caregiver sensitivity for secure versus insecure children. The weighted mean effect size of differences in unidimensional caregiver sensitivity for children who were secure versus insecure was calculated from a total sample of 2, 050 caregiver-child dyads, that consisted of four clinical samples [42,57,58,64] and six normative samples [14,48,60,61,63,65]. Five [14,42,57,60,63] studies had been assigned a higher quality judgment and five studies [48,58,61,64,65] had been assigned a lower quality judgment. The meta-analyses revealed a medium effect g = 0.59, p < .0001, 95% CI [0.40, 0.79], indicating higher levels of

unidimensional caregiver sensitivity among caregivers of secure versus insecure children (See Table 5 and Fig7). There was a moderate degree of true between study heterogeneity (Q = 25.85, p = .002, I^2 = 61.36%). The results of Egger's regression test [49] for funnel plot asymmetry was non-significant (p = .27), suggesting no evidence of publication bias.

Five separate moderator analyses were conducted to determine if the concurrent relationship between unidimensional sensitivity and secure versus insecure attachment varies as a function of key study variables. The moderator analyses were non-significant for quality score (Q_b = 0.03, p = 0.86), child gender (Q_b = 3.05, p = 0.08), sample type (clinical vs. normative; Q_b = 0.05, p = 0.80), age that preschool attachment was assessed (Q_b = 0.01, p = 0.91), and socioeconomic status (Q_b = 0.36, p = 0.16). Of note, the moderator analysis for socioeconomic status included one less study [60], given that socioeconomic status had already been controlled for in the study's original analysis.

2.1.2. Secure vs. insecure: qualitative synthesis.

Seven studies were included in the qualitative synthesis examining differences in unidimensional caregiver sensitivity for secure versus insecure children [15,30,45,46,47,59,62]. Two of the studies [30,47] did not provide sufficient data to be included in the quantitative synthesis and five studies [15,45,46,59,62] were drawn from the same samples of articles [14,60,61] prioritized for quantitative synthesis.

For the present qualitative synthesis, two studies [30,47] consisted of a clinical sample, and five studies [15,45,46,59,62]consisted of a normative sample. Four of the studies were judged to have a higher quality [15,45,46,59] and three of the studies were judged to have a lower quality [30,47,62]. Between-group effect sizes were calculated to examine the direction and magnitude of the differences in unidimensional caregiver sensitivity among caregivers of

children who are secure versus insecure. Among the studies [45,46,59,62] drawn from two different samples within the same research group, the overall effect ranged from a medium (bordering large) effect (g = .61) to a very large effect (g = 1.09), suggesting that unidimensional caregiver sensitivity was higher for caregivers of children who were secure versus insecure. This finding was supported by a study [15] from another research group also identifying an overall medium effect (g = .49). The two remaining studies had insufficient data to calculate a between-groups effect size. Both of the studies [30,47] identified a non-significant relationship between caregiver sensitivity and preschool attachment. Of note, one study [30] analyzed the overall relationship between caregiver sensitivity and the four categories of preschool attachment. Interestingly, both studies reporting non-significant findings [30,47] were from clinical samples, judged to have lower methodological quality, and were identified as having lower socioeconomic status, in comparison to the studies in the qualitative synthesis identified to have a medium to very large overall effect size.

2.1.3. Organized vs. disorganized: quantitative synthesis

Nine studies were included in the quantitative synthesis examining differences in unidimensional caregiver sensitivity for organized versus disorganized children. The weighted mean effect size of differences in unidimensional caregiver sensitivity for children who were organized versus disorganized was calculated from a total sample of 2, 001 caregiver-child dyads, that consisted of four clinical samples [15,42,57,66] and five normative samples [48,60,61,63,65]. Six [15,42,57,60,63,66] studies had been assigned a higher quality judgment and three studies [48,61,65] had been assigned a lower quality judgment. The meta-analyses revealed a medium effect g = 0.50, p < .0001, 95% CI [0.29, 0.72], indicating higher levels of unidimensional caregiver sensitivity among caregivers of organized versus disorganized children

(See Table 5 and Fig 8). There was a moderate degree of true between study heterogeneity (Q = 15.55, p = .05, I^2 = 56.44%). The results of Egger's regression test [49] for funnel plot asymmetry was non-significant (p = .10), suggesting no evidence of publication bias.

Five separate moderator analyses were conducted to determine if the concurrent relationship between unidimensional sensitivity and organized versus disorganized attachment varies as a function of key study variables. The moderator analyses were non-significant for child gender (Q_b = 2.89, p = 0.09), quality score (Q_b = 0.42, p = 0.52), sample type (clinical vs. normative; Q_b = 0.49, p = 0.48), age that preschool attachment was assessed (Q_b = 0.48, p = 0.49), and socioeconomic status (Q_b = 0.06, p = 0.81). Of note, the moderator analysis for socioeconomic status included one less study [60], given that socioeconomic status had already been controlled in the study's original analysis.

2.1.4. Organized vs. disorganized: qualitative synthesis

Six studies were included in the qualitative synthesis examining differences in unidimensional caregiver sensitivity for organized versus disorganized children [30,45,46,47,59,62]. Two of the studies [30,47] did not provide sufficient data to be included in the quantitative synthesis and the remaining four studies [45,46,59,62] utilized samples from studies [60,61] that were already prioritized for the quantitative analysis.

For the present qualitative synthesis, two studies [30,47] consisted of a clinical sample, and four studies [45,46,59,62] consisted of a normative sample. Three of the studies were judged to have a higher quality [45,46,59] and three of the studies were judged to have a lower quality [30,47,62]. Between-group effect sizes were calculated to examine the direction and magnitude of the differences in unidimensional caregiver sensitivity among caregivers of children who are organized versus disorganized. Among the studies [45,46,59,62] drawn from two different

samples within the same research group, the overall effect ranged from a medium effect (g = .42) to a very large effect (g = 1.66), suggesting that unidimensional caregiver sensitivity was higher for caregivers of children who were organized versus disorganized. The study [46] with the largest effect size (g = 1.66) had a sample that was more than double that of the other studies from the same research group [45,59,62] owing to combining participants from two separate cohorts. The two additional studies [30,47] identified a non-significant relationship between caregiver sensitivity and preschool attachment. Of note, one study [30] analyzed the overall relationship between caregiver sensitivity and the four categories of preschool attachment. Interestingly, both studies reporting non-significant findings were from clinical samples, judged to have lower methodological quality, and were identified as having lower socioeconomic status, in comparison to the studies in the qualitative synthesis identified to have a medium to very large overall effect size.

2.2. Concurrent associations between multidimensional caregiver sensitivity and preschool attachment

Twelve studies examined the concurrent relationship between multidimensional caregiver sensitivity and preschool attachment [13,41,43,51,53,65,67,68,69,70,71,72].

2.2.1. Secure vs. insecure: quantitative synthesis

A total of seven studies were included in the quantitative synthesis examining differences in multidimensional caregiver sensitivity for secure versus insecure children. It is important to note that among the seven studies, one study was treated as two separate studies and entered twice [51] because separate analyses were run for children with a secure versus insecure infant attachment history and the necessary statistical information to combine these effects to enter it as one study was not available. The weighted mean effect size of differences in multidimensional

caregiver sensitivity for children who were secure versus insecure was calculated from a total sample of 1, 665 caregiver-child dyads, that consisted of three clinical samples [51,67,68] and four normative samples [13,53,65,70]. Three [13,68,70] studies had been assigned a higher quality judgment and four studies [51,53,65,67] had been assigned a lower quality judgment. The meta-analyses revealed a medium effect $g = 0.49$, $p < .0001$, 95% CI [0.39, 0.59], indicating higher levels of multidimensional caregiver sensitivity among secure versus insecure children (See Table 6 and Fig 9). The test of heterogeneity revealed that almost none of the heterogeneity is due to true between-study heterogeneity ($Q = 6.25$, $p = .51$, $I^2 = 0.01\%$). The results of Egger's regression test [49] for funnel plot asymmetry was non-significant ($p = .62$), suggesting no evidence of publication bias.

Five separate moderator analyses were conducted to determine if the concurrent relationship between multidimensional sensitivity and organized versus disorganized attachment varies as a function of key study variables. The moderator analyses were non-significant for quality score ($Q_b = 0.16$, $p = 0.69$), child gender ($Q_b = 1.31$, $p = 0.25$), sample type (clinical vs. normative; $Q_b = 0.17$, $p = 0.68$), age that preschool attachment was assessed ($Q_b = 0.01$, $p = 0.93$), and socioeconomic status ($Q_b = 0.17$, $p = 0.68$). Of note, the moderator analysis for mean years of age at preschool attachment assessment included one less study [13] given that this variable had already been controlled for in the study's original analysis.

2.2.2. Secure vs. insecure: qualitative synthesis

Five studies were included in the qualitative synthesis examining differences in multidimensional caregiver sensitivity for secure versus insecure children [41,43,69,71,72]. One of the studies [71] did not provide sufficient data to be included in the quantitative synthesis and

four studies [41, 43, 69, 72] were drawn from the same samples of papers [53,70] prioritized for the quantitative synthesis.

For the present qualitative synthesis, one study [71] consisted of a clinical sample, and four studies [41, 43,69,72] consisted of a normative sample. One of the studies was judged to have a higher quality [41] and four of the studies were judged to have a lower quality [43,69,71,72]. Between-group effect sizes were calculated to examine the direction and magnitude of the differences in multidimensional caregiver sensitivity among caregivers of children who are secure versus insecure. One of the studies [41] had an overall small effect (g = .35), two of the studies [43,69] had medium effects (g = .45 and .41, respectively), and one of the studies (72) had an overall large effect (g = .74), indicating that multidimensional caregiver sensitivity is higher among caregivers with secure children relative to insecure children. The remaining study [71] with insufficient data to calculate a between-groups effect size reported a non-significant relationship between a multidimensional measure of caregiver sensitivity and secure versus insecure preschool attachment.

2.2.3. Organized vs. disorganized: quantitative synthesis

Five studies were included in the quantitative synthesis examining differences in multidimensional caregiver sensitivity for organized versus disorganized children. The weighted mean effect size of differences in multidimensional caregiver sensitivity for children who were organized versus disorganized was calculated from a total sample of 1, 465 caregiver-child dyads, that consisted of two clinical samples [67,68] and three normative samples [13,53,65]. Two [13,68] studies had been assigned a higher quality judgment and three studies [53,65,67] had been assigned a lower quality judgment. The meta-analyses revealed a small effect g = 0.39, p < .0001, 95% CI [0.25, 0.53], indicating higher levels of multidimensional caregiver sensitivity

among organized versus disorganized children (See Table 6 and Fig 10). The test of heterogeneity revealed that almost none of the heterogeneity is due to true between-study heterogeneity ($Q = 4.22$, $p = .37$, $I^2 = 0.01\%$). The results of Egger's regression test [49] for funnel plot asymmetry was non-significant ($p = .76$), suggesting no evidence of publication bias.

Five separate moderator analyses were conducted to determine if the concurrent relationship between multidimensional sensitivity and organized versus disorganized attachment varies as a function of key study variables. The moderator analyses were non-significant for quality score ($Q_b = 0.00$, $p = 0.24$), child gender ($Q_b = 0.06$, $p = 0.80$), sample type (clinical vs. normative; $Q_b = 0.04$, $p = 0.85$), age that preschool attachment was assessed ($Q_b = 0.21$, $p = 0.65$), and socioeconomic status ($Q_b = 0.04$, $p = 0.85$). Of note, the moderator analyses for mean years of age at preschool attachment assessment included one less study [13] given that this variable had already been controlled for in the study's original analysis.

2.2.4. Organized vs. disorganized: qualitative synthesis

One study was included in the qualitative synthesis examining differences in multidimensional caregiver sensitivity for organized versus disorganized children [71]. The study consisted of a clinical sample, and was judged to have lower quality. Insufficient data was reported in order to calculate a between-groups effect size. The study reported a non-significant relationship between a multidimensional measure of caregiver sensitivity and preschool attachment. Of note, the study only tested the overall relationship between caregiver sensitivity and the four attachment categories.

Discussion

This is the first study to systematically review and meta-analyze the relationship between caregiver sensitivity and preschool attachment measured specifically by the Cassidy and Marvin

[11] and Main and Cassidy [10] coding systems. Overall, the results of the present review demonstrate that caregiver sensitivity is associated with preschool attachment, both longitudinally and concurrently. Furthermore, regardless of whether caregiver sensitivity is implemented as a unidimensional or multidimensional measure, the quantitative and qualitative syntheses consistently demonstrated that higher levels of caregiver sensitivity is related to a greater likelihood of secure and organized preschool attachment compared to insecure and disorganized preschool attachment, respectively.

The longitudinal relationship between caregiver sensitivity and preschool attachment

One of the primary goals of the present study was to examine both the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment. In terms of longitudinal attachment, the results of the meta-analyses demonstrated a small to medium effect, with higher levels of caregiver sensitivity predicting greater secure and organized attachment in preschool, relative to insecure and disorganized attachment styles. Additionally, although most of the moderator analyses were non-significant, the longitudinal relationship between unidimensional caregiver sensitivity and secure versus insecure attachment had larger differences for studies with children who were older when they completed the attachment assessment. Thus, the longitudinal association between earlier unidimensional caregiver sensitivity predicting preschool attachment was stronger when preschoolers were older versus younger. This finding is parallel to the literature reviewing the relationship between caregiver sensitivity and attachment measured by the infant system which reported that there were stronger effect sizes when infants were older when they completed the attachment procedure [5]. Although one could interpret the present and past findings to indicate that a bigger time gap between assessments of caregiver sensitivity and infant or preschool attachment leads to better concordance, this interpretation

contradicts other related findings. DeWolff and van IJzendoorn [5] reported that a shorter time interval between caregiver sensitivity and infant attachment assessments led to greater effect sizes. The notion of stronger effect sizes with smaller time gaps is also observed in the present review whereby effect sizes were relatively larger for the concurrent meta-analyses compared to the longitudinal meta-analyses. An alternative and more likely interpretation of the findings that effect sizes are larger when attachment is assessed at a greater age may indicate that attachment assessed later in an infant's or child's life is more reliable.

Our analyses suggest the intricacies of the longitudinal relationship are better understood by examining how the relationship differs according to the measurement of caregiver sensitivity. In instances where a unidimensional measure of caregiver sensitivity was employed, the effect size was relatively larger (medium effect) compared to when a multidimensional measure (small effect) of caregiver sensitivity was employed. The differences in the longitudinal relationship when caregiver sensitivity was operationalized as a unidimensional versus a multidimensional measure may be explained by several factors. First, in terms of the grouping of articles, it is more likely that the unidimensional measures were more similar than the multidimensional measures. Unidimensional measures of caregiver sensitivity were operationalized by studies that assessed one single aspect of caregiver behaviour (i.e., a single rating on a sensitivity scale). In contrast, multidimensional measures of caregiver sensitivity were operationalized by studies that combined multiple aspects of caregiver behaviour (i.e., sensitivity, nonintrusiveness, warmth, etc.), but the combination varied pending on the study, thereby creating much more variability among studies identified as employing a multidimensional measure. A second factor to consider is more theoretical in nature. Ainsworth et al.'s [16] original works employed a unidimensional measure of caregiver sensitivity assessed by a single global scale [18]. It was not until

subsequent works that other different related behaviours (e.g., warmth, positive affect) were introduced in order to more broadly assess caregiver sensitivity [18]. Accordingly, perhaps introducing new aspects of caregiver behaviour that are related but not the same as sensitivity, results in a weaker longitudinal relationship between caregiver sensitivity and attachment.

The longitudinal relationship between caregiver sensitivity and preschool attachment can be further elucidated through examining the relationship for secure-insecure attachments versus organized-disorganized attachments. Generally, the longitudinal effect sizes were consistently medium when caregiver sensitivity was operationalized as a unidimensional measure and consistently small when caregiver sensitivity was operationalized as a multidimensional measure, regardless of preschool attachment outcomes (i.e., secure vs. insecure, organized vs. disorganized). However, it is noteworthy that in both instances when preschool attachment differences were examined according to organizational status they were slightly larger relative to secure status. This difference is particularly interesting because the syntheses with an organized-disorganized outcome consistently contained fewer studies and a smaller sample size than the studies with a secure-insecure outcome. This finding may suggest that early levels of caregiver sensitivity have a greater impact on determining whether a preschooler is observed to have an organized versus disorganized attachment, relative to a secure versus insecure attachment. This is contrary to expectations because disorganization is conceptualized as the result of frightening caregiver behaviours rather than insensitivity. One important consideration which may help to contextualize these findings is that for the purpose of the meta-analyses, disorganization is merged with role-reversal (i.e., controlling-punitive and controlling-caregiving behaviours), which is not assessed in infancy. Therefore, the concept of organization versus disorganization is more complex in the preschool years, as some may view role-reversal as a form of organization.

This may partially explain the results revealed in the present study, but future reviews that separate findings for disorganized versus controlling preschoolers are necessary to shed light on this issue.

The concurrent relationship between caregiver sensitivity and preschool attachment

Overall, the results of the present review revealed that relative to the longitudinal association, the concurrent relationship between caregiver sensitivity and preschool attachment was slightly stronger. This finding should be considered in the context of the concurrent syntheses consistently including a greater number of studies and a larger sample size relative to the longitudinal syntheses. However, this finding was also identified in a meta-analytic review of caregiver sensitivity and attachment during infancy through toddlerhood [19]. Conceptually, the minor difference in the strength of the concurrent versus longitudinal associations is not surprising due to the closer proximity of time between concurrent assessments of caregiver sensitivity and preschool attachment relative to longitudinal assessments. It is also important to explore the inherent cohesiveness of concurrent assessments relative to longitudinal. In order for studies to be included in the concurrent synthesis it was required that caregiver sensitivity and attachment were assessed within a month of one another. In contrast, while attempts were made to synthesize longitudinal studies as similarly as possible, there was definite variability in the proximity of assessment of caregiver sensitivity and attachment. For example, Pennestri et al. [54] assessed sensitivity at 6 months and preschool attachment at 36 months, whereas studies completed by the NICHD SECCYD [24,41,52,55] often averaged sensitivity at 6, 15, 24, and 36 months.

Despite the above noted differences between the concurrent and longitudinal relationships synthesized, the concurrent synthesis mostly paralleled that of the longitudinal synthesis with

regards to the subcategorization operationalizations of caregiver sensitivity (i.e., unidimensional versus multidimensional). As with longitudinal associations, the concurrent relationship between unidimensional measures of caregiver sensitivity and preschool attachment was greater than that of the concurrent relationship between multidimensional caregiver sensitivity and preschool attachment. Similar to the longitudinal associations, it is possible that different findings when caregiver sensitivity was operationalized as a unidimensional measure versus a multidimensional measure, are likely attributed to the greater variability in the studies employing a multidimensional measure, and also potentially explained by deviations from a "pure" assessment of caregiver sensitivity.

In contrast to the longitudinal synthesis, the concurrent synthesis demonstrated that relative to organized-disorganized attachment outcomes, the relationship between caregiver sensitivity and preschool attachment was greater when attachment differences were examined in terms of the secure-insecure dichotomy. One potential explanation for this finding is that when caregiver sensitivity is measured in close proximity to preschool attachment, there are clear differences in the sensitivity of caregivers with secure children relative to insecure children. However, when caregiver sensitivity is measured in further proximity from preschool attachment, changes have occurred in the quality of the sensitivity of caregivers and preschoolers' attachment status has changed relative to what it may have been when sensitivity was assessed at an earlier date (e.g., children switched from secure to insecure or vice versa). In contrast, possibly caregivers who demonstrate lower sensitivity at infancy are more likely to have lower sensitivity when their children are in preschool, thereby facilitating a consistency in disorganized attachment from infancy to preschool.

Limitations

There are some limitations that warrant consideration for the present review. Despite our comprehensive search strategy, studies were excluded if they were not in English or French. Another consideration is that although efforts were made to group uniform studies for each of the syntheses conducted, there was inherent variability in some of the studies that were synthesized. For example, given the vast range operationalizations of caregiver sensitivity [18], articles were categorized according to whether they employed a unidimensional measure of caregiver sensitivity (akin to Ainsworth et al.'s [16] original sensitivity construct), or a multidimensional measure of caregiver sensitivity. In addition to the inadvertent variability that this creates, particularly in the multidimensional synthesis, it is important to note that this is only one way to operationalize caregiver sensitivity. Perhaps a different approach to synthesis (e.g., grouping unidimensional and multidimensional measures together) would yield different results. It is also important to consider that the present review only included objective behaviourally coded measures of caregiver sensitivity. Taking a cohesive approach to the present review, studies implementing a measure of caregiver sensitivity through self-completed questionnaires were not included. Another consideration of the present review is that studies were only synthesized in terms of differences in caregiver sensitivity according to secure-insecure and organized-disorganized dichotomies. A final consideration is that it was not possible to calculate the attenuated effect sizes that account for variability in reliability coding across studies [73], due to limitations in the reliability statistics available for many of the reviewed studies. However, the effect sizes calculated in the present review were similar, if not slightly larger, than past reviews of caregiver sensitivity and attachment [19,23], including those that have previously calculated the attenuated effect sizes [5]. Therefore, we are confident that the effect sizes yielded in the present review are an adequate representation of the relationship between caregiver sensitivity

and preschool attachment in the field. Future reviews of this nature may choose to incorporate Hunter and Schmidt's [73] attenuation corrections for meta-analysis should the required data be available.

Conclusions

Overall, for the first time in the literature, the present systematic literature review and meta-analysis provides synthesized evidence that caregiver sensitivity is both longitudinally and concurrently related to preschool attachment outcomes. Due to the critical role ascribed to the first years of life on developmental trajectories [74], these findings are of great import for extending the collective body of literature [5,19,20,21,22,23] to the preschool age. Identifying caregiver sensitivity as a key factor that has a longitudinal and concurrent impact on preschooler attachment and thus developmental psychopathology, empirically confirms sensitivity as an area for early prevention and intervention. Implementation of programs to assess and improve the sensitivity in which caregivers interact with their infants and young children is paramount to improving attachment and thus mental health outcomes in childhood through adulthood. Further research is necessary in order to understand how caregiver sensitivity may interact with key predictors of child attachment. Additionally, as shown in the present review, more research is required in order to better elucidate the longitudinal relationship between early caregiver sensitivity and preschool attachment.

Moving forward, it will also be imperative for understanding how caregiver sensitivity is related to preschool attachment when caregiver sensitivity is assessed in different and naturalistic contexts. The attachment system is activated in distress, but laboratory distress paradigms are necessarily low to moderately low distress paradigms (free-play, semi-structed play paradigm, mild frustration). High distress paradigms, such as routine painful procedures (i.e., vaccinations),

will almost certainly augment current understanding in the mechanisms subsuming the interrelationships with the distress context, attachment and caregiver sensitivity.

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Figure 1 : PRISMA Flow Diagram.

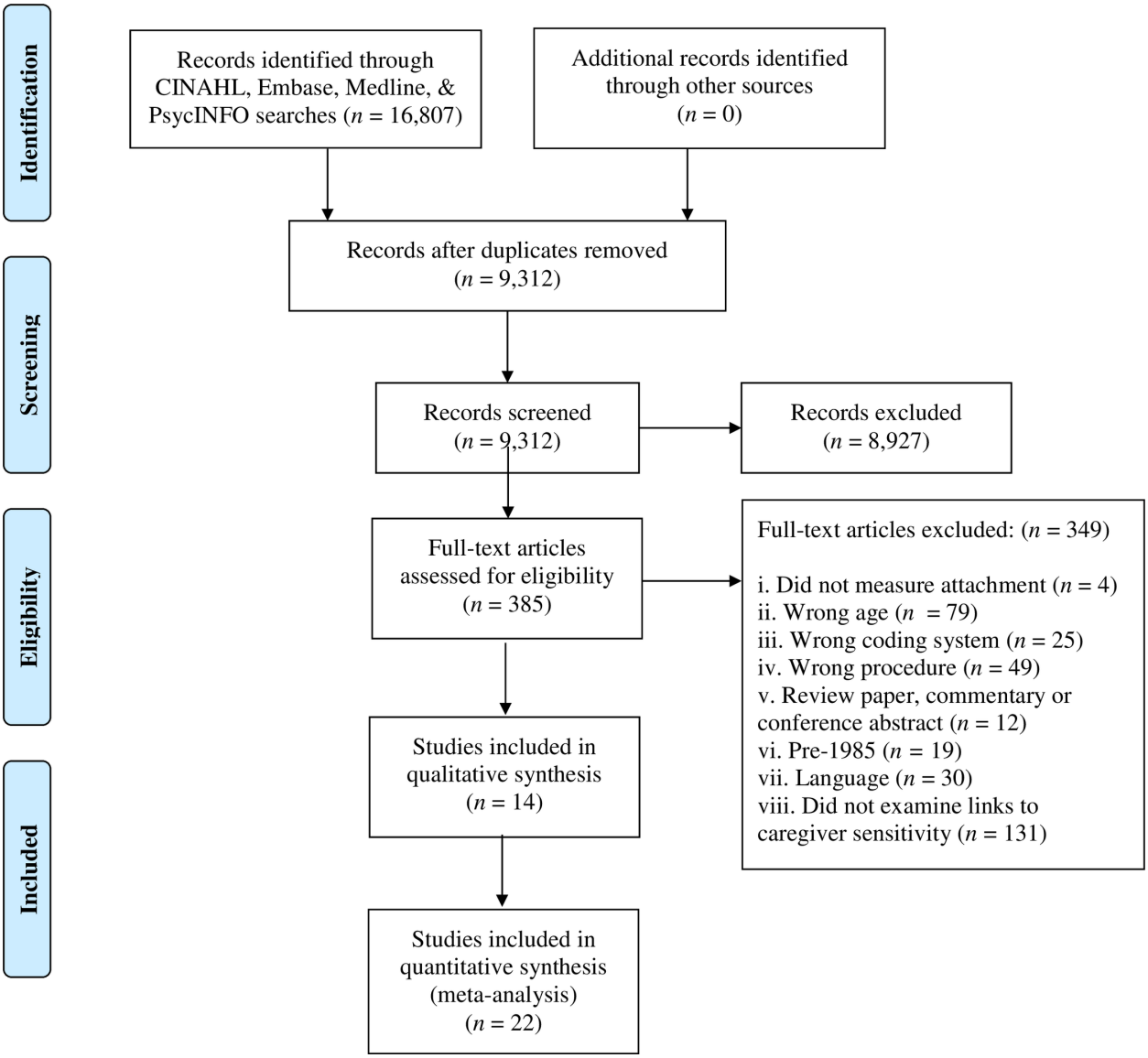


Figure 2. Quality assessment scores. Percentage of studies that fulfilled the criteria for each item on the quality assessment checklist.

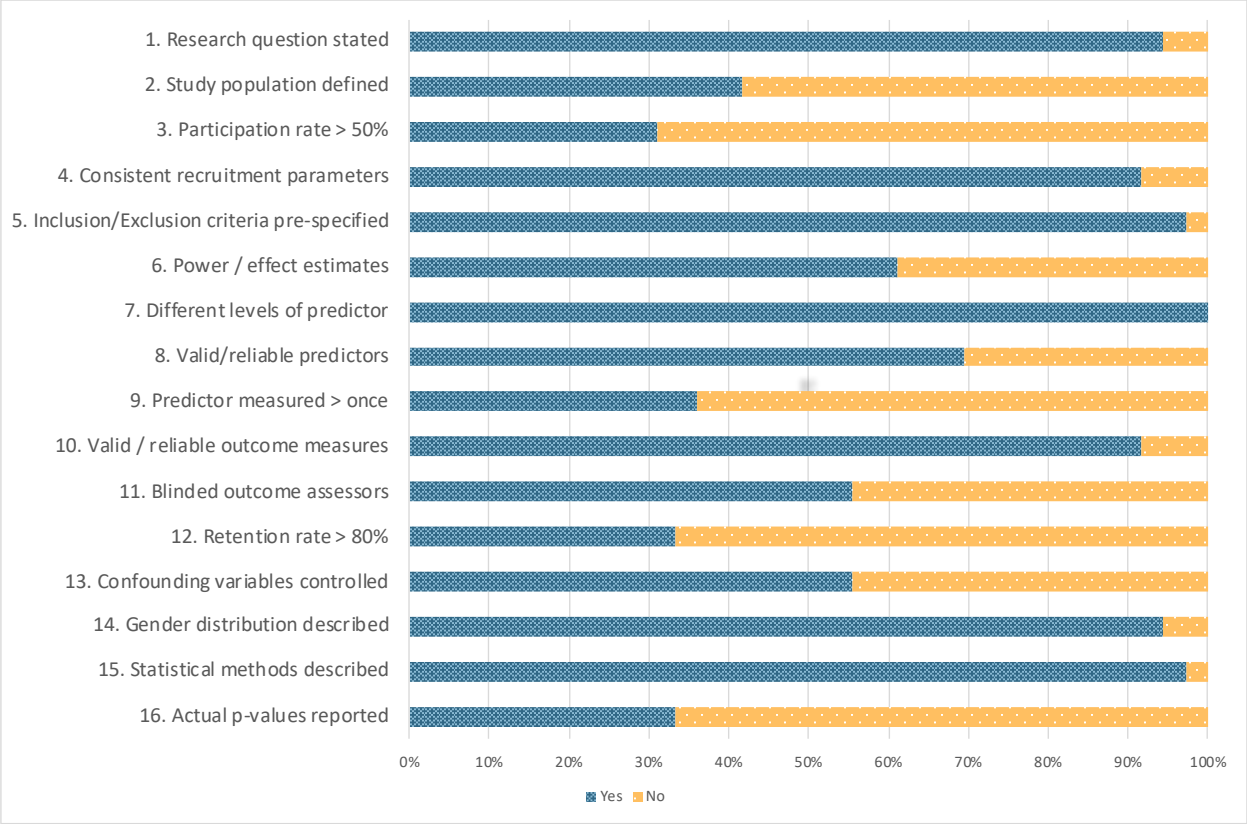
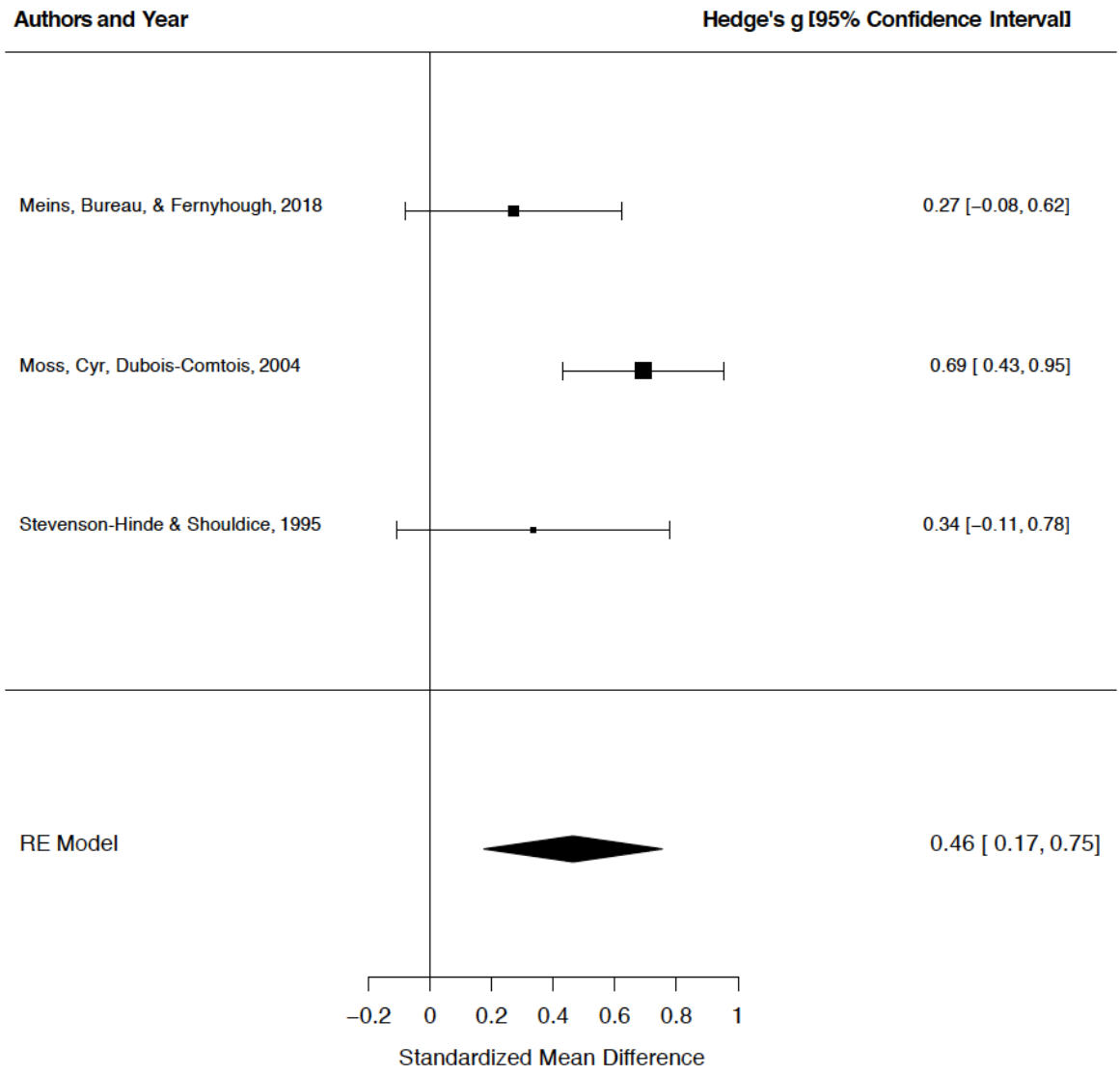
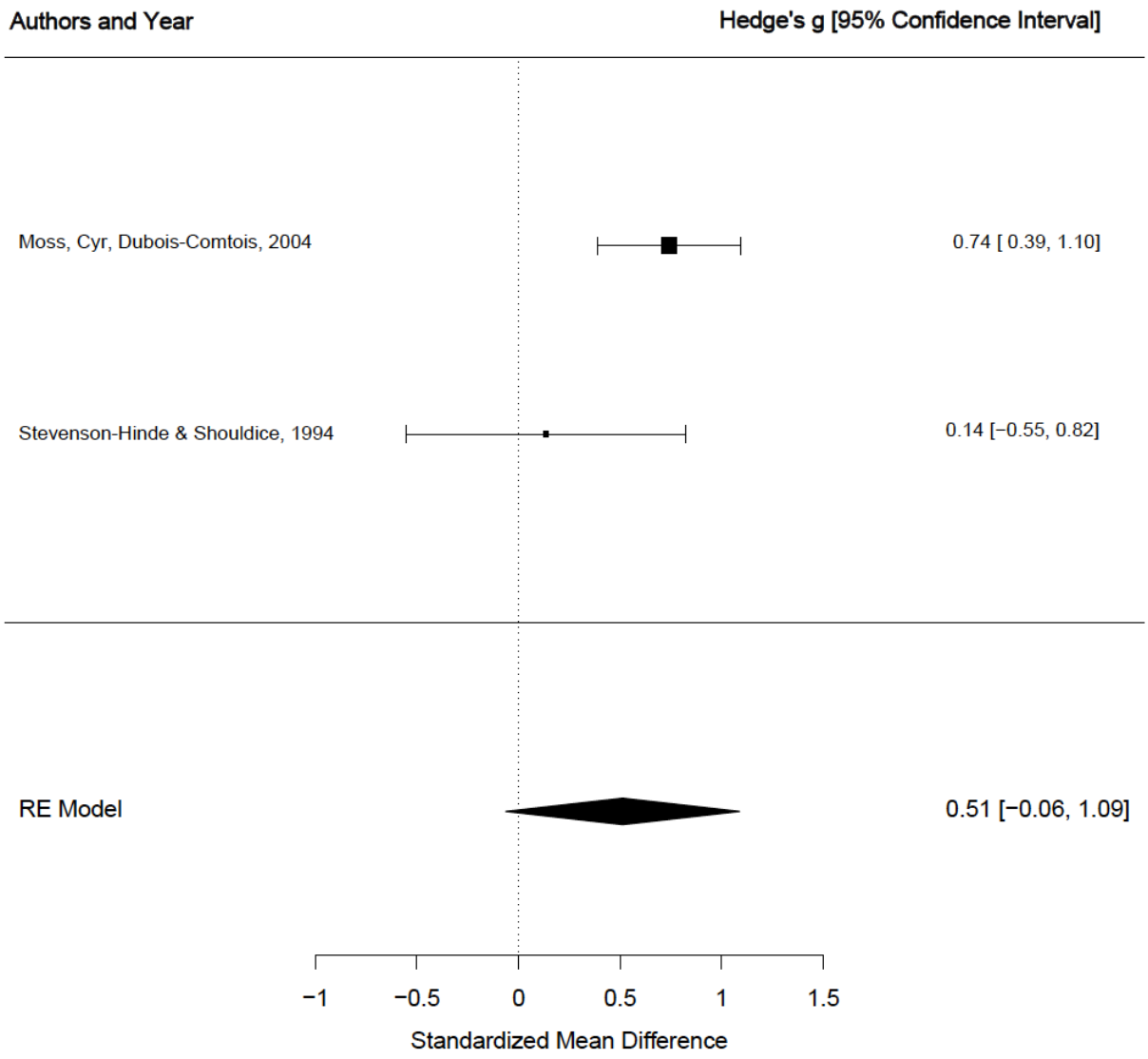


Figure 3. Forest plot for the longitudinal relationship between unidimensional caregiver sensitivity and secure versus insecure preschool attachment.



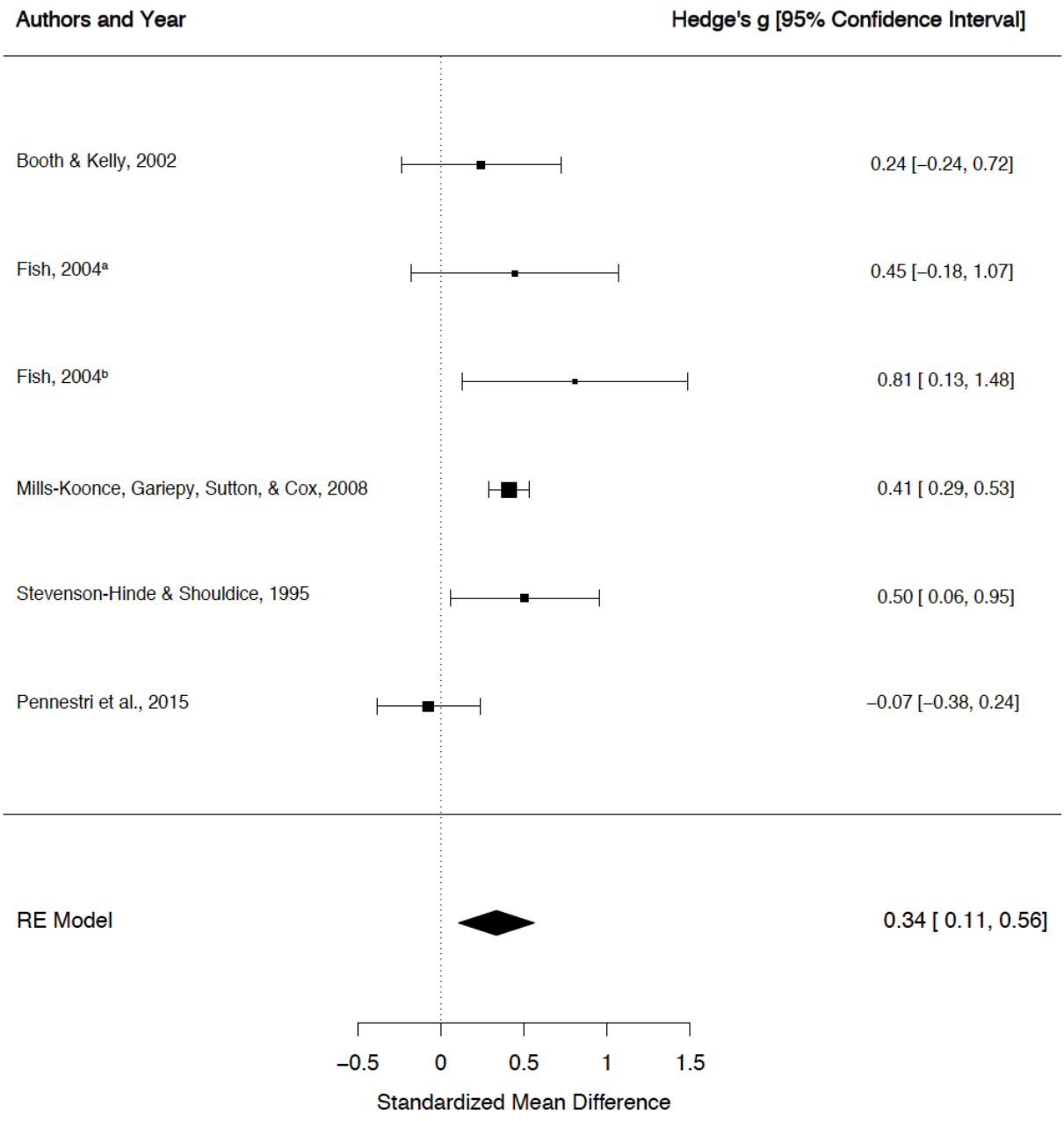
RE = Random Effects Model.

Figure 4. Forest plot for the longitudinal relationship between unidimensional caregiver sensitivity and organized versus disorganized preschool attachment.



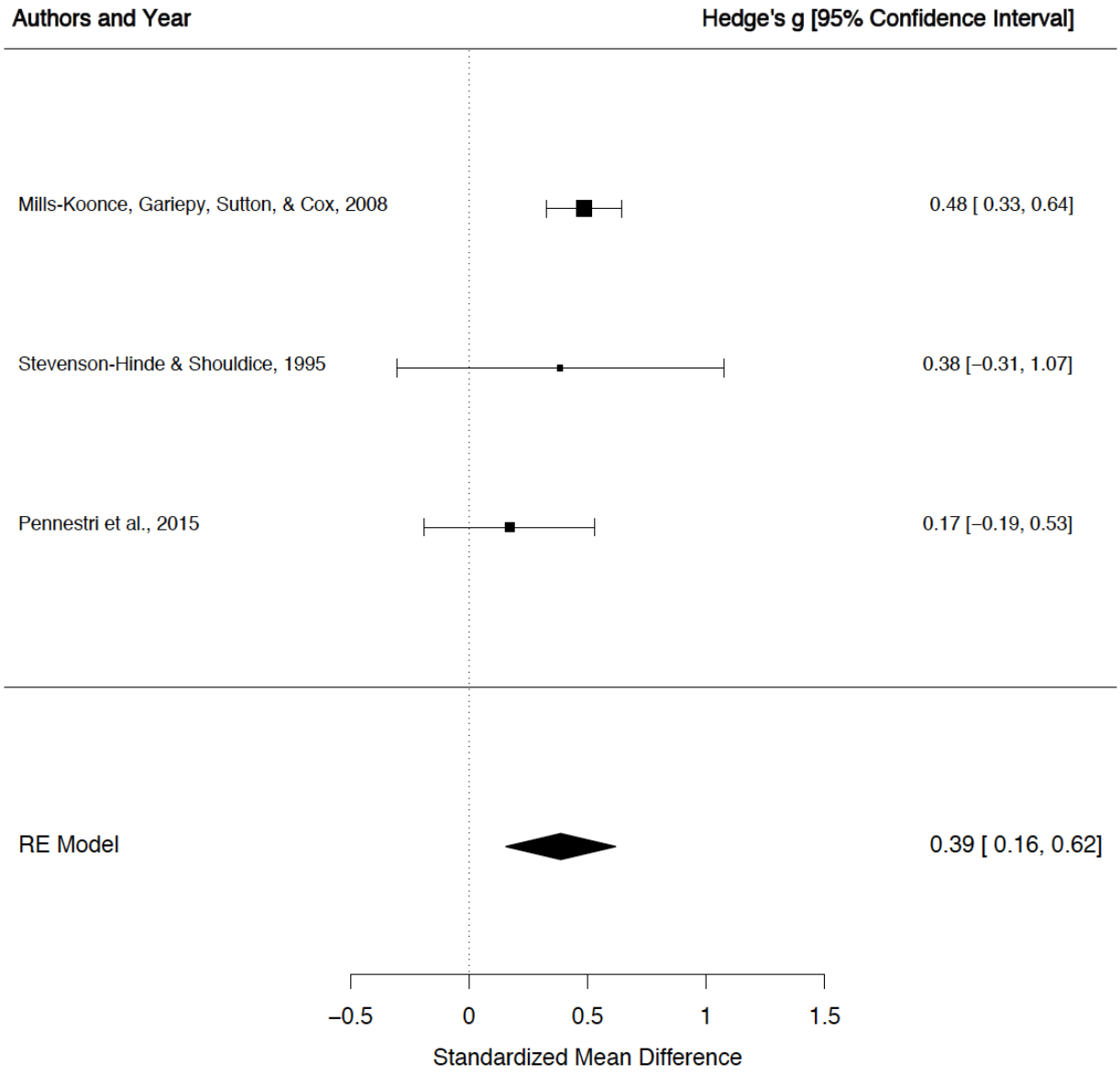
RE = Random Effects Model.

Figure 5. Forest plot for the longitudinal relationship between multidimensional caregiver sensitivity and secure versus insecure preschool attachment.



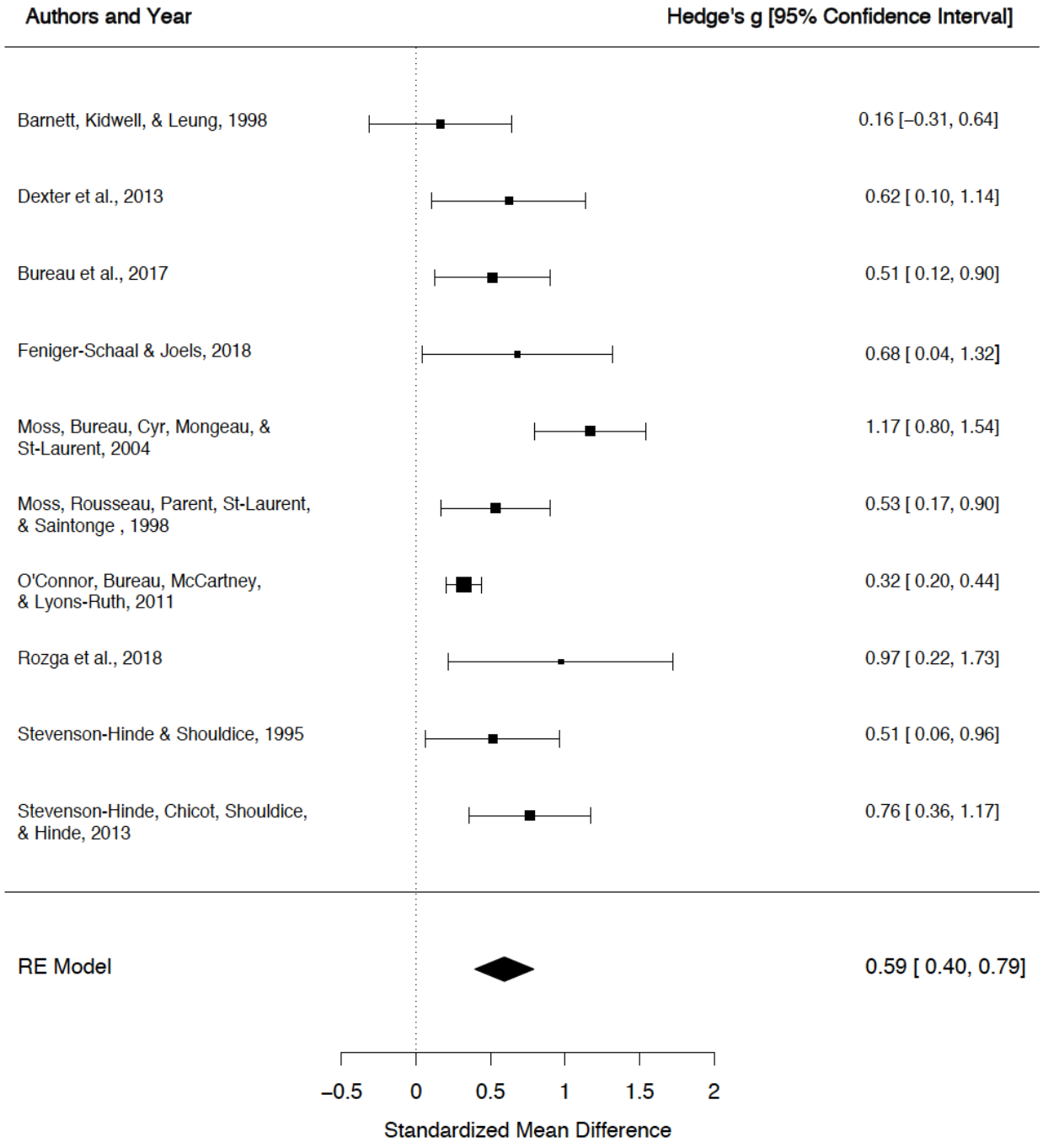
RE = Random Effects Model.

Figure 6. Forest plot for the longitudinal relationship between multidimensional caregiver sensitivity and organized versus disorganized preschool attachment.



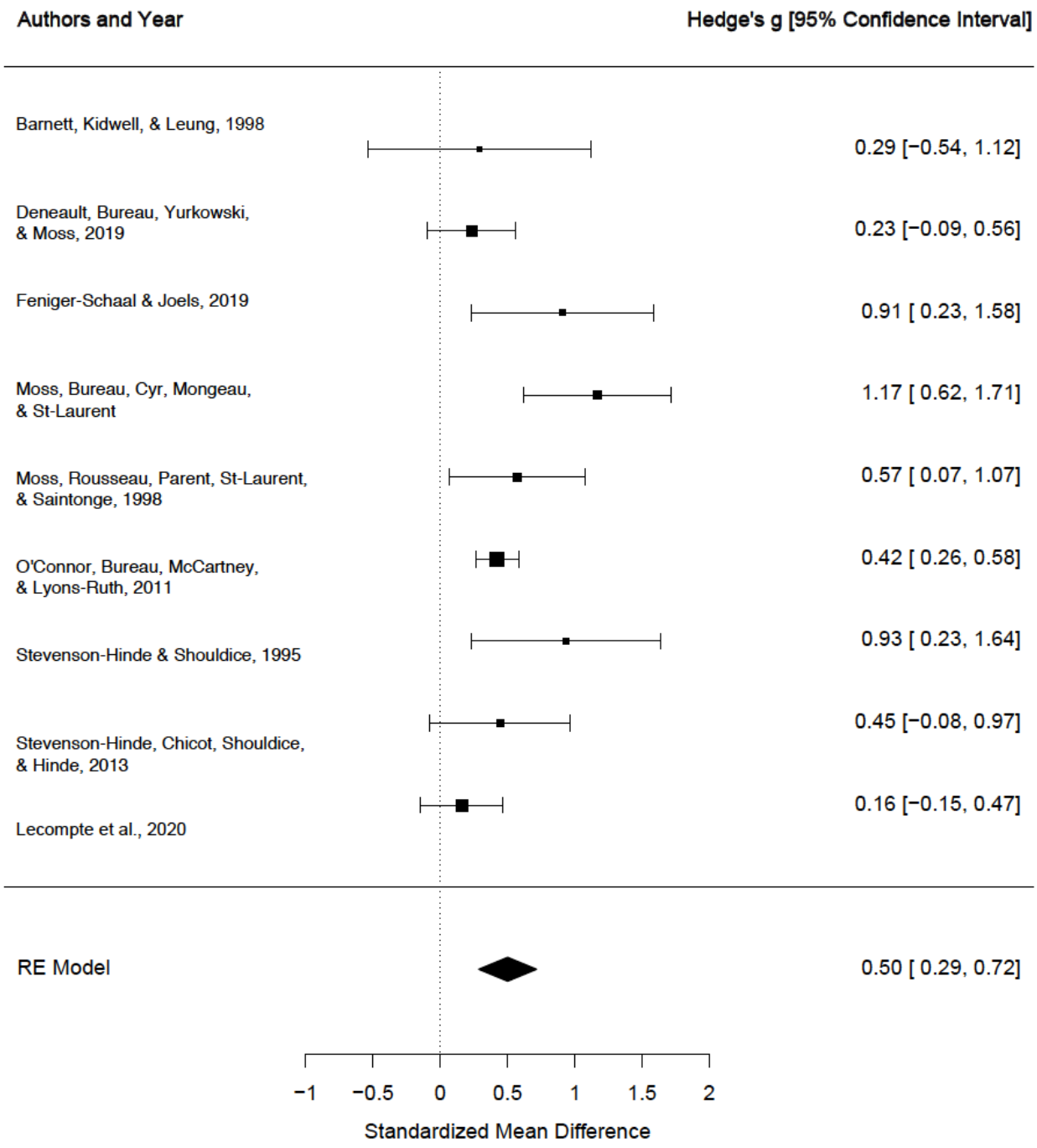
RE = Random Effects Model.

Figure 7. Forest plot for the concurrent relationship between unidimensional caregiver sensitivity and secure versus insecure preschool attachment.



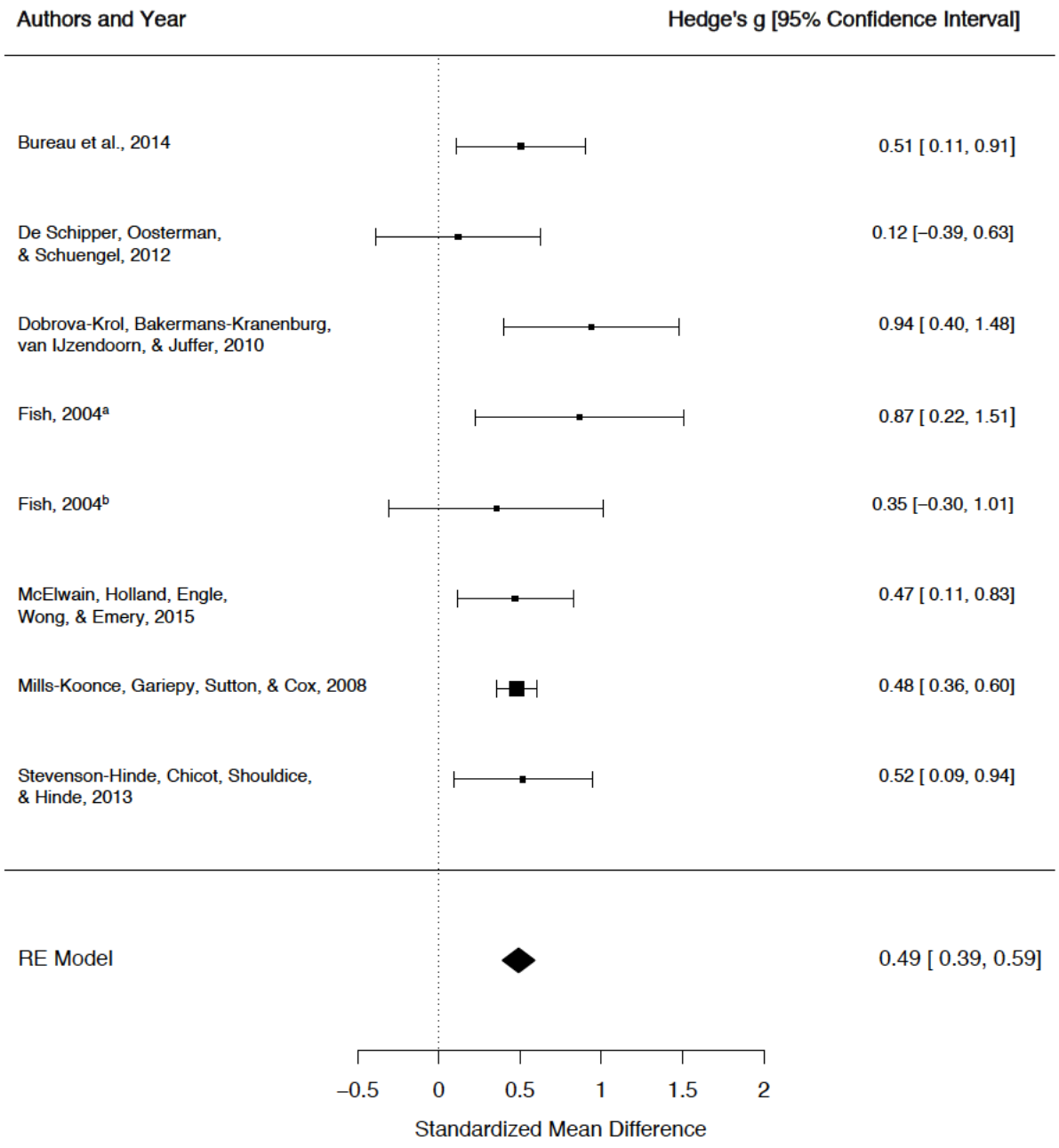
RE = Random Effects Model.

Figure 8. Forest plot for the concurrent relationship between unidimensional caregiver sensitivity and organized versus disorganized preschool attachment.



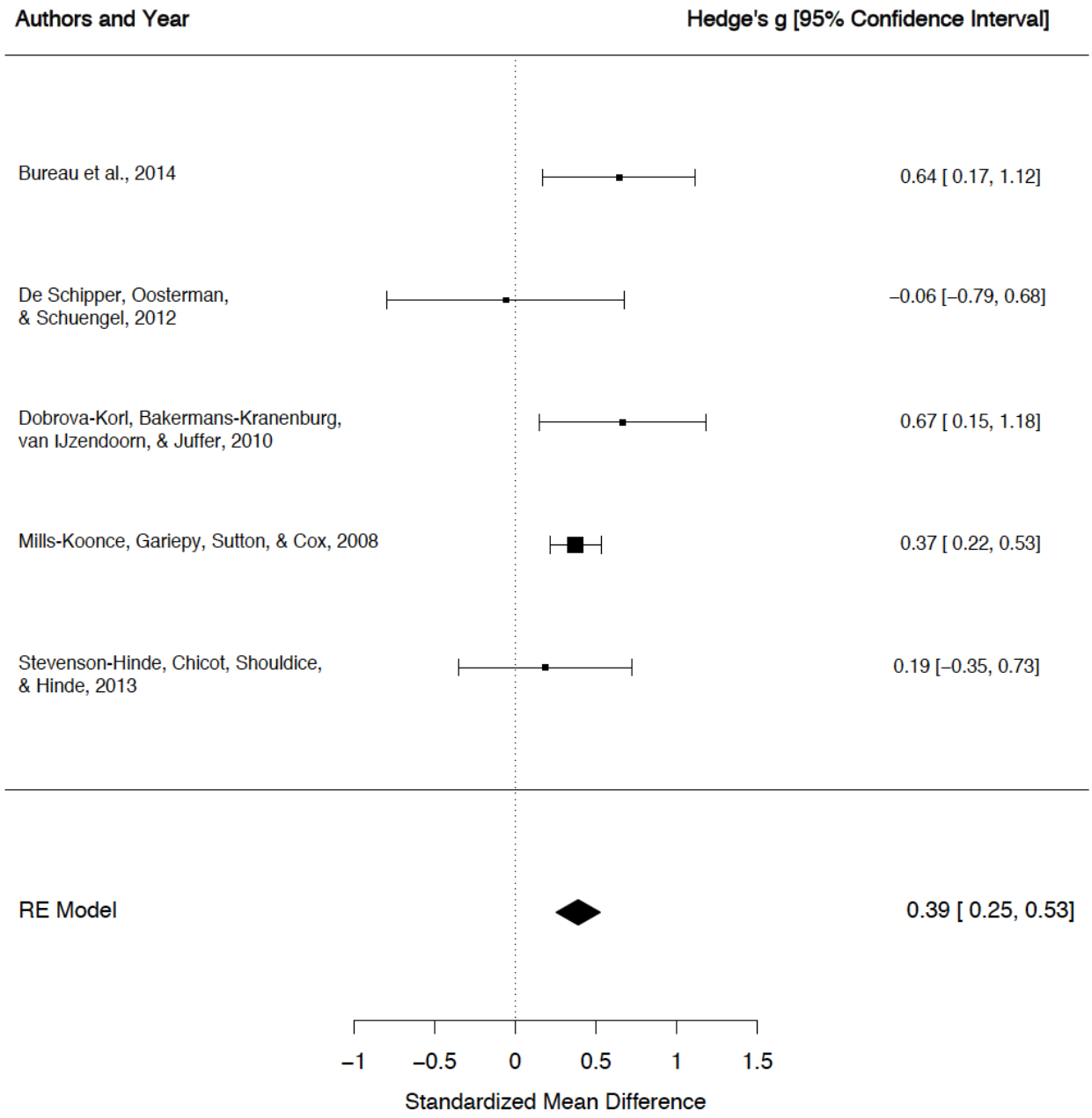
RE = Random Effects Model.

Figure 9. Forest plot for the concurrent relationship between multidimensional caregiver sensitivity and secure versus insecure preschool attachment.



RE = Random Effects Model.

Figure 10. Forest plot for the concurrent relationship between multidimensional caregiver sensitivity and organized versus disorganized preschool attachment.



RE = Random Effects Model.

Table 1. Study characteristics.

Research Group/Sample	Reference	Country	*N*[c]	Sample Type	Child Age at Attachment Assessment	Attachment Categorizations	Caregiver Sensitivity Measure(s)	Caregiver Sensitivity Composition	Quality Score (Quality Judgment)[e]
Bureau	[14]	Canada	107	Normative	2-5 years	SI	Modified Parent-Child Interaction Scale	Unidimensional	80.00 (Higher)
Bureau	[13]	Canada	107	Normative	2-5 years	SI OD	Modified Parent-Child Interaction Scale	Multidimensional	66.67 (Higher)
Bureau	[15]	Canada	144	Normative	2-5 years	SI OD	Modified Parent-Child Interaction Scale	Unidimensional	86.67 (Higher)
MAVAN	[54]	Canada	159	Clinical/Risk	2-5 years	SI OD	Ainsworth Scales	Multidimensional	50.00 (Lower)
MAVAN	[56]	Canada	301	Clinical/Risk	2-5 years	OD	Ainsworth Scales	Multidimensional	75.00 (Higher)
McElwain	[69]	USA	120	Normative	2-5 years	SI	Author Developed	Multidimensional	71.43 (Higher)
McElwain	[70]	USA	127	Normative	2-5 years	SI	Author Developed	Multidimensional	85.71 (Higher)
McElwain	[72]	USA	127	Normative	2-5 years	SI	Author Developed	Multidimensional	57.14 (Lower)
Moss[a]	[61]	Canada	121	Normative	5-7 years	SI OD	Parent-Child Interaction Scale	Unidimensional	56.25 (Lower)
Moss[a]	[62]	Canada	111	Normative	5-7 years	SI OD	Parent-Child Interaction Scale	Unidimensional	56.25 (Lower)

Moss [b]	[59]	Canada	83	Normative	5-7 years	SI OD	Author Developed	Unidimensional	62.50 (Higher)
Moss [b]	[60]	Canada	151	Normative	2-5 years	SI OD	Parent-Child Interaction Scale	Unidimensional	66.67 (Higher)
Moss [b]	[45]	Canada	120	Normative	Both	SI OD	Parent-Child Interaction Scale	Unidimensional	75.00 (Higher)
Moss [a, b]	[46]	Canada	242	Normative	5-7 years	SI OD	Parent-Child Interaction Scale	Unidimensional	81.25 (Higher)
NICHD SECCYD	[41]	USA	1077	Normative	2-5 years	SI	NICHD SECCYD	Multidimensional	87.50 (Higher)
NICHD SECCYD	[52]	USA	1060	Normative	2-5 years	SI	NICHD SECCYD	Multidimensional	75.00 (Lower)
NICHD SECCYD	[53]	USA	1140	Normative	2-5 years	SI OD	NICHD SECCYD	Multidimensional	75.00 (Lower)
NICHD SECCYD	[24]	USA	1140	Normative	2-5 years	SI OD	NICHD SECCYD	Multidimensional	87.50 (Higher)
NICHD SECCYD	[63]	USA	1140	Normative	2-5 years	SI OD	NICHD SECCYD	Unidimensional	75.00 (Higher)
NICHD SECCYD	[55]	USA	303	Normative	2-5 years	SI[d] OD[d]	NICHD SECCYD	Multidimensional	56.25 (Lower)
NICHD SECCYD	[43]	USA	1016	Normative	2-5 years	SI	NICHD SECCYD	Multidimensional	87.50 (Lower)
Unique	[57]	USA	69	Clinical/Risk	2-5 years	SI OD	Author Developed	Unidimensional	62.50 (Higher)
Unique	[50]	USA	69	Clinical/Risk	2-5 years	SI	ORCE	Multidimensional	81.25 (Higher)
Unique	[30]	USA	51	Clinical/Risk	2-5 years	SI OD	CARE-Index	Unidimensional	37.50 (Lower)
Unique	[67]	Netherlands	59	Clinical/Risk	2-5 years	SI OD	NICHD SECCYD	Multidimensional	53.33 (Lower)
Unique	[58]	USA	74	Clinical/Risk	2-5 years	SI	Author Developed	Unidimensional	62.50 (Lower)
Unique	[68]	Ukraine	64	Clinical/Risk	2-5 years	SI	EAS	Multidimensional	66.67

Unique	[42]	Israel	40	Clinical/Risk	2-5 years	OD SI	EAS	Unidimensional	(Higher) 87.50
Unique	[51]	USA	82	Clinical/Risk	2-5 years	OD SI	Author Developed	Multidimensional	(Higher) 68.75
Unique	[44]	England	128	Normative	2-5 years	SI	Ainsworth Scales	Unidimensional	(Lower) 75.00
Unique	[71]	United Kingdom	129	Clinical/Risk	2-5 years	SI OD[d]	Author Developed	Multidimensional	(Higher) 43.75 (Lower)
Unique	[64]	USA	29	Clinical/Risk	2-5 years	SI	Ainsworth Scales	Unidimensional	56.25 (Lower)
Unique	[47]	USA	732	Clinical/Risk	2-5 years	SI OD	Author Developed	Unidimensional	56.25 (Lower)
Unique	[65]	United Kingdom	98	Normative	2-5 years	SI OD	Author Developed	Both	75.00 (Lower)
Unique	[48]	England	78	Normative	2-5 years	SI OD	Author Developed	Both	60.00 (Lower)
Unique	[66]	Canada	161	Clinical/Risk	2-5 years	OD	EAS	Unidimensional	68.75 (Higher)

NICHD SECCYD = National Institute for Child Development: Study of Early Child Care and Youth Development; MAVAN = Maternal Adversity, Vulnerability and Neurodevelopment; EAS = Emotional Availability Scales; ORCE = Observational Record of the Caregiving Environment; SI = Secure-Insecure; OD = Organized-Disorganized

[a] Moss Research Group First Cohort

[b] Moss Research Group Second Cohort

[a,b] Moss Research Group First and Second Cohort Combined

[c] Study sample size reflective of that used in the present quantitative and qualitative analysis

[d] Interpretation of dichotomy based on non-significant findings for caregiver sensitivity as a function of the four categories of attachment, as insufficient information was available to interpret the two-way dichotomy

[e]The overall quality judgment (higher vs. lower) is determined based on meeting six key criteria (sample size and power; clearly defined, valid and reliable implementation of the predictor and outcome variables; coders of preschool attachment blind to other study variables; > or equal to 80% retention in longitudinal studies, accounting/controlling for potential confounding variables) from the 16 criteria used to determine the quality score.

Table 2. Quantitative and Qualitative Summaries.

	Articles analyzed	Synthesis technique	Effect size	Summary of results
1. Longitudinal relationship between caregiver sensitivity and preschool attachment				
1.1. Unidimensional caregiver sensitivity and preschool attachment				
1.1.1. *Secure vs. Insecure*	[44,46,48]	Quantitative	Medium effect (g = 0.46)	Medium effect indicating higher levels of unidimensional caregiver sensitivity among caregivers of secure relative to insecure children (g = 0.46, p = .002, 95% CI [0.17, 0.75]). Higher effects among samples where children were older when preschool attachment was assessed.
1.1.2. *Secure vs. Insecure*	[45,47]	Qualitative	Mixed effects	One study reported a large overall effect (g = . 0.84) suggesting that caregiver sensitivity was higher for caregivers of children who were secure versus insecure. The other study reported that caregiver sensitivity did not significantly differ as a function of child secure and insecure attachment. Of note, the study reporting a non-significant finding controlled for both child birthweight and socioeconomic status.
1.1.3. *Organized vs. Disorganized/Controlling*	[46,48]	Quantitative	Medium effect (g = 0.51)	Medium effect indicating higher levels of unidimensional caregiver sensitivity among caregivers of organized relative to disorganized children (g = 0.51, p = .08, 95% CI [-0.06, 1.09]).
1.1.4. *Organized vs. Disorganized/Controlling*	[45,47]	Qualitative	Mixed effects	One study revealed a medium effect (g = .42) suggesting that unidimensional caregiver sensitivity was higher for caregivers of children who were organized versus disorganized. The other study reported that caregiver sensitivity did not significantly differ as a function of child organization

				versus disorganization. Of note, the study reporting a non-significant finding controlled for both child birthweight and socioeconomic status.
1.2. Multidimensional caregiver sensitivity and preschool attachment				
1.2.1. *Secure vs. Insecure*	[48,50,51,53,54]	Quantitative	Small effect (g = 0.34)	Small effect indicating higher multidimensional sensitivity levels of caregiver sensitivity among caregivers of secure relative to insecure children (g = 0.34, p = .004, 95% CI [0.11, 0.56]).
1.2.2. *Secure vs. Insecure*	[24,41,52,55]	Qualitative	Mixed effects	Four studies from the same sample (NICHD SECCYD) revealed a small (g = .32) to medium (g = .49) overall effect suggesting that multidimensional caregiver sensitivity was higher for caregivers of children who were secure versus insecure.
1.2.3. *Organized vs. Disorganized/Controlling*	[48,53,54]	Quantitative	Small effect (g = 0.39)	Small effect g = 0.39, p = .001, 95% CI [0.16, 0.62], indicating that higher multidimensional caregiver sensitivity among caregivers of organized children relative to disorganized children.
1.2.4. *Organized vs. Disorganized/Controlling*	[24,55,56]	Qualitative	Mixed effects	Two studies from the same sample revealed a small (g = .30) to medium (g = .47) effect, suggesting that multidimensional caregiver sensitivity is higher for caregivers of organized versus disorganized children. Another study reported a medium overall effect (g = .61), supporting the finding that multidimensional caregiver sensitivity is higher for caregivers of children who are organized relative to disorganized.
2. Concurrent relationship between caregiver sensitivity and preschool attachment				

2.1 Unidimensional caregiver sensitivity and preschool attachment				
2.1.1. *Secure vs. Insecure*	[14,42,48, 57,58,60,61,63,64,65]	Quantitative	Medium effect (g = 0.59)	Medium effect indicating higher unidimensional levels of caregiver sensitivity among caregivers of secure versus insecure children (g = 0.59, p < .0001, 95% CI [0.40, 0.79]).
2.1.2. *Secure vs. Insecure*	[15,30,45,46,47,59,62]	Qualitative	Mixed effects	In five studies, stemming from three different samples, there was a medium (g = .49) to very large (1.09) effect, suggesting that unidimensional caregiver sensitivity was higher for caregivers of children who were secure as opposed to insecure. Two studies reported a non-significant relationship between unidimensional caregiver sensitivity and preschool attachment, but these studies were noted to report on clinical samples of lower socioeconomic status and were judged to have lower quality.
2.1.3. *Organized vs. Disorganized/Controlling*	[15,42,48,57,60,61,63,65,66]	Quantitative	Medium effect (g = 0.50)	Medium effect indicating higher unidimensional levels of caregiver sensitivity for caregivers of organized children relative to disorganized children (g = 0.50, p < .0001, 95% CI [0.29, 0.72]).
2.1.4. *Organized vs. Disorganized/Controlling*	[30,45,46,47,59,62]	Qualitative	Mixed effects	In four studies comprised of two different samples, there was a medium (g = .42) to very large (g = 1.66) effect, suggesting that unidimensional caregiver sensitivity was higher for caregivers of children who were organized compared to disorganized. Two additional studies identified a non-significant relationship between unidimensional caregiver sensitivity and preschool attachment. The studies reporting non-significant findings were among clinical samples, of lower socioeconomic status, and were judged to have lower quality.

2.2 Multidimensional caregiver sensitivity and preschool attachment				
2.2.1. *Secure vs. Insecure*	[13,51,53,65,67,68,70]	Quantitative	Medium effect (g = 0.49)	Medium effect (g = 0.49, p < .0001, 95% CI [0.39, 0.59]) indicating higher levels of multidimensional caregiver sensitivity among caregivers with secure children relative to insecure children.
2.2.2. *Secure vs. Insecure*	[41,43,69,71,72]	Qualitative	Mixed effects	Four studies demonstrated small (g = .35), medium (g = .41 to .45), and large (g = .74) effects indicative that multidimensional caregiver sensitivity is higher among caregivers with secure children compared to insecure children. Another study, reported a non-significant relationship between multidimensional caregiver sensitivity and preschool attachment.
2.2.3 *Organized vs. Disorganized*	[13,53,65,67,68]	Quantitative	Small effect (g = 0.39)	Small effect indicating higher multidimensional levels of caregiver sensitivity among caregivers of organized children relative to disorganized children (g = 0.39, p < .0001, 95% CI [0.25, 0.53]).
2.2.4 *Organized vs. Disorganized*	[71]	Qualitative	Non-significant (no effect size reported)	One study reported a non-significant relationship between multidimensional caregiver sensitivity and preschool attachment.

Table 3. The longitudinal relationship between unidimensional caregiver sensitivity and preschool attachment.

Comparison	*g*	SE	z	95% CI	*p*	Q	I^2 (%)	*Df*
Secure vs. Insecure (*n* = 448)	0.46	0.15	3.14	[0.17, 0.75]	.002	4.25	56.62	2
Organized vs. Disorganized/controlling (*n* = 320)	0.51	0.29	1.75	[-0.06, 1.09]	.08	2.36	57.55	1

Note: *g* = Hedges' *g; Q* = Cochran's heterogeneity statistic; Q; I^2 = percentage of variability across studies that is due to between-study heterogeneity.

Table 4. The longitudinal relationship between multidimensional caregiver sensitivity and preschool attachment.

Comparison	*g*	SE	z	95% CI	*p*	Q	I^2 (%)	*df*
Secure vs. Insecure (*n* = 1,528)	0.34	0.16	2.90	[0.11, 0.56]	.004	10.52	54.30	5
Organized vs. Disorganized/controlling (*n* = 1,377)	0.39	0.12	3.28	[0.16, 0.62]	.001	2.46	33.40	2

Note: *g* = Hedges' *g; Q* = Cochran's heterogeneity statistic; Q; I^2 = percentage of variability across studies that is due to between-study heterogeneity.

Table 5. The concurrent relationship between unidimensional caregiver sensitivity and preschool attachment

Comparison	*g*	SE	z	95% CI	*p*	Q	I^2 (%)	*df*
Secure vs. Insecure (*n* = 2,050)	0.59	0.10	5.89	[0.40, 0.79]	.0001	25.85	61.36	9
Organized vs. Disorganized/controlling (*n* = 2,001)	0.50	0.11	4.56	[0.29, 0.72]	.0001	15.55	56.44	8

Note: *g* = Hedges' *g; Q* = Cochran's heterogeneity statistic; Q; I^2 = percentage of variability across studies that is due to between-study heterogeneity.

Table 6. The concurrent relationship between multidimensional caregiver sensitivity and preschool attachment.

Comparison	*g*	SE	z	95% CI	*p*	Q	I^2 (%)	*df*
Secure vs. Insecure (*n* = 1,665)	0.49	0.05	9.64	[0.39, 0.59]	.0001	6.25	0.01	7
Organized vs. Disorganized/controlling (*n* = 1,456)	0.39	0.07	5.61	[0.25, 0.53]	.0001	4.22	0.01	4

Note: *g* = Hedges' *g; Q* = Cochran's heterogeneity statistic; Q; I^2 = percentage of variability across studies that is due to between-study heterogeneity.

Chapter 3: Bridging Two Paradigms: The Vaccination Context and The Separation-Reunion Procedure

The primary goal of Study 1 (Chapter 2) was to synthesize the literature examining the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment. The systematic literature review both quantitatively and qualitatively synthesized this literature through accounting for the temporal relationship between caregiver sensitivity and preschool attachment (i.e., longitudinal vs. concurrent), the operationalization of caregiver sensitivity (i.e., unidimensional vs. multidimensional), and attachment categorizations (i.e., secure-insecure vs. organized-disorganized). Additionally, a series of meta-regressions were completed in order to account for the impact of potential moderator variables.

For the first time in the literature, quantitative estimates for the longitudinal and concurrent relationship between caregiver sensitivity and attachment are available for the preschool age. Moreover, the estimates were comparable, and in some cases larger, to that of De Wolff and van IJzendoorn's (1997) combined effect size (r = .22) for the previous synthesis of the literature linking caregiver sensitivity to attachment in infancy. Overall, the Study 1 qualitative and quantitative syntheses were consistent such that there was greater caregiver sensitivity among caregivers with secure and organized children relative to insecure and disorganized children, respectively.

Although this was the first synthesis of the literature examining both the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment measured using the "gold standard" (Solomon & George, 2016) Main and Cassidy (1988) and Cassidy and Marvin (1992) classification systems, there were several challenges identified with the state of the current literature. The most notable limitation of the synthesized literature is the use of low to

moderate distress paradigms (i.e., free-play, mild frustration task) to examine caregiver sensitivity. Given instances of fear or pain are postulated to activate the attachment system (Bowlby 1969/1982), it is important to examine how a naturally-occurring high distress paradigm (i.e., routine vaccinations) may affect the relationship between caregiver sensitivity and preschool attachment. Exploring caregiver sensitivity in a natural paradigm, outside the scope of the laboratory, will also broaden current understandings of the economic ways to screen for factors related to preschool attachment in order to prevent developmental psychopathology. Another challenge identified through the synthesis in Study 1, was the heterogeneity in the categorization of attachment outcomes. Often researchers varied their categorization of preschool attachment outcomes, which necessitated a synthesis of the literature according to the preschool secure-insecure and organized-disorganized categories. Therefore, it was difficult to synthesize the literature in accordance with the intricate additional patterns that comprise preschool attachment (i.e., avoidance, ambivalence, controlling-caregiving, controlling-punitive). A final challenge noted, was the relatively fewer studies that examined longitudinal relationships compared to the wealth of studies examining concurrent relationships. Accordingly, it is difficult to discern if the meta-analyses would have yielded different findings if there were a comparable number of longitudinal and concurrent studies available.

In light of the above noted limitations identified from the synthesis in Study 1 (Chapter 2), the primary aim of Study 2 and Study 3 (Chapter 4) was to examine the longitudinal and concurrent relationships between caregiver-child behaviours in the vaccination context and preschool attachment outcomes. Study 2 and Study 3 were completed using the OUCH Cohort, a longitudinal cohort of healthy caregiver-child dyads followed during routine immunizations across the first year of life. The preschool attachment scores (which were based on the preschool

separation-reunion procedure; Cassidy & Marvin, 1992) were measured in a separate full-day psychological assessment in the lab, within 8 weeks of the preschool vaccination. Study 2 analyses included infants ($N = 84$) with infant vaccination data at 2-months and preschool attachment data. Appendix E provides an overview of the variables' measurement timelines for the infant vaccination. Study 3 analyses included preschoolers ($N = 117$) with preschool vaccination data at 4-5 years and preschool attachment data. Appendix F provides an overview of the variables' measurement timelines for the preschool vaccination. Study 2 examined the longitudinal relationship between caregiver behaviours (i.e., caregiver sensitivity, caregiver proximal soothing) and infant pain-related distress on preschool attachment outcomes. Study 3 examined the concurrent relationship between caregiver behaviours (i.e., caregiver sensitivity) and preschooler pain-related distress on preschool attachment outcomes. For both Study 2 and Study 3, the attachment outcome was based on the Preschool Attachment Rating Scales (PARS; Moss, Lecompte & Bureau, 2015), a measure which extends upon the Cassidy and Marvin (1992) coding system, applying a continuous rating to each of the Cassidy and Marvin (1992) preschool attachment categories (i.e., security, avoidance, ambivalence, behaviourally disorganized, controlling-punitive, controlling-caregiving). The PARS (Moss et al., 2015), allows for a fine-grained continuous rating of preschoolers attachment patterns on all six of the preschool attachment categories, which facilitates an estimate of the intensity of attachment behaviours while allowing for greater statistical power in smaller sample sizes (Moss et al., 2015).

Study 2 and Study 3 (Chapter 4) address the gaps in the literature identified in Study 1 (Chapter 2) through: 1) examining caregiver sensitivity in a naturally-occurring high distress paradigm (i.e., routine vaccinations); 2) using a fine-grained coding system (i.e., PARS; Moss et

al., 2015) which allows for a thorough understanding of caregiver sensitivity and preschool attachment with respect to the multifaceted sophisticated patterns of attachment; and 3) providing both a longitudinal and concurrent examination of caregiver-child behaviours and preschool attachment. Moreover, the analyses presented in Study 2 and Study 3 facilitate an opportunity to examine the role of child emotion regulation during this high distress paradigm, thus adding a new dimension to this body of literature.

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Chapter 4: Longitudinal and Concurrent Relationships Between Caregiver-Child Behaviours in the Vaccination Context and Preschool Attachment[2]

1. Introduction

The development of immediate reactive and more distal regulatory acute pain behaviours in infancy has been shown to relate to infants' attachment relationship with their primary caregiver [20,21,22]. Attachment relationships are fundamentally rooted in how a child is soothed during distressing events, such as pain, during early childhood [17,48]. Understanding how discrete caregiver behaviours relate to a child's pain behaviours has been demonstrated within different stages of early childhood [6, 36]. This set of analyses takes the next step to examine both longitudinal and concurrent relationships between a parent and child behaviours during vaccinations and an objective measure of the caregiver-child dyadic relationship at 4 to 5 years of age (i.e., preschool attachment). Examining precursors to attachment in the preschool age is particularly important due to the links between preschool attachment and developmental psychopathology outcomes [19,24,25,31,33,34,35,46]. Thus, the current set of studies allows for an important contextualization of both parent and child behaviours during painful vaccinations within a larger child development context.

Although research has examined the relationship between infant vaccination behaviours and infant attachment, no research exists linking parent and infant vaccination behaviours and attachment at the preschool age. Although one small pilot study examined caregiver sensitivity to *children's* pain-related distress and childhood attachment to date, and found parents of secure

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children were more likely to engage in pain soothing behaviours [39]. The current study provides a unique longitudinal window linking both parent and child vaccination behaviours, in infancy and preschool, to preschool attachment outcomes. Moreover, the present study employed an attachment rating system [32], adapted from a "gold standard" measure [7,41], that allows for a fine-grained assessment of each of the four broad preschool attachment categories rather than narrow categorizations of secure (a calm and comfortable interaction, where the preschooler uses the caregiver a secure base to explore) versus insecure patterns [ambivalent (emphasis on dependency through immaturity and/or resistance), avoidant (a neutral interaction through avoidance of physical or emotional contact), and disorganized (behaviourally disorganized subtype with disordered sequences, confusion, or a mix of other classifications; controlling-caregiving subtype that guides, orients, or cheers-up the parent; and controlling-punitive subtype with punitiveness and hostility toward the parent)]. Study 1 examined caregiver-infant behaviours during the first vaccination of early childhood (2-months) as predictors of preschool attachment ratings. Study 2 examined caregiver-preschooler behaviours during the last vaccination of early childhood (4-5 years) as predictors of preschool attachment ratings. We hypothesized that:

(1) More optimal caregiver behaviours (i.e., higher caregiver sensitivity, more soothing behaviours) would be related to higher levels of security and lower levels of insecure attachments.

(2) Higher anticipatory distress (pre-needle pain-related distress) would be related to higher levels of security and ambivalence, and lower anticipatory distress would be related to higher levels of the remaining types of insecure attachments. Previous research has suggested that in the vaccination context, due to the commonality of high signalling,

relationships between distress behaviours and both security and ambivalence are similarly valenced [21].

(3) Given our past work in infants suggests that the first 15 seconds post-needle are the most painful [37] and the optimal nature of honest signalling of pain when pain is present [22], we would expect that all infants/preschoolers would exhibit high amounts of pain initially, and therefore it would not strongly relate to attachment. However, higher levels of pain-related distress during the regulatory phases (1 and 2 minutes post-needle) would be related to higher levels of security, and lower levels of pain-related distress during the regulatory phases would be related to higher levels of the insecure attachment types.

2. Method

2.1 Participants

The participants in this study are from the Opportunities to Understand Childhood Hurt (OUCH) cohort, a longitudinal sample (N = 760) of healthy caregiver-child dyads observed in infancy through preschool. Caregiver-child dyads were recruited in infancy at three pediatrics clinics in Toronto, Ontario, Canada. Dyads were eligible to participate if infants had no suspected developmental delays or impairments or chronic illnesses, had not previously been admitted to a neonatal intensive care unit, and were born at 36 weeks gestation or greater. Ethics approval was obtained from all participating institutions, and informed consent was obtained at each phase of participation.

Caregiver-child dyads from the OUCH cohort were followed over children's routine vaccination appointments over the first year of life (2-, 4-, 6- and 12-months of age) and then at preschool (4-5 years of age). Caregiver-child dyads who participated in the preschool vaccination phase of the study were contacted and asked if they would like to participate in the

preschool assessment phase, which involved a separate full-day psychological assessment that included the preschool separation-reunion procedure [7]. Previous analysis of the preschool phase of our cohort [6] examined the difference in caregivers who chose to participate in the preschool phase versus not participate on various demographic variables (i.e., age, education, acculturation). Few demographic differences were identified such that caregivers who participated were marginally older, held slightly more graduate degrees, and no differences in acculturational ratings were identified [6]. Specifically at the 2-month vaccination infants were 48.8% female, and caregivers were 92.2% mothers (7.6% fathers, and .2% mothers and fathers), had an average age of 28.03 (*SD* = 13.31), and achieved high levels of education (30.3% with graduate school/professional training, 41.7% with a university degree, 20.8% with partial university, trade school, or community college, 6.6% with a high school diploma, .4% with some high school, and .2% with less than the 7th grade). Similarly, at the preschool vaccination, preschoolers were 47.7% female, and caregivers were 85.1% mothers (13.9% fathers and 1.0% grandmothers). Due to the longitudinal nature of the study, caregivers had an average age of 38.30 (*SD* = 5.35) at the preschool vaccination phase. Finally, among those choosing to participate in the separate full-day psychological assessment, preschoolers were 47.1% female, and caregivers were 86% mother (14% fathers), had an average age of 39.22 (*SD* = 4.12), and achieved high levels of education (37.13% with graduate school/professional training, 48.5% with a university degree, 12.57% with partial university, trade school, or community college, and 1.8% with a high school diploma).

A total of 172 caregiver-child dyads agreed to participate in the preschool assessment wave of the cohort study. However, 23 of those caregiver-child dyads could not be coded in the preschool separation-reunion procedure due to issues with the video (*n* = 19), or due to the

caregiver-child speaking in a non-English language (n = 4), resulting in a total of 149 coded preschool-separation reunion procedures.

The present paper examines data from the 2-month vaccination wave and the preschool separation-reunion procedure wave (Study 1), and data from the preschool vaccination wave and the preschool separation-reunion procedure wave (Study 2). Of the 149 caregiver-preschooler dyads coded in the preschool separation-reunion procedure, 103 had 2-month vaccination data, and 137 had preschool vaccination data. However, some cases were dropped in the analysis in order to ensure that the caregiver coded during a given vaccination wave was consistent with the caregiver participating in the preschool separation-reunion procedure (i.e., ensuring the parent whose sensitivity was coded during the preschool vaccination was also the same parent participating in the preschool separation-reunion procedure), resulting in n = 84 caregiver-child dyads in Study 1 analyses, and n = 117 caregiver-child dyads in Study 2 analyses. Figures 1 and 2 provide a flow diagram to further clarify the number of caregiver-child dyads included within the analyses for Study 1 and 2, respectively.

Preschoolers who completed the preschool separation-reunion procedure were 50.3% female and had an average age of 4.83 years (SD = .58) at the preschool assessment. Caregivers who completed the preschool separation-reunion procedure were 87.9% mothers (12.1% fathers), had an average age of 39.24 (SD = 4.22), and achieved high levels of education (35.17% with graduate school or professional training, 48.97% with a 4-year university degree, 13.79% with partial university, trade school or community college, and 2.07% with a high school diploma). Children were identified as healthy, from middle/high socioeconomic status families, and developmentally typical.

Two other papers from our cohort [6,40] have published data linking the infant and preschool waves. However, the focus was solely on pain-related worry and distress behaviours within the vaccination context itself. Additionally, the aforementioned papers did not examine the preschool attachment data analyzed in the current study.

2.2 Procedure

Details have been published elsewhere pertaining to the infant and preschool vaccination procedures [36,40] and the preschool psychological assessment procedure [6]. Accordingly, we describe only details pertaining to the preschool separation-reunion procedure that occurred as part of the full-day preschool psychological assessment.

The modified separation-reunion procedure was adapted from the procedure described by Cassidy and Marvin with the MacArthur Working Group on Attachment [7] that specifies an ordered series of 2 separations and 2 reunions. Although the Cassidy and Marvin [7] procedure informed the separation-reunion procedure in the present study, we also incorporated adaptations from previous studies [30] to integrate the separation-reunion procedure within the context of our full day psychological assessment where the child was often separated from their caregiver while working with a clinical examiner. The present study protocol for the modified separation-reunion procedure [7] is described below.

After arriving at the laboratory and completing informed consent (warm-up), the caregiver and preschooler separated for approximately 2 hours for the morning session. During the morning session, the parent completed some questionnaires in an adjacent room to where the preschooler completed several achievement and cognitive assessment measures with a clinical examiner. At the close of the morning session, the examiner stated to the child, “I am going to try to find your mom/dad now, you wait here.” These instructions served to activate the

attachment system (i.e., the child becomes uncertain about the location of their caregiver). After leaving the preschooler in the room for 4 minutes (Separation 1), the caregiver is asked to enter the room (without any instructions about how to interact with their child) for a 4-minute reunion (Reunion 1). The caregiver and preschooler then left for a 1-hour lunch. When the caregiver and preschooler returned from lunch they separated and the child continued to complete some cognitive measures with the clinical examiner, while the caregiver completed measures in the adjacent room. After approximately 2 hours of testing, the second separation-reunion procedure was implemented with identical instructions (Separation 2), this time leaving the preschooler in the room for 6 minutes, followed by a 4-minute reunion (Reunion 2).

2.3 Measures

2.3.1 Demographic Information

Caregivers completed a brief demographic questionnaire that inquired about questions including; caregiver age, caregivers' relation to their child, education, income, child age, and child sex.

2.3.2 Preschoolers' Attachment Outcomes

Preschooler attachment behaviour during the separation-reunion procedure was coded using the Preschool Attachment Rating Scales (PARS) [32]. The PARS [32] was implemented to rate preschoolers on six separate scales corresponding to the Cassidy and Marvin [7] attachment categories (i.e., secure, avoidant, ambivalent, behaviourally disorganized/insecure-other, controlling-caregiving, and controlling-punitive). The *security* scale examines the degree to which preschoolers are observed to have a calm and enjoyable interaction with their primary caregiver, using the caregiver as a secure base in which to explore their environment. The *avoidance* scale examines the degree to which preschoolers are observed to maintain a neutral

interaction with their caregiver through avoidance of physical or emotional interactions which may bring attention to the dyad's relationship. The *ambivalence* scale examines the degree to which preschoolers are observed to emphasize dependency on the caregiver through immaturity and/or resistance. The behaviourally disorganized scale examines the degree to which preschoolers are observed to have disordered sequences, incomplete movements, confusion and apprehension, disoriented expressions, depressed affect, or a mix of the other attachment classifications within or between episodes (i.e., a mix of avoidant and ambivalent patterns). The *controlling-caregiving* scale examines the degree to which preschoolers are observed to demonstrate a desire to guide, orient, or cheer-up the parent, whereas the *controlling-punitive* scales examines the degree to which preschoolers are observed to demonstrate punitiveness or hostility toward the parent [7,32].

Each scale is scored using a 9-point scale with a total ranging from 1-9. A higher score is indicative of greater child attachment behaviours corresponding to a given scale (i.e., a higher score on the security scale is indicative of greater security, whereas a higher score on behavioural disorganization is indicative of greater behavioural organization). The PARS has been shown to have adequate psychometric properties to evaluate child-mother and child-father attachment [10].

The PARS was coded by four trained and reliable coders. Twenty-eight percent of the videos were double-coded, and any major discrepancies in coding were reviewed and resolved through consensus meetings. The interrater reliability for the PARS was examined using intraclass correlations (ICC), which ranged between ICC = .69 to ICC = .85. All attachment coders were blind to the caregiver-child dyad scores on all of the other study variables.

2.3.3 Infant Vaccination Predictors: 2-months

The Emotional Availability Scales (EAS) was used to code caregivers' sensitivity across the entire duration of infants' 2-month vaccination [2]. The EAS provides an overall clinical judgement of caregiver behaviour in which caregivers are rated on four separate subscales; sensitivity, structuring, nonintrusiveness, and nonhostility. Caregivers are rated on seven dimensions for each of the four subscales, yielding a potential score of 7 to 29 on each subscale. Subscales are summed to create a combined score for emotional availability, with scores ranging from 28 to 116. A higher score on the emotional availability composite and/or the subscales is indicative of a more optimal caregiver interaction. The EAS was coded by four trained coders. The intraclass correlations for the caregiver emotional availability composite ranged between .88 to .93. All coders were blind to the other study measures.

The Measure of Adult and Infant Soothing and Distress (MAISD), a reliable and valid coding system of infant and caregiver behaviour in the vaccination context [8], was used to code caregiver proximal soothing (physical comfort and rocking) during infants' 2-month vaccination appointments. Physical comfort and rocking were coded as absent (0) or present (1) over 5-second epochs for three phases during the vaccination appointment: 1 minute before the first needle, 1 minute after the last needle, and 2 minutes after the last needle. A total score for each behaviour (i.e., physical comfort and rocking) was first calculated for each of the three phases coded. Each behaviour was calculated by first summing the frequency of 5-second epochs where the given behaviour was observed for each minute and then divided by the total number of codable epochs (most often 12 epochs per minute; range 0-1). Subsequently, a composite score for proximal soothing was calculated by summing the index score for each target behaviour (physical comfort and rocking) at each of the three phases coded (1 minute pre-needle, 1 minute post-needle, 2-minutes post-needle). Scores ranged from 0-2 for each epoch. Higher scores on

the proximal soothing index are indicative of a higher incidence of these soothing behaviours. Seven reliable MAISD coders, who were blind to the other study measures, coded the data. Intraclass correlations ranged from .91 to .95 for rocking, and .75 to .88 for physical comfort.

The Modified Behaviour Pain Scale (MBPS) was used to code infant pain-related distress during infants' 2-month vaccination appointment [44]. The MPBS measures infant-pain related distress over 15-second epochs at different phases across the appointment. In order to obtain a broad based measure of infant pain-related distress, infant behaviours are rated on three different dimensions: facial actions (range: 0-3), cry (range: 0-4), and distressed body movements (0-3). A composite score of infants' overall pain-related distress for a given epoch is created by summing infants' behaviours on each of the dimensions, resulting in a total score ranging from 0 to 10. A higher score is indicative of more pain-related distress. The present study examined four 15-second epochs of pain-related distress: 15-seconds prior to the first needle (MBPS Baseline), the first 15-seconds immediately after the last needle (MBPS0), 1 minute after the last needle (MBPS1), and 2 minutes after the last needle (MBPS2). Examining scores 15-seconds before the first needle facilitates an assessment of infants' anticipatory distress [40]. Obtaining scores at 15-seconds after the last needle and 1- and 2-mintues post-needle facilitates a differentiation between infants initial reactivity and regulation periods of pain-related distress [37]. Twenty percent of the data was double-coded and all coders were blind to the other study measures. Intraclass correlations ranged from .93 to .96, indicating excellent interrater reliability.

2.3.4 Preschoolers' Vaccination Predictors

Caregiver sensitivity during preschoolers 4-5 year vaccination appointment was coded using the Maternal Behaviour Q-Set Short Version (MBQS) [45]. The MBQS uses 25 items that examine sensitivity-related caregiver behaviours including: responsiveness, monitoring,

attentiveness, appropriateness of caregiver affect, and support in negative/distressing situations. The 25 items are rated on a scale from “not at all” (-2) to “very much like” (+2) a prototypically sensitive caregiver. The overall sensitivity score is created by calculating the item-by-item correlation between the observed sort of the caregivers’ interaction and the aggregate sort of the prototypically sensitive caregiver. A higher overall score is indicative of greater caregiver sensitivity. Sixty-seven percent of the MBQS-SF data was double-coded by two trained and reliable coders who were blind to the other study measures. The interrater reliability was high, with an overall intraclass correlation of .82.

The Face, Legs, Activity, Cry, Consolability coding system (FLACC) was used to code preschoolers’ pain-related distress behaviours during preschoolers 4-5 year vaccination appointments [28]. The scale measures five dimensions (face, legs, activity level, cry, and consolability) to obtain a broad-based assessment of pain-related distress behaviours. Each behavioural category is scored using a 0-2 scale, with a total score ranging from 0-10. A higher score is indicative of greater pain-related distress. Paralleling the MBPS coding from infancy, the present study analysis examined total scores over 15-second epochs during four phases of the appointment: 15-seconds prior to the first needle (FLACC Baseline), the first 15-seconds immediately after the last needle (FLACC0), 1 minute after the last needle (FLACC1), and 2 minutes after the last needle (FLACC2). Examining scores 15-seconds before the first needle facilitates the assessment of preschoolers’ anticipatory distress [40]. Obtaining scores at 15-seconds after the last needle and 1- and 2-mintues post-needle facilitates a differentiation between preschoolers’ reactivity and regulation periods of pain-related distress [37]. The FLACC was coded by trained and reliable coders, and all intraclass correlations were greater than .85 for each of the five behaviours coded.

2.4 Plan of Data Analysis

2.4.1 Study 1: The longitudinal relationship between caregiver-infant behaviours in the vaccination context and preschool attachment

In order to examine the relationship between caregiver-infant behaviours in the vaccination context at 2-months of age and preschool attachment at 4-5 years of age, a series of hierarchical multiple regressions predicting each preschool attachment rating (i.e., security, avoidance, ambivalence, disorganization, controlling-caregiving, and controlling-punitive) were conducted.

A total of six planned hierarchical multiple regression (6 attachment rating outcomes [security, avoidance, ambivalence, disorganization, controlling-caregiving, controlling-punitive] were completed. Caregivers' overall sensitivity across the entire duration of the appointment, caregiver proximal soothing (1 minute pre-needle, 1 minute post-needle, and 2 minutes post-needle), and infant-pain related distress over four 15-second epochs (15-seconds pre-needle [MBPS Baseline], 15-seconds post-needle [MBPS0], 60-74 seconds post-needle [MBPS1] and 120-134 seconds post-needle [MBPS2]) were entered as predictors in each model. Bivariate correlations were examined to ensure there was no multicollinearity between the predictor variables. None of the correlations were greater than .52, which is a well-below the acceptable cut-off criterion of $r \geq .9$ [43]. Some of the model variables had a violation of the assumptions pertaining to multiple regression analyses (e.g., normality), and therefore bootstrapping methods were employed as they provide robust methods that generate bias corrected confidence intervals and significance tests of the model parameters.

Across all models, the caregiver sensitivity and proximal soothing variables were entered in Step 1, and infant pain-related distress variables were entered in Step 2. This decision was

based on the previous evidence linking caregiver sensitivity and proximal soothing to attachment outcomes, both in our cohort [20] and in the broader literature [1,9,12,18,23,50]. The conducted models examined the longitudinal relationship between caregiver behaviours in the infant vaccination context and preschool attachment, and also investigated if infant pain-related distress would predict preschool attachment above and beyond the impact of caregiver behaviours.

2.4.2 Study 2: The concurrent relationship between caregiver-preschooler behaviours in the vaccination context and preschool attachment

The analysis plan for the second study followed in a similar fashion. In order to examine the relationship between caregiver-preschooler behaviours in the vaccination context and preschool attachment, a series of six planned hierarchical multiple regressions predicting each preschool attachment rating (i.e., security, avoidance, ambivalence, disorganization, controlling-caregiving, and controlling-punitive) were conducted. Caregivers' overall sensitivity across the entire duration of the preschool vaccination appointment, and preschoolers' pain-related distress over four 15-second epochs (15-seconds pre-needle [FLACC Baseline], 15-seconds post-needle [FLACC0], 60-74 seconds post-needle [FLACC1] and 120-134 seconds post-needle [FLACC2]) were entered as predictors in each model. Bivariate correlations were examined to ensure there was no multicollinearity between the predictor variables, and none of the correlations were greater than .66, which is well below the acceptable cut-off criterion of $r \geq .9$ [43]. Similar to study 1, some of the model variables had a violation of the assumptions pertaining to multiple regression analyses (e.g., normality), and therefore bootstrapping methods were employed.

Parallel to the analyses in study 1, caregiver sensitivity was entered in Step 1, and preschooler pain-related distress variables were entered in Step 2 across all study 2 models. The conducted models facilitated an examination of the relationship between caregiver sensitivity in

the preschool vaccination context and preschool attachment, and further investigated if preschooler pain-related distress would predict preschool attachment above and beyond the impact of caregiver sensitivity.

3. Results

All analyses were interpreted by examining both the *p*-values and the standardized regression coefficients (i.e., Beta weights). Because the predictor variables were not highly correlated, our interpretation of the strength of the relationships between the predictor variables and outcome variables was informed by the Beta weights [13,49]. The strength of the Beta weights was determined using the criteria from recent guidelines for interpretation of effect sizes [16], which suggests that Cohen's traditional categorizations are too stringent. Recommended categorizations [16] are: very small effect (r = .05), small effect (r = .10), medium effect (r = .20), large effect (r = .30), and very large effect (r = .40). In the present study, results were interpreted if the *p*-value was < .05, or if both the Beta weights reflected large effect sizes (β > .30) and the *p*-value was < .1.

The interpretation of both *p*-values and Beta weights were considered in order to account for the exploratory nature of this research and to compensate for the risk of a Type II error. Additionally, G*Power Statistical Power Analysis Software for Mac was used to determine if there was enough power to detect significant effects in both Study 1 and Study 2 analyses. The power analysis for Study 1 was calculated based on a Linear Multiple Regression with an estimated effect size = .2, alpha error prob = .05, Power = .8, and 8 predictor variables. The total sample size required for Study 1 was 84 participants, which is consistent with the sample size in the Study 1 analyses. The power analysis for Study 2 was calculated based on a Linear Multiple Regression with an estimated effect size = .2, alpha error prob = .05, Power = .8, and 5 predictor

variables. The total sample size required for Study 2 was 70, which is below the sample size for the Study 2 analyses.

Sex analyses were completed to determine if child sex should be entered as a control variable in the main analyses. However, the relationship between child sex and all of the preschool attachment scales was non-significant (all *p*'s > .05). Table 1 presents the descriptive statistics for all model (Study 1 and Study 2) variables.

3.*1 Study 1: The longitudinal relationship between caregiver-infant behaviours in the vaccination context and preschool attachment*

Table 2 provides the bivariate correlations for all of the model variables examining the relationship between caregiver-infant behaviours during the 2-month vaccination and preschool attachment.

3.1.1 The longitudinal relationship between 2-month caregiver-infant behaviours in the vaccination context and preschool attachment.

Each of the hierarchical regressions are described below separately for each preschool attachment rating outcome. Table 3 provides the unstandardized and standardized regression coefficients, standard error, *p*-values, and bias-corrected confidence intervals for each of the 2-month models. While reported in Table 3, the model for Controlling-Caregiving will not be described due to non-significant findings.

3.1.1.1 Security

Details of the hierarchical model are in Table 3. The final regression model predicting preschool security from the infant vaccination variables (caregiver sensitivity, caregiver proximal soothing, infant pain-related distress) was non-significant ($p = .07$) with an R^2 of .20. Although the overall model was non-significant, there was a significant positive relationship

between infant pain-related distress at 2 minutes post-needle and preschooler security (β = .39, p = .01).

3.1.1.2 Avoidance

Details of the hierarchical model are in Table 3. The final regression model predicting preschool avoidance from the infant vaccination variables (caregiver sensitivity, caregiver proximal soothing, infant pain-related distress) was non-significant (p = .39) with an R^2 of .12. Although the overall model was non-significant, there was a significant positive relationship between caregiver sensitivity in the 2-month infant vaccination and preschooler avoidance (β = .30, p = .03).

3.1.1.3 Ambivalence

Details of the hierarchical model are in Table 3. The final regression model predicting preschool ambivalence from the infant vaccination variables (caregiver sensitivity, caregiver proximal soothing, infant pain-related distress) was non-significant (p = .36) with an R^2 = .13. Although the overall model was non-significant, there was a significant negative relationship between proximal soothing at 1 minute pre-needle and preschooler ambivalence (β = -.23, p = .04).

3.1.1.4 Disorganization

Details of the hierarchical model are in Table 3. The final regression model predicting preschool disorganization from the infant vaccination variables (caregiver sensitivity, caregiver proximal soothing, infant pain-related distress) was non-significant (p = .54) with an R^2 = .10. Although the overall model was non-significant, there was a marginally significant negative relationship between infant pain-related distress at 2 minutes post-needle and preschooler disorganization (β = -.35, p = .05).

3.1.1.5 Controlling-Punitive

Details of the hierarchical model are in Table 3. The final regression model predicting preschool controlling-punitive attachment from the infant vaccination variables (caregiver sensitivity, caregiver proximal soothing, infant pain-related distress was significant (p = .04) with and R^2 = .22. There was a marginally significant negative relationship between infant pain-related distress at 2 minutes post-needle and preschooler controlling-punitive attachment (β = -.43, p = .07).

3.2 Study 2: The concurrent relationship between caregiver-preschooler behaviours in the vaccination context and preschool attachment

Tables 4 provides the bivariate correlations for all model variables examining the relationship between caregiver-preschooler behaviours in the vaccination context and preschool attachment.

3.2.1 The concurrent relationship between caregiver-preschooler behaviours in the vaccination context and preschool attachment

Table 5 provides the unstandardized and standardized regression coefficients, standard error, p-values, and bias-corrected confidence intervals for each of the models. While reported in Table 5, models for Avoidance, Ambivalence, Disorganization, Controlling-Caregiving and Controlling-Punitive attachment outcomes will not be described below due to non-significant findings.

3.2.1.1 Security

Details of the hierarchical model are in Table 5. The final regression model predicting preschool security from the preschool vaccination variables (caregiver sensitivity, preschool pain-related distress) was non-significant (p = .08) with an R^2 = .09. Although the overall model

was non-significant, there was a significant positive relationship between caregiver sensitivity in the preschool vaccination and preschooler security (β = .29, p = .003).

4. Discussion

To our knowledge, this is the first study to comprehensively elucidate the longitudinal and concurrent relationships between routine vaccination behaviours, in infancy and preschool, and subsequent preschool attachment. Moreover, the vaccination appointments examined in the present paper facilitated a comparison between caregiver-child behaviours during the first and the last vaccination of early childhood. The results offer an interesting developmental contrast in examining the caregiver-child dyad given at the 2-month vaccination when the caregiver and child have had limited interactions versus the preschool vaccination, by which point the caregiver-child dyadic patterns are much more established. Moreover, it allows a contrast between a developmental stage wherein the child is wholly dependent on a parent for regulation from pain-related distress and a developmental stage where the child is learning to regulate pain-related distress independently. Study 1 identified both caregiver behaviours (sensitivity and proximal soothing) and infant pain-related distress as predictors of preschoolers' attachment outcomes. In contrast, in Study 2, caregiver sensitivity was the only significant predictor of preschoolers' attachment outcomes.

4.1 Study 1: The Longitudinal Relationship Between Caregiver-Infant Behaviours During the 2-month Vaccination and Preschool Attachment

Consistent with our hypotheses, the present study findings revealed that higher infant pain-related distress at 2-minutes post-needle was related to both higher security ratings and lower behavioural disorganization and controlling-punitive ratings at preschool. The 2-minute post-needle phase is particularly interesting because it is the phase of the vaccination

appointment often referred to as the regulation period [37] whereby infant pain-related distress behaviours are levelling off. Intuitively, one may mistakenly predict that higher security and lower disorganization or lower controlling-punitive attachments in preschool would be associated with faster regulation in infancy. However, further consideration of attachment theory and distress regulation within a pain paradigm elucidates the current study findings and confirms previous findings within infancy [22]. It is important to acknowledge that 2 minutes following exposure to a noxious stimuli (i.e., vaccination), infants continued to experience pain and pain-related distress. Thus, continued attachment signalling (i.e. pain behaviours or honest signalling) would actually be adaptive, as children would still need the caregiver near.

Previous examinations of our infant cohort [36] revealed that early caregiver sensitivity (i.e., during infants' 2-month vaccinations) predicted later caregiver sensitivity (i.e., during infants' 12 months vaccinations). Given that a key tenet of attachment theory is that with repeated exposure to a sensitive attachment figure, children learn to explore the world with confidence and obtain support when necessary [3], it follows that children with more secure (and less disorganized and/or controlling-punitive attachments) at preschool would have also experienced repeated exposure to a sensitive caregiver and therefore would have been more likely to signal their pain-related distress in infancy. Therefore, it is reasonable that preschoolers with higher security and/or lower disorganization or lower controlling-punitive attachments would have shown higher pain-related distress behaviours following their 2-month vaccination when they are still attempting to recover from their pain-related distress.

Additionally, consistent with our hypothesis, when caregivers demonstrated higher proximal soothing of their infant at 1 minute before the first needle, preschoolers were rated as lower on the ambivalence scale. Often caregivers of preschoolers with ambivalent attachment

styles are intrusive at the expense of the preschoolers' autonomy [7]. Accordingly, it follows that caregivers who are able to appropriately anticipate and respond to their infants' distress (i.e., notice their infants' anticipatory distress pre-needle and provide intervention via proximal soothing), would likely have children with lower levels of ambivalence. In contrast to the aforementioned finding, the relationship between 2-month caregiver sensitivity and preschool avoidance was contrary to our hypothesis. More optimal caregiver sensitivity at 2-months was related to preschoolers having higher levels of avoidance during preschool. One explanation is that this finding is related to a third unexamined variable. A previous study [21] from our cohort examining infant behaviours in the vaccination context and infant attachment found that when avoidant infants had higher temperamental fear (i.e., prone to high distress reactivity) they were observed to exhibit pain-related distress longer than secure infants. In contrast, when avoidant infants had lower temperamental fear (i.e., prone to low distress reactivity) they exhibited pain-related distress for a shorter period than secure infants. Therefore, the temperamental fear of the infants and their relative pain-related distress behaviour patterns may have yielded more caregiver sensitivity, in turn explaining why preschoolers with greater avoidance ratings had caregivers who demonstrated greater sensitivity during their 2-month infant vaccination.

4.2 Study 2: The Concurrent Relationship Between Caregiver-Preschooler Behaviours and Preschool Attachment

Across all of the concurrent models examined, caregiver sensitivity was the only variable that was significantly related to preschool attachment outcomes. Specifically, higher caregiver sensitivity across the duration of preschoolers' vaccination appointments was related to higher security attachment ratings. This finding is concordant with the literature which has consistently identified caregiver sensitivity as a key predictor of preschool attachment in low to moderate

distress contexts [4,5,10,11,14,15,26,27,29,42]. Moreover, the present findings are consistent with previous results in the OUCH Cohort [6,40] identifying caregiver behaviours in the pain context (e.g., sensitivity, distress-promoting behaviours), as consistent predictors of child outcomes (e.g., anticipatory distress, coping responses, cognitive abilities) above and beyond that of pain-related behaviours. Study 2 findings provide a significant contribution to the literature through identifying an association between caregiver sensitivity within a routinely occurring distress paradigm and preschool attachment security. While some studies have attempted to examine child and caregiver vaccination behaviours with preschool attachment, they have used an aggregate measure of attachment [47], a small sample size with a wide age range [39], and they have not specifically examined caregiver sensitivity as a predictor of preschool attachment outcomes. Furthermore, the present study implemented a fine-grained continuous measure [32] that is complementary to the PACS [7], and allows for examination of the level of each attachment category for each preschooler rather than assigning preschoolers to one specific attachment category.

4.3 Conclusion

Overall, the present paper's findings provide valuable information about the relationship between caregiver-child vaccination behaviours and preschool attachment. At the 2-month vaccination, higher pain-related distress at 2 minutes post-needle was related to higher attachment security at preschool. In the context of vaccinations where parents did not employ pharmacological agents that block pain, we identified that infants who expressed pain for a longer period were more secure. Given that pain has been reported for at least 1 day following the vaccination [38], the present findings validate that in the infant high distress context, continuing to signal when in pain is predictive of greater security and also less disorganization

and controlling-punitive attachments in preschool. Moreover, our findings identified that caregiver behaviour at the preschool vaccination is a strong indicator of security, confirming previous 12 month data from our cohort [20] that brief primary care vaccination appointments are a valuable way to take the temperature of the caregiver-child dyadic relationship. However, the lack of findings associated with the 2-month caregiver vaccination behaviour should be interpreted with caution because the first vaccination is a very foreign and high stress context during a time when the infant-child relationship is in early stages of development.

4.4 Limitations

There are some limitations that warrant consideration for the present study. The present study revealed several null findings. Although there were some identified relationships between caregiver-child vaccination behaviours and preschool attachment, the null findings are possibly the result of attempting to compare behaviours in two separate paradigms (i.e., stress induced due to a painful procedure versus separation from one's primary caregiver). Additionally, in order to contain the number of analyses in this two-study paper, we did not examine additional vaccination variables (i.e., peak distress, rate of decline) that could potentially be associated with preschool attachment outcomes. Finally, the study sample was quite homogeneous in regard to demographics (i.e., socioeconomic status, education) and continued self-selection to participate in a longitudinal study. Accordingly, it is difficult to determine how the present study findings may generalize to a different population of caregiver-child dyads that may have a greater representation of insecure attachments.

4.5 Clinical Implications and Future Directions

Overall, the current study presents a novel examination of both the longitudinal and concurrent relationship between caregiver-child behaviours in a naturally occurring distress

paradigm and preschool attachment outcomes using a rigorous and fined-grained measure (PARS) [32]. Moreover, the present findings provide evidence that caregiver-child dyads develop patterns of responding within the acute pain paradigm which can at least, in part, predict subsequent patterns of responding in an attachment paradigm. The present study findings offer important contributions to both the clinical literature and the attachment literature. Clinically, the importance of preschool attachment in predicting developmental psychopathology is emphasized through the wealth of literature linking preschool attachment to internalizing and externalizing problems [24,25,33,34,35]. Accordingly, the present study supports that the level of parental sensitivity and/or sensitive behaviours during early childhood vaccinations is related to attachment outcomes both in infancy and preschool. Moreover, infants and preschoolers who have secure attachments with their primary caregivers tend to signal longer (i.e. express more pain behaviours) during routine vaccinations. Confirming these findings with populations at greater risk for maladaptive development trajectories will provide important insights about the generalizability of the current set of studies.

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Figure 1: Flow diagram of the number of caregiver-child dyads included in the analyses of Study 1.

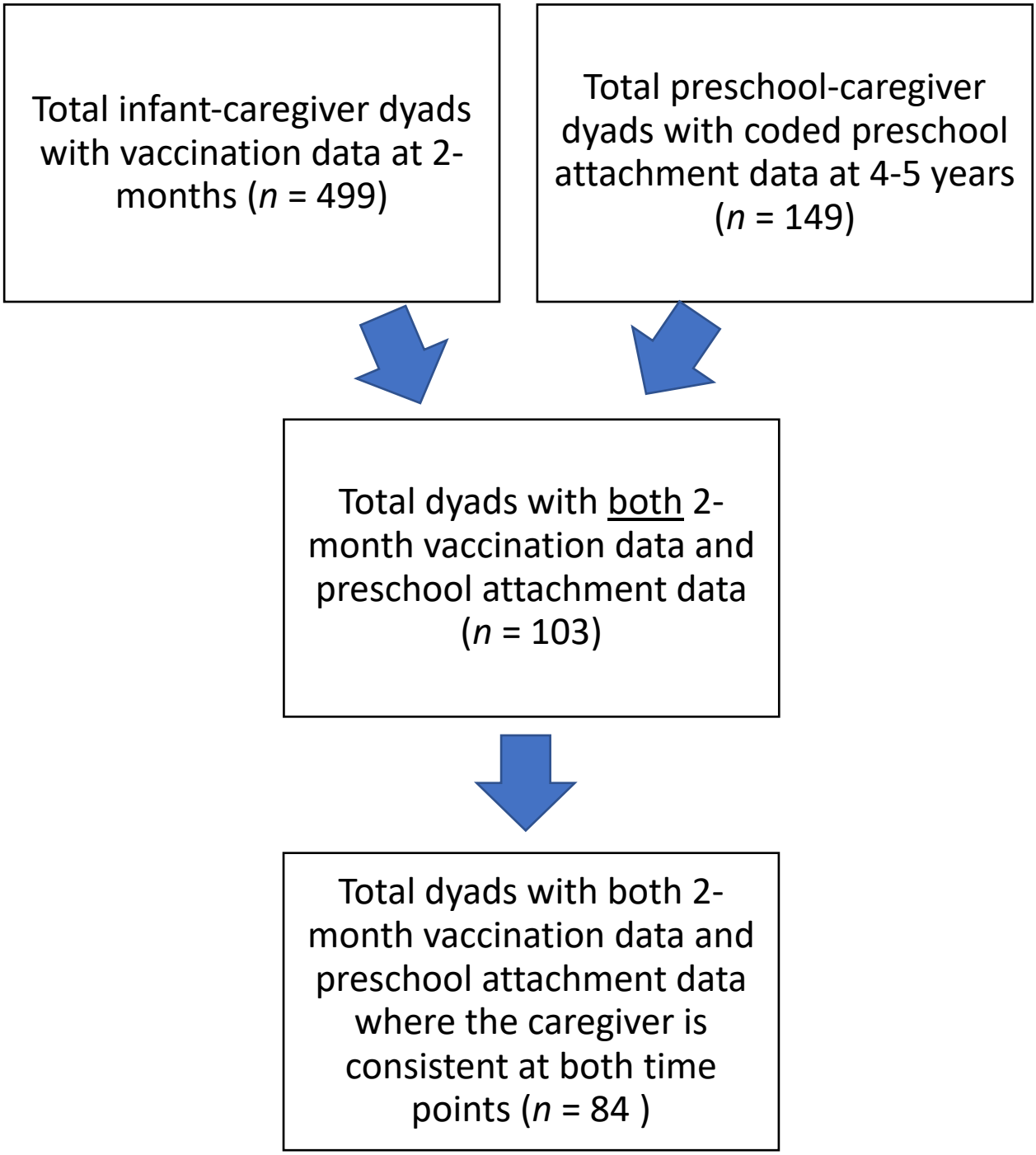

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Figure 2: Flow diagram of the number of caregiver-child dyads included in the analyses of Study 2.

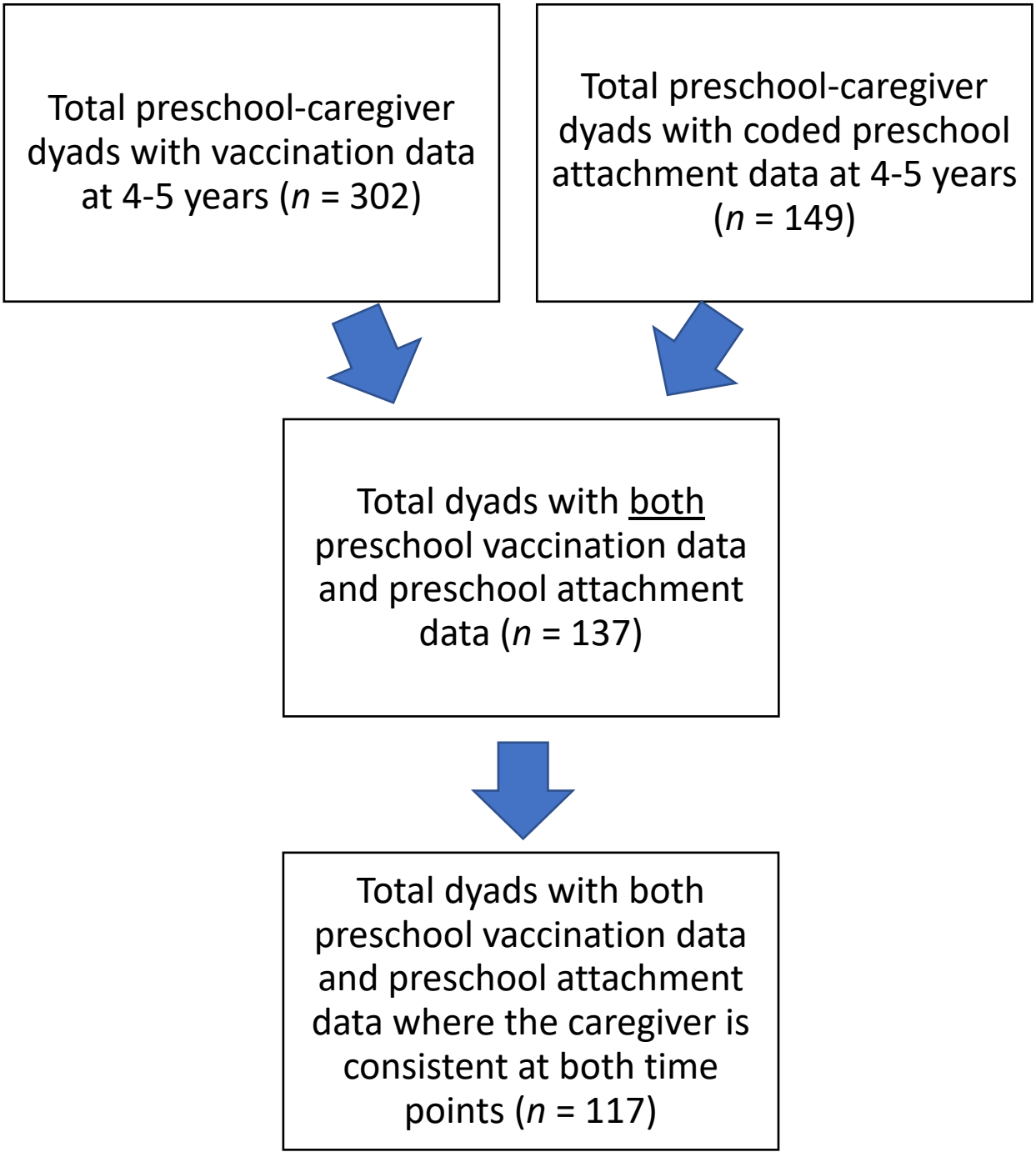

Table 1. Means and standard deviations of all model variables.

		N	Mean	SD	Scale Range
Infant Predictor Variables (2 months)					
	EAS	497	92.32	10.25	28-116
	Proximal Soothing (1 minute pre-needle)	492	.21	.29	0-2
	Proximal Soothing (1 minute post-needle)	497	.84	.50	0-2
	Proximal Soothing (2 minutes post-needle)	484	.62	.57	0-2
	MBPS Baseline	495	2.99	2.07	0-10
	MBPS0	498	8.81	.76	0-10
	MBPS1	461	6.18	2.37	0-10
	MBPS2	437	5.64	2.56	0-10
Preschool Predictor Variables (4-5 years)					
	MBQS	229	.32	.41	0-1
	FLACC Baseline	298	3.19	3.46	0-10
	FLACC0	299	4.47	2.99	0-10
	FLACC1	298	2.52	2.45	0-10
	FLACC2	295	1.57	2.18	0-10
Preschool Ouctome Variables (4-5 years)					
	Security	149	4.67	1.69	1-9
	Avoidance	149	2.35	1.49	1-9
	Ambivalence	149	3.48	1.76	1-9
	Disorganization	149	2.38	2.01	1-9
	Controlling-Caregiving	149	2.64	1.90	1-9
	Controlling-Punitive	149	1.53	1.29	1-9

Note. EAS = Emotional Availability Scales; MBPS = Modified Behavior Pain Scale; MBQS = Maternal Behaviour Q-Set Short Version; FLACC= Face Legs Activity Cry Consolability coding system

Table 2. Correlations among preschool attachment and all 2-month infant vaccination predictors.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Security	1	-.16	-.52**	-.68**	-.44**	-.51**	.15	.20	.03	.06	-.05	-.20	-.07	.24*
2. Avoidance		1	-.26*	.17	-.02	-.08	.20	-.11	-.11	-.02	.01	.08	-.03	-.15
3. Ambivalence			1	.32**	-.00	.30**	-.15	-.31**	.04	-.10	.10	.14	.12	.04
4. Disorganization				1	.18	.46**	-.05	-.13	.00	-.00	.12	.07	.07	-.22
5. Controlling- Caregiving					1	.04	-.15	.01	-.02	-.04	-.18	.10	.09	-.07
6. Controlling-Punitive						1	-.16	-.16	-.03	-.14	.24*	.05	.09	-.15
7. EAS							1	.14	.06	.09	-.08	-.07	-.35**	-.31**
8. Proximal Soothing (1 min pre-needle)								1	.12	.18	.22*	-.05	-.10	-.03
9. Proximal Soothing (1 min post-needle)									1	.52**	.09	.10	.05	.22
10. Proximal Soothing (2 mins post-needle)										1	.22*	.22*	.25*	.26*
11. MBPS Baseline											1	.22*	.18	.12
12. MBPS0												1	.22*	-.04
13. MBPS1													1	.45**
14. MBPS2														1

Note. EAS = Emotional Availability Scales; MBPS = Modified Behavior Pain Scale

*Correlation is significant at < .05 (two-tailed)

**Correlation is significant at < .01 (two-tailed).

Table 3. Linear regressions analyses of preschool attachment predicted by infant vaccination variables at 2-months.

	B	SE *B*	β	*p*	CI (Lower, Upper)
Security					
Step 1					
EAS	.02	.02	.14	.30	(-.02, .06)
Proximal Soothing (1 minute pre-needle)	.20	.75	.03	.80	(-1.42, 1.79)
Proximal Soothing (1 minute post-needle)	.01	.42	.00	.99	(-.83, .81)
Proximal Soothing (2 minutes post-needle)	.35	.37	.13	.33	(-.47, 1.16)
Step 2					
EAS	.03	.02	.20	.10	(-.01, .07)
Proximal Soothing (1 minute pre-needle)	.31	.73	.05	.68	(-1.09, 1.72)
Proximal Soothing (1 minute post-needle)	-.22	.41	-.07	.58	(-1.05, .66)
Proximal Soothing (2 minutes post-needle)	.31	.38	.11	.43	(-.39, 1.03)
MBPS Baseline	.07	.13	.07	.62	(-.19, .37)
MBPS0	-.70	.43	-.21	.07	(-1.43, .09)
MBPS1	-.08	.10	-.12	.40	(-.31, .18)
MBPS2*	.26	.09	.39	.01	(.07, .45)
Avoidance					
Step 1					
EAS*	.04	.02	.28	.02	(.01, .06)
Proximal Soothing (1 minute pre-needle)	-.35	.64	-.07	.58	(-1.58, .88)
Proximal Soothing (1 minute post-needle)	-.42	.38	-.16	.26	(-1.20, .44)
Proximal Soothing (2 minutes post-needle)	.12	.31	.05	.72	(-.46, .69)
Step 2					
EAS*	.04	.02	.30	.03	(.01, .07)
Proximal Soothing (1 minute pre-needle)	-.49	.62	-.10	.43	(-1.6, .75)
Proximal Soothing (1 minute post-needle)	-.36	.40	-.14	.33	(-1.13, .50)
Proximal Soothing (2 minutes post-needle)	.02	.38	.01	.95	(-.72 .68)
MBPS Baseline	.09	.17	.10	.54	(-.15, .68)
MBPS0	.02	.43	.01	.98	(-.93, .68)
MBPS1	.08	.11	.13	.49	(-.13, .27)
MBPS2	-.05	.09	-.10	.55	(-.22, .16)
Ambivalence					
Step 1					
EAS	-.02	.02	-.16	.16	(-.06, .01)
Proximal Soothing (1 minute pre-needle)	-1.16	.60	-.22	.05	(-2.25, -.08)
Proximal Soothing (1 minute post-needle)	.42	.37	.15	.27	(-.22, 1.21)
Proximal Soothing (2 minutes post-needle)	-.30	.32	-.12	.30	(-.94, .32)
Step 2					
EAS	-.03	.02	-.17	.24	(-.07, .01)
Proximal Soothing (1 minute pre-needle)*	-1.24	.63	-.23	.04	(-2.49, .09)
Proximal Soothing (1 minute post-needle)	.43	.39	.15	.30	(-.28, 1.13)
Proximal Soothing (2 minutes post-needle)	-.37	.37	-.14	.31	(-1.12, .50)
MBPS Baseline	.01	.14	.01	.94	(-.29, .26)
MBPS0	.53	.49	.17	.25	(-.73, 1.35)

MBPS1	-.03	.13	-.04	.82	(-.26, .18)
MBPS2	.01	.10	.01	.93	(-.20, .21)
Disorganization					
Step 1					
EAS	-.01	.02	-.08	.50	(-.06, .03)
Proximal Soothing (1 minute pre-needle)	-.14	.83	-.02	.87	(-1.72, 1.60)
Proximal Soothing (1 minute post-needle)	.05	.54	.01	.93	(-1.03, 1.25)
Proximal Soothing (2 minutes post-needle)	-.20	.37	-.06	.62	(-.84, .38)
Step 2					
EAS	-.02	.03	-.12	.38	(-.07, .02)
Proximal Soothing (1 minute pre-needle)	-.11	.92	-.02	.91	(-1.94, 1.92)
Proximal Soothing (1 minute post-needle)	.28	.54	.08	.61	(-.72, 1.26)
Proximal Soothing (2 minutes post-needle)	-.08	.43	-.03	.85	(-.91, .73)
MBPS Baseline	-.11	.16	-.09	.44	(-.40, .33)
MBPS0	.04	.64	.01	.94	(-1.44, 1.07)
MBPS1	.13	.14	.16	.34	(-.14, .41)
MBPS2	-.27	.13	-.35	.05	(-.53, -.02)
Controlling-Caregiving					
Step 1					
EAS	-.04	.03	-.20	.20	(-.10, .02)
Proximal Soothing (1 minute pre-needle)	.99	.97	.15	.32	(-.69, 2.69)
Proximal Soothing (1 minute post-needle)	-.23	.44	-.06	.60	(-1.06, .59)
Proximal Soothing (2 minutes post-needle)	-.37	.39	-.12	.34	(-1.11, .30)
Step 2					
EAS	-.03	.03	-.18	.23	(-.09, .01)
Proximal Soothing (1 minute pre-needle)	1.27	1.09	.19	.26	(-.82, 3.54)
Proximal Soothing (1 minute post-needle)	-.09	.48	-.02	.87	(-1.00, .82)
Proximal Soothing (2 minutes post-needle)	-.35	.40	-.11	.40	(-1.09, .33)
MBPS Baseline	-.21	.16	-.18	.17	(-.58, .16)
MBPS0	.20	.60	.05	.70	(-1.06, 1.03)
MBPS1	.12	.11	.14	.28	(-.11, .30)
MBPS2	-.11	.11	-.14	.36	(-.35, .12)
Controlling-Punitive					
Step 1					
EAS	-.01	.02	-.07	.70	(-.05, .02)
Proximal Soothing (1 minute pre-needle)	-.14	.32	-.04	.65	(-.73, .69)
Proximal Soothing (1 minute post-needle)	.24	.24	.12	.36	(-.27, .75)
Proximal Soothing (2 minutes post-needle)	-.46	.22	-.26	.08	(-.89, -.08)
Step 2					
EAS	-.01	.01	-.11	.51	(-.04, .02)
Proximal Soothing (1 minute pre-needle)	-.10	.39	-.03	.78	(-.76, .90)
Proximal Soothing (1 minute post-needle)	.41	.25	.21	.14	(-.05, .94)
Proximal Soothing (2 minutes post-needle)	-.43	.24	-.24	.11	(-.94, -.04)
MBPS Baseline	-.10	.08	-.15	.16	(-.30, .01)
MBPS0	.31	.21	.14	.13	(-.03, .76)
MBPS1	.10	.10	.22	.36	(-.05, .32)
MBPS2	-.19	.08	-.43	.07	(-.38, -.06)

Note. EAS = Emotional Availability Scales; MBPS = Modified Behavior Pain Scale; Unstandardized Regression Coefficients, standard errors, *p*-values, and confidence intervals are based on 1000 bootstrap sample.

* *p*-value is significant at < .05

Table 4. Correlations among preschool attachment and all preschool vaccination predictors.

	1	2	3	4	5	6	7	8	9	10	11
1. Security	1	-.15	-.55**	-.62**	-.33**	-.46**	.31**	-.07	-.04	.01	.00
2. Avoidance		1	-.31**	.12	.03	-.08	-.17	.04	.02	.04	-.02
3. Ambivalence			1	.31**	-.11	.34**	-.08	-.06	-.03	.01	.04
4. Disorganization				1	.17	.40**	-.04	.01	-.00	-.03	-.08
5. Controlling-Caregiving					1	-.10	-.14	.12	.10	.12	.05
6. Controlling-Punitive						1	-.18	.08	-.08	-.13	-.09
7. MBQS							1	-.05	-.02	-.02	-.01
8. FLACC Baseline								1	.63**	.37**	.22*
9. FLACC0									1	.66**	.50**
10. FLACC1										1	.64**
11. FLACC2											1

Note. MBQS = Maternal Behaviour Q-Set Short Version, FLACC = Face, Legs, Activity, Cry, Consolability coding system.
*Correlation is significant at < .05 (two-tailed)
**Correlation is significant at < .01 (two-tailed)

Table 5. Linear regressions analyses of preschool attachment predicted by preschool vaccinations variables.

	B	SE *B*	β	*p*	CI (Lower, Upper)
Security					
Step 1					
MBQS*	1.22	.38	.29	.002	(.48, 2.04)
Step 2					
MBQS*	1.22	.40	.29	.003	(.48, 1.98)
FLACC Baseline	-.02	.06	-.05	.68	(-.13, .08)
FLACC0	-.01	.09	-.02	.87	(-.18, .17)
FLACC1	.00	.10	.00	.99	(-.23, .22)
FLACC2	.03	.10	.41	.76	(-.14, .20)
Avoidance					
Step 1					
MBQS	-.58	.36	-.16	.11	(-.13, .08)
Step 2					
MBQS	-.58	.36	-.16	.13	(-.13, .08)
FLACC Baseline	.02	.05	.04	.75	(-.08, .10)
FLACC0	-.02	.07	-.05	.73	(-.16, .11)
FLACC1	.06	.08	.10	.46	(-.09, .21)
FLACC2	-.05	.08	-.07	.54	(-.19, .11)
Ambivalence					
Step 1					
MBQS	-.29	.42	-.06	.52	(-1.15, .55)
Step 2					
MBQS	-.29	.43	-.06	.52	(-1.14, .53)
FLACC Baseline	-.03	.07	-.07	.61	(-.17, .09)
FLACC0	-.03	.08	-.04	.72	(-.18, .15)
FLACC1	.03	.10	.05	.74	(-.18, .26)
FLACC2	.02	.10	.03	.81	(-.16, .20)
Disorganization					
Step 1					
MBQS	-.14	.54	-.03	.78	(-1.25, 1.11)
Step 2					
MBQS	-.15	.55	-.03	.78	(-1.29, 1.17)
FLACC Baseline	.00	.07	.00	.99	(-.14, .14)
FLACC0	.03	.11	.04	.78	(-.19, .25)
FLACC1	.02	.12	.02	.88	(-.20, .21)
FLACC2	-.11	.14	-.11	.43	(-.38, .19)
Controlling-Caregiving					
Step 1					
MBQS	-.68	.54	-.14	.22	(-1.77 .31)
Step 2					
MBQS	-.65	.54	-.13	.23	(-1.77, .43)

FLACC Baseline	.04	.08	.06	.64	(-.13, .20)
FLACC0	-.001	.11	-.002	.99	(-.23, .21)
FLACC1	.09	.13	.12	.46	(-.17, .32)
FLACC2	-.04	.13	-.05	.75	(-.29, .23)
Controlling-Punitive					
Step 1					
MBQS	-.55	.43	-.17	.21	(-1.51, .28)
Step 2					
MBQS	-.57	.44	-.18	.20	(-1.58, .28)
FLACC Baseline	.07	.04	.19	.07	(-.002, .16)
FLACC0	-.05	.06	-.11	.48	(-.19, .09)
FLACC1	-.07	.07	-.14	.29	(-.21, .05)
FLACC2	.00	.05	.00	.98	(-.10, .10)

Note. MBQS = Maternal Behaviour Q-Set Short Version, FLACC = Face, Legs, Activity, Cry, Consolability coding system; Unstandardized Regression Coefficients, standard errors, *p*-values, and confidence intervals are based on 1000 bootstrap samples.
**p*-value is significant at < .01

Chapter 5: Conclusion

The attachment lens is an important approach to contextualize an understanding of child development. Measurement of the attachment relationship during early childhood has been predicated on examining stable patterns regarding how young children use caregivers to regulate from distress after the first year of life (Ainsworth, Blehar, Waters, & Wall, 1978). These attachment patterns are seen as shaped by parents behaviours during early childhood. Contingent and sensitive caregiving behaviour when a young child is distressed has been shown to be foundational to secure attachment patterns (Ainsworth et al., 1978) and better emotion regulation throughout the lifespan (Kopp, 1989). Challenges with emotion regulation have been shown to be associated with over 75% of mental health disorders (as cited in Werner & Gross, 2010). Additionally, preschool attachment has been shown to be a critical predictor of future mental health challenges (Groh, Roisman, van IJzendoorn, Bakermans-Kranenburg & Fearon, 2012; Lecompte & Moss, 2014; Lecompte, Moss, Cyr, & Pascuzzo, 2014; Moss, Rousseau, Parent, St-Laurent, & Saintonge, 1998; Moss, Smolla, Cyr, Dubois-Comtois, & Mazzarello, 2006; O'Connor, Bureau, McCartney, & Lyons-Ruth, 2011; Thompson, 2006) and developmentally is a sensitive period where many children are first engaging with structured education systems and emotion regulation is essential. However, understanding the relationship between sensitive caregiving and attachment during the preschool stage has been impacted by the lack of a systematic review specifically focused on this age group and a sole focus of understanding relationships using laboratory-based distress paradigms with low to moderate child distress.

The present dissertation aimed to provide novel insights into the relationships between caregiver and child behaviours and preschool attachment using a naturalistic and high distress paradigm (i.e., routine vaccinations). Three studies were conducted that not only contributed to

the broader attachment literature, but also deepened our knowledge of how behaviours (parent and child) during infant and preschool vaccinations help us understand a child's attachment patterns at the end of early childhood (preschool attachment). Study 1 was a systematic literature review and meta-analysis examining the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment outcomes. Findings from Study 1 examined caregiver sensitivity within low to moderate distress paradigms (i.e., free play, frustration tasks), as it relates to preschool attachment outcomes. This analysis set the stage for the quantitative analyses in Study 2 and Study 3- to our knowledge the first longitudinal work examining caregiver and child vaccination behaviours with preschool attachment. Study 2 examined the longitudinal relationship between caregiver-infant behaviours during routine vaccinations in early infancy (2-months) and preschool attachment. Study 3 examined the relationship between caregiver-child behaviours during routine vaccination at the end of early childhood (4-5 years) and preschool attachment outcomes. The subsequent sections provide a synthesis of the findings in each of the three studies, as well as an integrative synthesis and a discussion of clinical implications, limitations, and future directions for research. A summary of the three study aims, analyses, and main findings are also provided in Appendix A.

Study 1: A Systematic Literature Review and Meta-Analysis of the Longitudinal and Concurrent Relationships Between Caregiver Sensitivity and Preschool Attachment

The primary aim of Study 1 was to synthesize the literature examining both the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment outcomes. In order to complete the objectives of Study 1, a series of eight main analyses were examined in order to synthesize the literature according to the temporal relationship (i.e., longitudinal, concurrent), the operationalization of caregiver sensitivity (i.e., unidimensional,

multidimensional), and attachment categorization (i.e., secure-insecure, organized-disorganized). Additionally, meta-regression analyses were implemented in order to determine the effect of various moderator variables (i.e., normative vs. clinical/risk populations, child age at attachment assessment, child gender, socioeconomic status, and study quality scores).

Overall, the findings of the quantitative and qualitative syntheses suggest that caregiver sensitivity is greater among caregivers with preschoolers who have secure or organized attachments compared to insecure or disorganized attachments, respectively. When a unidimensional measure of caregiver sensitivity was employed, there were medium effect sizes (g = .46 to .59) for both the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment. In contrast, when a multidimensional measure of caregiver sensitivity was employed, there were small to medium effect sizes (g = .34 to .49) for both the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment. This slight discrepancy between effect sizes for unidimensional compared to multidimensional measures of caregiver sensitivity are possibly attributed to the fact that studies that employed a unidimensional measure of caregiver sensitivity (i.e., examining caregiver sensitivity on a single rating scale) were often more similar than studies that employed a multidimensional measure (i.e., examining sensitivity, nonintrusiveness, warmth, etc.) due to the necessitated variability within and across different multidimensional measures of caregiver sensitivity. Of note, the strength of the concurrent relationships examined were relatively larger than the longitudinal relationships examined. The difference in strength across concurrent associations compared to longitudinal associations is likely attributed to several factors including: the greater number of studies included within the concurrent meta-analyses; and the shorter temporal window between assessments of caregiver sensitivity and preschool attachment within the concurrent studies. In terms of potential

moderators, all moderator analyses (longitudinal and concurrent) were non-significant with the exception of age at assessment of attachment. Specifically, the longitudinal relationship between unidimensional caregiver sensitivity and preschool attachment security status was stronger when preschool attachment was assessed at an older age compared to a younger age. One possible explanation for this finding is that a stronger relationship when preschool attachment is assessed at an older age is reflective of the fact that attachment assessments may become more reliable when preschoolers are older versus younger.

Study 2: The Longitudinal Relationship Between Caregiver-Infant Behaviours During Routine Vaccinations and Preschool Attachment

The primary aim of Study 2 was to examine the longitudinal relationship between caregiver and infant behaviours during routine vaccinations in infancy (2-months) and preschool attachment. Study 2 was completed with $N = 84$ children and caregivers from the OUCH Cohort with behavioural data from the 2-month vaccination appointment and preschool attachment data from a separate full-day psychological assessment using the separation-reunion procedure (Cassidy & Marvin, 1992). Caregiver sensitivity was measured using the Emotional Availability Scales (EAS, Biringen, 2008) over the duration of the appointment. Caregiver proximal soothing was measured using the Measure of Adult and Infant Soothing and Distress (MAISD; Cohen, Bernard, McClellan, & MacLaren, 2005) at 1 minute pre-needle, 1 minute post-needle, and 2 minutes post-needle. Infant pain-related distress was measured using the Modified Behaviour Pain Scale (MBPS; Taddio, Nulman, Koren, Stevens, & Koren, 1995) for 15 second epochs at 15 seconds pre-needle, 15 seconds after the last needle, and at 1 and 2 minutes post needle. Preschool attachment was measured using the Preschool Attachment Rating Scales (PARS; Moss, Lecompte & Bureau, 2015). A series of six hierarchical multiple regressions were

conducted in order to examine if caregiver behaviours and infant pain-related distress behaviors predicted preschool attachment ratings (i.e., security, avoidance, ambivalence, disorganization, controlling-caregiving, controlling-punitive). In terms of caregiver behaviours, greater caregiver sensitivity during infants' vaccination appointment was significantly related to higher preschool avoidance. Moreover, greater proximal soothing at 1 minute pre-needle was significantly related to lower preschooler ambivalence. In terms of infant pain-related distress behaviours, higher pain-related distress at 2 minutes post-needle was significantly related to higher preschooler security. Additionally, there was a marginally significant finding such that higher infant pain-related distress at 2-minutes post-needle was related to lower preschooler disorganization and lower preschooler controlling-punitive attachment. All analyses examining caregiver and infant behaviours in relation to controlling-caregiving attachment ratings were non-significant. Study 3 built on these longitudinal findings and examined the concurrent relationship between caregiver-child behaviours during preschool routine vaccinations and preschool attachment outcomes.

Study 3: The Concurrent Relationship Between Caregiver-Preschooler Behaviours During Routine Vaccinations and Preschool Attachment

The primary aim of Study 3 was to examine the concurrent relationship between caregiver-preschooler behaviours during routine vaccinations in preschool (4-5 years) and preschool attachment. Study 3 was completed with $N = 117$ children from the OUCH Cohort with preschool vaccination data and preschool attachment data from a separate full-day psychological assessment which included the separation-reunion procedure (Cassidy & Marvin, 1992). Caregiver sensitivity was measured using the Maternal Behaviour Q-Set Short Version (MBQS; Tarabulsy et al., 2009) across the duration of the appointment. Preschool pain-related distress was measured using the Face, Legs, Activity, Cry, Consolability coding system

(FLACC; Merkel, Voepelo-Lewis, Shayevitz, & Malviya, 1997) and again assessed for 15 second epochs at four time points (i.e., 15 seconds pre-needle, 15 seconds post-needle, 1 minute post-needle, 2 minutes post-needle). Consistent with Study 2, preschool attachment was measured using the PARS (Moss et al., 2015). Parallel to Study 2, a series of six hierarchical multiple regressions were conducted in order to examine if caregiver sensitivity and preschool pain-related distress predicted the six different preschool attachment ratings.

Contrary, to the findings in Study 2, all findings were non-significant with the exception of the relationship between caregiver sensitivity and preschool attachment security. Specifically, higher caregiver sensitivity during preschoolers' vaccination appointments was related to greater preschool attachment security. This finding is consistent with the findings linking the concurrent relationship between caregiver sensitivity and the secure-insecure dichotomy within the synthesis of the literature in Study 1. Although most of the relationships examined were non-significant, these findings offer novel contributions through linking the caregiver sensitive behaviours in an acute pain paradigm to preschoolers' attachment security measured through a fine-grained continuous measure (i.e., PARS; Moss et al., 2015).

Integrative Synthesis

Overall, the dissertation findings consistently supported the notion that caregiver sensitivity was related to preschool attachment outcomes. Study 1 demonstrated that, regardless of operationalization of caregiver sensitivity (i.e., unidimensional vs. multidimensional), temporal window (longitudinal vs. concurrent) and attachment dichotomy (i.e., secure-insecure vs. organized-disorganized), greater caregiver sensitivity was related to more optimal attachment outcomes. When understanding the relationships between infant and caregiver behaviour

(including sensitivity) and preschool attachment in a naturally occurring high-distress paradigm, a number of interesting, and at times, unexpected patterns emerged.

First examining caregiver behaviours, operationalized both by an overarching measurement of sensitivity and by examining discrete proximal soothing behaviours, the longitudinal results in Study 2 identified greater proximal soothing at 1 minute pre-needle during infants' 2-month vaccination was related to lower preschool ambivalence. As identified in the paper, this finding was understood within the context of ambivalent patterns of attachment in preschool (Cassidy & Marvin, 1992). Specifically, caregivers of preschoolers with ambivalent patterns of attachment may respond inappropriately or overrespond to the preschooler at the expense of the preschooler's autonomy (Cassidy & Marvin, 1992). Caregiver proximal soothing is looking at a frequency count of proximal soothing behaviours toward the infant in pain as opposed to sensitivity (i.e., the caregiver could be implementing proximal soothing behaviours while also being intrusive if not sensitively responding to the infant's signals). However, given that caregiver proximal soothing at 1 minute pre-needle was related to lower ambivalence in preschool, it follows that caregivers who were able to accurately identify and appropriately respond to their infant's pre-needle distress would demonstrate appropriate responding behaviours, thereby resulting in lower ambivalence in preschool.

Additionally, findings for the longitudinal analyses revealed that greater caregiver sensitivity during infants' 2-month vaccination was related to greater preschooler avoidance. One hypothesis discussed in the paper was that this unexpected finding could be the result of a third unexamined variable (i.e., temperamental fear). However, it is also important to highlight that this finding may also be reflective of the early stage (2-months) that caregiver sensitivity was examined, owing to the fact that the caregiver-infant relationship is still in the early stages of

development. Contrary, to the infant analysis, when examining the relationship between caregiver sensitivity during preschool vaccinations and preschool attachment in Study 3, the findings were consistent with those of the synthesis of the broad attachment literature in that higher sensitivity to preschoolers' pain-related distress was related to greater security.

It is interesting that sensitivity during the 2-month vaccination was related to suboptimal preschool attachment (i.e., higher avoidance behaviours), whereas caregiver sensitivity during the 4-5 year vaccination was not. One plausible finding is with regards to what is happening in the early stages of the caregiver and infant relationship during the infant vaccination. During the 2-month vaccination the infant is very much reliant on the caregiver for proximity, and the caregiver is also in the early stages of learning to accurately interpret the infant's signals. It is possible that although the caregiver is exhibiting sensitivity during the 2-month vaccination, a third variable (i.e., caregiver anxiety) is also communicated to the infant in pain. If the infant perceives the caregiver as anxious when communicating distress (within the 2-month vaccination and across other high distress contexts), the infant may learn to inhibit signals of distress in order to maintain proximity to the caregiver and thus, developing an avoidant pattern of attachment in preschool.

Study 2 and 3 also examined the longitudinal and concurrent relationships between child pain-related distress and preschool attachment. The findings in infancy were somewhat consistent with what would be expected in the context of the literature examining emotion regulation and attachment. Cassidy (1994) suggested that the secure child may dysregulate less than an insecure child, but if the child is still in distress they will feel secure enough to continue to signal in order to gain the support of their caregiver. This is consistent with what was found in the infant analyses such that higher infant pain-related distress at 2 minutes post-needle was

related to greater preschool attachment security. Moreover, higher infant pain-related distress at 2 minutes, was related to lower ratings of disorganization (i.e., behavioural disorganization, controlling-punitive). Considering the developmental stage of the 2-month-old infant, descending cognitive mechanisms such as internal working models (Bowlby, 1973) or pain modulation thoughts (Goubert et al., in press) are not developmentally possible. Therefore, 'honest signalling' (as cited in Barr, 1998) of pain is not a young infant's choice, but rather an automatic reaction. The present study findings demonstrate that within the high-distress pediatric pain paradigm, the regulation phase (i.e., infant pain-related distress behaviours at 2 minutes post-needle) is key to predicting later childhood attachment. In contrast, pain reactivity (i.e., infant pain-related distress immediately after the needle) is not predictive of attachment outcomes, perhaps due to the limited variability of the very high immediate pain-related distress responses post-needle at 2 months (Pillai Riddell, Racine, Craig, & Campbell, 2013). Therefore, the infant's regulatory responses demonstrate that the more pain-related distress the infant expresses at 2 minutes after the vaccination (i.e., during the regulation phase when the infant would be in pain due to the stinging vaccine being injected under the skin) is related to both higher security and less disorganization in preschool.

The pattern in infancy, described above, was not replicated in the analysis examining the relationship between preschooler pain-related behaviours and preschool attachment outcomes. Although the distress incurred during the preschool vaccination was definitely much higher than the lab-based preschool separation-reunion procedure (Cassidy & Marvin, 1992), previous research with The OUCH Cohort (Waxman et al., 2017) suggests that pain-related distress expression in the preschool phase is moderate compared to infant pain-related distress. Additionally, these findings may be suggestive that the preschooler is learning to self-regulate

through deliberate modulation of their own pain (i.e., implementing strategies such as deep breathing or distraction). Moreover, owed to the developmental stage of preschool, as opposed to infancy, preschoolers' may enact more sophisticated behaviours (i.e., verbal communication to the caregiver, gestures toward the caregiver) than the pain-related distress behaviours that were examined, in order to communicate distress and maintain proximity to the primary caregiver. Furthermore, preschool behaviours may be influenced by the broader psychosocial factors (i.e., temperament, previous painful experiences) that impact their distress and deliberate in the modulation of that distress (Blount, Bunke, & Zaff, 2000a, 2000b; Blount, Piira, & Cohen, 2003; Manimala, Blount, & Cohen, 2000; Varni. Blount, Waldron, & Smith, 1995).

Attachment Theory: What Have We Learned From the Acute Pain Paradigm?

Revisiting attachment theory facilitates an understanding of the findings in the current dissertation with regards to the relationship between caregiver and infant or child behaviours in the vaccination context and preschool attachment. The findings from the analyses linking the 2-month vaccination to preschool attachment were consistent with several aspects of attachment theory. The first finding to consider is that infant pain-related distress immediately after the needle (i.e., during the reactivity phase of the vaccination appointment) was not related to preschool attachment outcomes. This finding supports that during the reactivity phase, whereby the infant experiences peak distress (i.e., O'Neill, Ahola Kohut, Pillai Riddell, & Oster, 2019), the infant will signal that distress in order to promote proximity toward the primary caregiver (Bowlby, 1969/1982). Moreover, the finding that higher infant pain-related distress at 2 minutes post-needle (i.e., during the regulatory phase of the appointment) was related to greater preschooler security and lower disorganization supports the theory linking patterns of regulation to patterns of attachment (Cassidy, 1994). Cassidy (1994) asserts that secure infants will

continue to signal their distress to their primary caregiver in order to obtain support regulating that distress. While this paradigm is described within the framework of the infant Strange Situation Procedure (Ainsworth et al., 1978; Cassidy, 1994), it appears that these patterns of responding are also evident in the acute pain paradigm and predict forward to preschool attachment. In contrast, the analyses examining preschool pain-related distress during the regulatory period of the preschool vaccination appointment did not relate to preschool attachments. Although this finding is contrary to the theory linking patterns of regulation to patterns of attachment (Cassidy, 1994), it can be understood within Bowlby's (1969/1982) phases of development of attachment. The fourth phase, occurring during preschool (Marvin & Britner, 2008), is a phase when the preschooler is able to engage in goal-corrected behaviour in order to promote proximity to the primary caregiver. Owing to the sophistication of this phase (i.e., the ability to verbally communicate needs, the ability to implement self-regulatory strategies such as distraction), it follows that the behavioural measure of preschool pain-related distress did not relate to attachment outcomes.

The findings pertaining to caregiver behaviours in the vaccination context and preschool attachments can also be understood within attachment theory. The finding that caregiver sensitivity during the infant vaccination at 2 months was related to suboptimal preschool attachment outcomes (i.e., higher avoidance) is perhaps reflective of the early phase of the development of the attachment system (Bowlby, 1969/1982) whereby the caregiver is still building a repertoire of understanding the infant's signals and developing appropriate response patterns. In contrast, the finding that higher caregiver sensitivity during the preschool vaccination appointment is related to higher preschooler security is perhaps reflective of the later stage of development of the attachment system (Bowlby 1969/1982), whereby the caregiver has built a

repertoire of opportunities to consistently identify the child's needs and respond appropriately. Moreover, owing to the goal-corrected partnership within the preschool phase of attachment (Bowlby, 1969/1982), the caregiver and preschooler are *both* able to identify one another's needs in order to make a plan to promote a secure relationship.

The present dissertation aimed to better understand how different concepts (i.e., caregiver sensitivity, child emotion regulation) relate to preschool attachment in order to inform the use of the acute pain paradigm as a cost-effective way to provide screening and intervention to promote health caregiver-child attachments. Accordingly, the next section will now identify the clinical implications informed by the current dissertation findings.

Clinical Implications

Overall, the set of studies in this dissertation offer interesting clinical implications. First, the findings that caregiver sensitivity during preschool vaccination was related to preschool attachment outcomes identifies that how a caregiver interacts with their child during a vaccination context is reflective of how they may be interacting with their child in distress outside the vaccination context. Thus, health care providers could use this naturally occurring scenario as s a potential area for screening and early intervention in order to support healthy affect regulation development. The pragmatic naturally-occurring vaccination context is also a teachable moment in which health care providers may demonstrate how caregivers may sensitively intervene in order to support their child's distress. This suggestion is supported by past findings that providing caregivers with a brief 5-minute video identifying four simplistic strategies to support their child's pain both decreased child pain and increased caregivers' use of pain management strategies during child vaccination appointments (Pillai Riddell et al., 2018).

Second, the finding that infant pain-related distress was related to preschool attachment also offers insight to infant or child factors within a routine vaccination paradigm that may be helpful for supporting the development of the child's relationship to the primary caregiver. Reframing infant distress related behaviours as aimed at gaining proximity to the caregiver in order to obtain support ('honest signalling' as cited in Barr, 1998), may help promote caregiver responding to their infant in distress and also prevent anxiety or guilt induced from the caregiver perceiving their infant's distress as an indication of something they are doing wrong. Although more research is required, implementing this knowledge into early screening and intervention of well-baby visits may allow health care providers to provide some sensitive ways of supporting the infant in pain thereby promoting the infant's or child's attachment to their primary caregiver.

Limitations

Across the three studies in the present dissertation there are several limitations which warrant discussion. In terms of Study 1, studies were only included if they were published in English or French, which limits the findings to journals publishing in these languages. Additionally, caregiver sensitivity was operationalized as unidimensional or multidimensional in order to account for the multifaceted measures of caregiver sensitivity in the literature (Mesman & Emmen, 2013). However, there are multiple ways that caregiver sensitivity could have been operationalized and it is important to acknowledge that alternative operationalizations may have modified the results. In terms of Study 2 and Study 3, some additional limitations should be acknowledged. Most importantly, it is critical to recognize the number of non-significant findings that were identified in both Study 2 and Study 3 analyses. Although the findings linking caregiver-child vaccinations to preschool attachment identifies the acute pain context as a potential paradigm for early screening and intervention, there is much more research needed in

order to better understand the replicability of the significant and non-significant findings. A final limitation to note in regard to Study 2 and Study 3 is that despite the ethnocultural diversity of the sample, socioeconomic status and education were relatively higher compared to the general population and thus, the results may not generalize to samples at higher risk of maladaptive outcomes (i.e., due to trauma , poverty, etc.). Additionally, given that the OUCH Cohort was the first cohort to longitudinally follow healthy caregiver-child dyads during routine immunizations across the first year of life and then preschool, it was important observe a "normative" sample in order to better understand developmental trajectories. However, this necessitated various eligibility requirements (i.e., full term, no developmental delays or chronic illnesses). Therefore, it is difficult to know how the findings would generalize to children with a history of painful medical conditions.

Future Directions

The findings in the present dissertation inspire several future directions for research. Owing to the heterogeneity in preschool attachment outcomes (i.e., secure-insecure, organized-disorganized, security scales, A/B/C/D-Controlling), Study 1 synthesized the literature according to secure-insecure and organized-disorganized preschool attachment outcomes. However, with increasing studies employing the Main and Cassidy (1988) and Cassidy and Marvin (1992) coding systems emerging, as well as the PARS (Moss et al., 2015), future research may be able to synthesize the literature looking at caregiver sensitivity and additional attachment categories. Of particular interest would be differentiating outcomes between behavioural disorganization, controlling-caregiving, and controlling-punitive attachments as it would juxtapose disorganized patterns to those with varying types of role reversal. Additionally, as this body of literature grows, it may be possible to have less heterogeneity between operationalizations of caregiver

sensitivity and more opportunities to synthesize longitudinal relationships between caregiver sensitivity and preschool attachment. Moreover, an increase in research assessing caregiver sensitivity within a high distress paradigm (i.e., vaccination appointments) would also broaden the synthesis of this literature. In terms of the experimental analyses examining caregiver-child behaviours in the vaccination context and preschool attachment outcomes, more research is needed. Replicating these analyses with different populations (i.e., diverse socioeconomic backgrounds, children with a history of medical issues, at-risk families) would shed light on the generalizability of the findings to other populations. Moreover, linking these relationships (i.e., caregiver-child vaccination behaviours and preschool attachment) to subsequent socioemotional outcomes in later childhood or early adolescence would provide further insight on trajectories of developmental psychopathology.

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Appendix A

Dissertation Summary of Analyses and Significant Results

Study 1: O'Neill, M. C., Badovinac, S., Pillai Riddell, R., Bureau, J-F., Rumeo, C., & Costa, S. (under review). The longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment: A systematic review and meta-analysis.

Research Question: What are the longitudinal and concurrent relationships between caregiver sensitivity and preschool attachment measured using the Main and Cassidy (1998) and Cassidy and Marvin (1992) attachment classification systems?

Analysis: A systematic electronic literature search yielded 9, 312 studies, which were examined according to inclusion/exclusion. The review included a total of 36 studies. Both narrative and meta-analytic techniques were utilized.

Results:

- Overall, the analyses consistently revealed higher levels of caregiver sensitivity among caregivers of children with secure and organized preschoolers compared to insecure and disorganized preschoolers, respectively.
- There were medium effect sizes (g = .46 to .59) for both the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment when caregiver sensitivity was operationalized as unidimensional.
- There were small to medium effect sizes (g = .34 to .49) for both the longitudinal and concurrent relationship between caregiver sensitivity and preschool attachment when caregiver sensitivity was operationalized as multidimensional.
- The longitudinal relationship between unidimensional caregiver sensitivity and preschool attachment was moderated by child age at attachment measurement. Specifically, there were greater between-group differences for the longitudinal relationship between unidimensional sensitivity and secure versus insecure attachment when children were older.

Study 2 and 3: O'Neill, M. C., Pillai Riddell, R., Bureau, J-F., Deneault, A-A., Garfield, H., & Greenberg, S. (in press). Longitudinal and concurrent relationships between caregiver-child behaviours in the vaccination context and preschool attachment. *PAIN.* doi: 10.1097/j.pain.0000000000002091

a) Study 2: The longitudinal relationships between caregiver and infant behaviours during the infant vaccination appointment (i.e., caregiver sensitivity, caregiver, proximal soothing, infant pain-related distress) and preschool attachment.

Research Question: What is the longitudinal relationship between caregiver and infant behaviours (i.e., caregiver sensitivity, caregiver proximal soothing, infant pain-related distress) during infants' first vaccination of early infancy (2-months of age) and preschool (4-5 years of age) attachment ratings?

Analysis: A series of six planned hierarchical multiple regression models with caregiver and infant behaviour variables at infants' 2 month vaccination predicting each of the preschool attachment rating outcomes (i.e., security, avoidance, ambivalence, disorganization, controlling-caregiving, and controlling-punitive).

Results:

Predicting Preschool Attachment from Infant Behaviour (2-month Vaccination)

- Higher pain-related distress at 2 minutes post-needle during the 2-month vaccination was significantly related to higher preschooler security.
- There was a marginally significant negative relationship between infants' pain-related distress at 2 minutes post-needle and preschooler disorganization, such that higher pain-related distress at 2 minutes was related to lower preschooler disorganization.
- There was a marginally significant negative relationship between infant pain-related distress at 2 minutes post-needle and preschooler controlling-punitive attachment.

Predicting Preschool Attachment from Caregiver Behaviour (2-month Vaccination)

- Higher caregiver sensitivity during infants' 2-month vaccinations was significantly related to higher preschooler avoidance.
- Higher proximal soothing at 1 minute pre-needle during infants' preschool vaccination was significantly related to lower preschooler ambivalence.

b) Study 3: The concurrent relationships between caregiver and preschooler behaviours during the preschool vaccination appointment (i.e., caregiver sensitivity, preschool pain-related distress) and preschool attachment.

Research Question: What is the concurrent relationship between caregiver and preschooler behaviours (i.e., caregiver sensitivity, preschooler pain related distress) during the last vaccination of early childhood (4-5 years) and preschool attachment ratings?

Analysis: A series of six planned hierarchical multiple regression models with caregiver and preschooler behaviour variables at the 4-5 year vaccination predicting each of the preschool attachment rating outcomes (i.e., security, avoidance, ambivalence, disorganization, controlling-caregiving, and controlling-punitive).

Results:

Predicting Preschool Attachment from Preschool Behaviour (4-5 year Vaccination)

- Preschooler pain-related distress did not significantly predict any of the preschool attachment ratings (i.e., security, avoidance, ambivalence, disorganization, controlling-caregiving, and controlling-punitive).

Predicting Preschool Attachment from Caregiver Behaviour (4-5 year Vaccination)

- There was a significant positive relationship between caregiver sensitivity during the preschool vaccination and preschooler security. Specifically, higher caregiver sensitivity during the preschool vaccination was associated with higher preschool attachment security.

Appendix B

Systematic Review Search Strategy for Chapter 2 (Dissertation Study 1)

MEDLINE Search Strategy

1 Object Attachment/ (12715)

2 attachment*.mp. (119266)

3 1 or 2 (119266)

4 (separation* adj7 reunion*).mp. (175)

5 strange situation*.mp. (469)

6 Preschool Attachment Classification System*.mp. (1)

7 PACS.mp. (4150)

8 cassidy.af. (4665)

9 MacArthur.af. (3461)

10 Attachment Working Group.af. (1)

11 Organized.mp. (78552)

12 Disorganized.mp. (8506)

13 Disorganization.mp. (8466)

14 controlling.mp. (236419)

15 Insecur*.mp. (7919)

16 Secure.mp. (20324)

17 Security*.mp. (51110)

18 Avoidant*.mp. (3852)

19 Avoidance.mp. (71787)

20 Ambivalent.mp. (2896)

21 Dependent.mp. (1479677)

22 Resistant.mp. (415969)

23 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 (2297806)

24 (infan* or baby* or babies or child* or toddler* or schoolchild* or school child* or school age* or pre-school or preschool* or nursery school* or kindergar* or primary school* or elementary school*).mp. (2925448)

25 3 and 23 and 24 (3293)

EMBASE Search Strategy

1 emotional attachment/ or object relation/ (15584)

2 attachment*.mp. (111677)

3 1 or 2 (119831)

4 (separation* adj7 reunion*).mp. (199)

5 strange situation*.mp. (487)

6 Preschool Attachment Classification System*.mp. (1)

7 PACS.mp. (5541)

8 Cassidy.af. (3986)

9 MacArthur.af. (7121)

10 Attachment Working Group.af. (1)

11 Organized.mp. (78460)

12 Disorganized.mp. (9107)

13 Disorganization.mp. (10016)

14 Controlling.mp. (248186)

15 Insecur*.mp. (9400)

16 Secure.mp. (26372)

17 Security*.mp. (55438)

18 Avoidant*.mp. (4648)

19 Avoidance.mp. (84723)

20 Ambivalent.mp. (3343)

21 Dependent.mp. (1752222)

22 Resistant.mp. (492577)

23 4 or 5 or 6 or 7 or 8 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 (2667938)

24 (infan* or baby* or babies or child* or toddler* or schoolchild* or school child* or school age* or pre-school or preschool* or nursery school* or kindergar* or primary school* or elementary school*).mp. (2911628)

25 3 and 23 and 24 (3776)

PsycINFO Search Strategy

1 attachment behavior/ (18574)

2 attachment theory/ (1626)

3 attachment*.tw. (35573)

4 1 or 2 or 3 (37081)

5 (separation* adj7 reunion*).mp. (365)

6 strange situation*.mp. (1311)

7 Preschool Attachment Classification System*.mp. (7)

8 PACS.mp. (171)

9 cassidy.af. (11148)

10 MacArthur.af. (15753)

11 Attachment Working Group.af. (4)

12 Organized.mp. (38484)

13 Disorganized.mp. (3493)

14 Disorganization.mp. (4058)

15 Controlling.mp. (58808)

16 Insecur*.mp. (10272)

17 Secure.mp. (13635)

18 Security*.mp. (25513)

19 Avoidant*.mp. (6872)

20 Avoidance.mp. (47428)

21 Ambivalent.mp. (5305)

22 Dependent.mp. (130492)

23 Resistant.mp. (17833)

24 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 (359189)

25 (infan* or baby* or babies or child* or toddler* or schoolchild* or school child* or school age* or pre-school or preschool* or nursery school* or kindergar* or primary school* or elementary school*).mp. (750640)

26 4 and 24 and 25 (7916)

27 limit 26 to all journals (5124)

CINAHL Search Strategy

#	Query	Results	Limiters/Expanders
S26	S4 AND S24 AND S25	1,008	Search modes - Boolean/Phrase
S25	(infan* or baby* or babies or child* or toddler* or schoolchild* or school child* or school age* or pre-school or preschool* or nursery school* or kindergar* or primary school* or elementary school*)	631,451	Search modes - Boolean/Phrase
S24	S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23	161,424	Search modes - Boolean/Phrase
S23	Resistant	29,707	Search modes - Boolean/Phrase
S22	Dependent	56,474	Search modes - Boolean/Phrase
S21	Ambivalent	839	Search modes - Boolean/Phrase
S20	Avoidance	8,824	Search modes - Boolean/Phrase
S19	Avoidant*	1,093	Search modes - Boolean/Phrase
S18	Security*	21,759	Search modes - Boolean/Phrase
S17	Secure	5,146	Search modes - Boolean/Phrase
S16	Insecur*	3,113	Search modes - Boolean/Phrase
S15	controlling	29,120	Search modes - Boolean/Phrase
S14	Disorganization	582	Search modes - Boolean/Phrase
S13	Disorganized	596	Search modes - Boolean/Phrase

S12	Organized	9,414	Search modes - Boolean/Phrase
S11	Attachment Working Group	0	Search modes - Boolean/Phrase
S10	MacArthur	337	Search modes - Boolean/Phrase
S9	cassidy	179	Search modes - Boolean/Phrase
S8	PACS	1,851	Search modes - Boolean/Phrase
S7	Preschool Attachment Classification System*	0	Search modes - Boolean/Phrase
S6	strange situation*	102	Search modes - Boolean/Phrase
S5	(separation* N7 reunion*)	19	Search modes - Boolean/Phrase
S4	S1 OR S2 OR S3	11,095	Search modes - Boolean/Phrase
S3	attachment*	11,095	Search modes - Boolean/Phrase
S2	(MH "Reactive Attachment Disorder")	168	Search modes - Boolean/Phrase
S1	(MH "Attachment Behavior")	3,437	Search modes - Boolean/Phrase

Appendix C

Protocol for Ambiguous Abstracts for Chapter 2 (Dissertation Study 1)

Abstracts that did not clearly identify the age at which attachment was measured or the type of measurement used to examine attachment were set aside for full text review if they met one of the following criteria:

1. The abstracts were authored by individuals identified to contribute to the Preschool Attachment Classification System (PACS) Manual.
2. The abstracts were authored by key researchers in the field of child attachment.
3. The abstracts were completed using National Institute of Child Health and Development (NICHD) data.

Authors to Search for "More Info"	Justification
Cassidy	Authored kindergarten attachment coding guidelines; Authored Preschool Attachment Classification System guidelines
Main	Authored kindergarten attachment coding guidelines; Contributor to Preschool Attachment Classification System guidelines
Marvin	Authored the Preschool Attachment Classification System guidelines
Attachment Working Group	Authored the Preschool Attachment Classification System guidelines
MacArthur	Authored the Preschool Attachment Classification System guidelines
Ainsworth	Contributor to Preschool Attachment Classification System guidelines
Beckwith	Contributor to Preschool Attachment Classification System guidelines
Belsky	Contributor to Preschool Attachment Classification System guidelines
Booth	Contributor to Preschool Attachment Classification System guidelines
Bronson	Contributor to Preschool Attachment Classification System guidelines
Crnic	Contributor to Preschool Attachment Classification System guidelines
Easterbrooks	Contributor to Preschool Attachment Classification System guidelines
Greenberg	Contributor to Preschool Attachment Classification System guidelines
LaGasse	Contributor to Preschool Attachment Classification System guidelines
Ridgeway	Contributor to Preschool Attachment Classification System guidelines
Barnard	Contributor to Preschool Attachment Classification System guidelines
Beeghly	Contributor to Preschool Attachment Classification System guidelines
Blacher	Contributor to Preschool Attachment Classification System guidelines
Bretherton	Contributor to Preschool Attachment Classification System guidelines
Carmichael-Olsen	Contributor to Preschool Attachment Classification System guidelines
Cicchetti	Contributor to Preschool Attachment Classification System guidelines
Cummings	Contributor to Preschool Attachment Classification System guidelines
Gottman	Contributor to Preschool Attachment Classification System guidelines
Harmon	Contributor to Preschool Attachment Classification System guidelines
Morisset	Contributor to Preschool Attachment Classification System guidelines
Slough	Contributor to Preschool Attachment Classification System guidelines
Spieker	Contributor to Preschool Attachment Classification System guidelines
Stevenson-Hinde	Contributor to Preschool Attachment Classification System guidelines

Speltz	Contributor to Preschool Attachment Classification System guidelines
Purcell	Contributor to Preschool Attachment Classification System guidelines
Moss	Key researcher in field of attachment
Lecompte	Key researcher in field of attachment
Bureau	Key researcher in field of attachment
Bernier	Key researcher in field of attachment
Tarabulsy	Key researcher in field of attachment
Moran	Key researcher in field of attachment
Sroufe	Key researcher in field of attachment
Van IJzendoorn	Key researcher in field of attachment
McElwain	Key researcher in field of attachment
Howes	Key researcher in field of attachment
NICHD, National Institute of Child Health and Development	Key researcher in field of attachment
O'Connor	Key researcher in field of attachment
Lyons-Ruth	Key researcher in field of attachment
Pierrehumbert	Key researcher in field of attachment
Pederson	Key researcher in field of attachment
Bailey	Key researcher in field of attachment
Dubois	Key researcher in field of attachment
Cyr	Key researcher in field of attachment
Humber	Key researcher in field of attachment
McCartney	Key researcher in field of attachment
Rousseau	Key researcher in field of attachment
Parent	Key researcher in field of attachment
St-Laurent	Key researcher in field of attachment
Mongeau	Key researcher in field of attachment
Pascuzzo	Key researcher in field of attachment
Crittenden	Key researcher in field of attachment

Appendix D

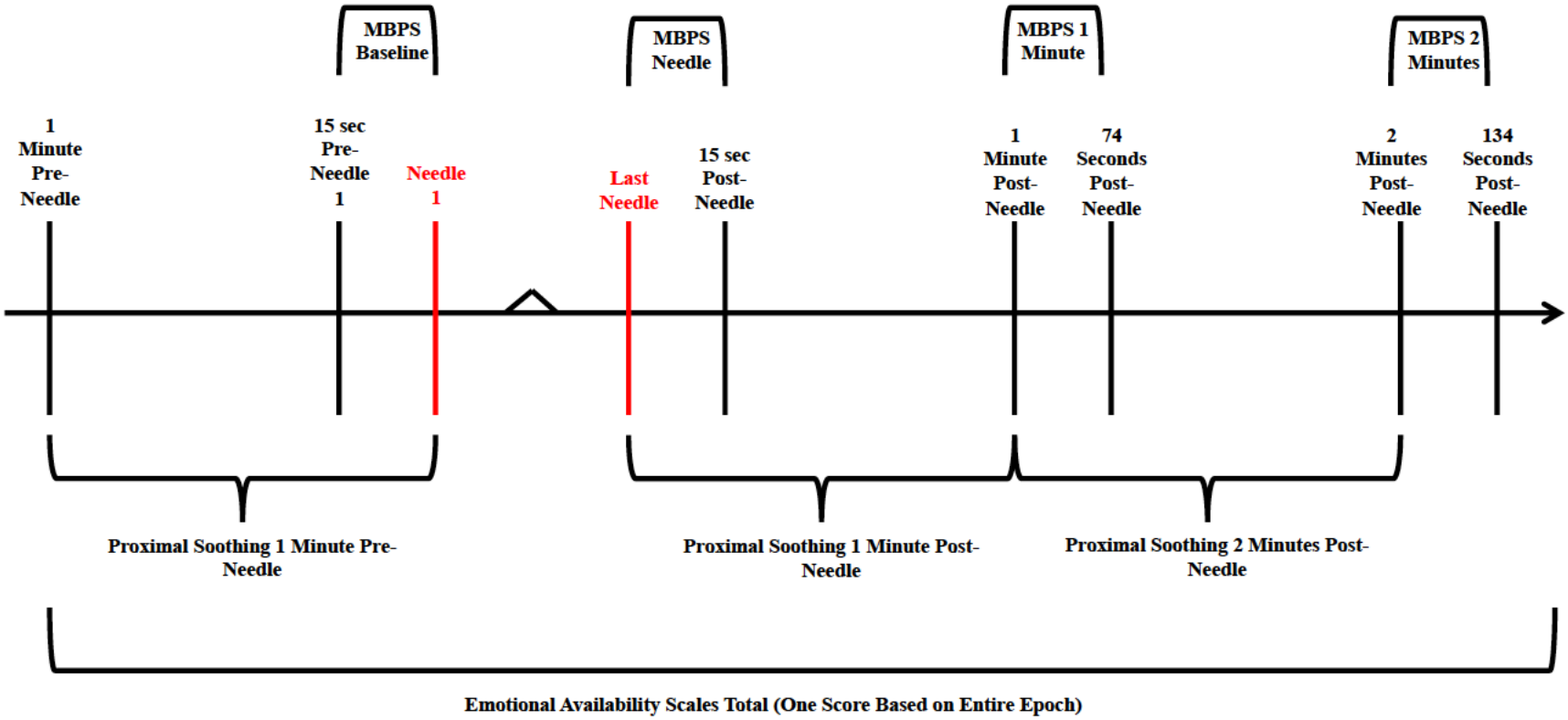
Quality Assessment Checklist for Chapter 2 (Dissertation Study 1)

1. Was the research question or objective in this paper clearly stated?
2. Was the study population clearly specified and defined?
3. Was the participation rate of eligible persons at least 50%?
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)?
5. Were inclusion and exclusion criteria for being in the study pre-specified and applied uniformly to all participants?
6. Was a sample size justification, power description, variance accounted for or effect estimates provided for the sensitivity and PACS analyses?*****
7. For predictor variables (i.e., caregiver sensitivity variables) that can vary in amount or level, did the study examine different levels of the predictor as related to the outcome (i.e., PACS) (e.g., categories of sensitivity levels, or sensitivity measured as continuous variable)?
8. Were the predictor variables (i.e., caregiver sensitivity variables) clearly defined, valid, reliable, and implemented consistently across all study participants?*****
9. Was the predictor variable (i.e., caregiver sensitivity) assessed more than once over time?
10. Were measures of the outcome variable (i.e., PACS) clearly defined, valid, reliable, and implemented consistently across all study participants?*****
11. Were the outcome assessors (i.e., PACS coders) blinded to the participants' scores on caregiver sensitivity?*****
12. Was loss to follow-up after baseline 20% or less (i.e., was the retention rate greater than or equal to 80%)?*****
13. Were key potential confounding variables measured and adjusted statistically for their impact on the outcome (PACS)?*****
14. Is the distribution of the overall study population by gender (of the child) described?
15. Are the statistical methods described?
16. Have actual probability values been reported (e.g., 0.035 rather than < 0.05) for the main outcomes except where the probability value is less than 0.001?

***Items were used to determine an overall quality judgment (Higher vs. Lower).**

Appendix E

Infant Vaccination Timeline for Chapter 4 (Dissertation Study 2)



Appendix F

Preschool Vaccination Timeline for Chapter 4 (Dissertation Study 3)