Clinical Child and Family Psychology Review (2022) 25:529–551
https://doi.org/10.1007/s10567-022-00383-7

Parent–Child Synchrony After Early Childhood: A Systematic Review

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Accepted: 27 January 2022 / Published online: 8 February 2022

Abstract

Parent–child synchrony, or the coordination of biological and behavioral processes between parent and child, is thought to promote healthy relationships and support youth adjustment. Although extensive work has been conducted on parent–child synchrony during infancy and early childhood, less is known about synchrony in middle childhood and adolescence and the contextual factors that impact synchrony, particularly physiological synchrony. This is a systematic and qualitative review of 37 studies of behavioral and physiological synchrony in parent–child interactions after early childhood (parents with youth ages 5–18). Behavioral and physiological synchrony were typically identified in youth and their parents beyond early childhood and related to positive outcomes; however, research on father-child synchrony is rarer with mixed findings. Multiple factors are associated with synchrony, including parent and youth psychological symptoms and disorders, parenting factors, such as over-controlling parenting, and parent characteristics, such as interparental aggression and conflict. Few studies have examined behavioral and physiological synchrony simultaneously and longitudinally, limiting our ability to understand the relationship between types of synchrony and later adjustment. Available studies suggest that the context, such as presence of psychopathology or exposure to trauma, influences whether synchrony is associated with positive or negative outcomes. This review highlights the need for additional research to understand the relationship between types of synchrony and the long-term effects and contextual factors that impact youth outcomes.

Keywords Parent–child synchrony · Physiological synchrony · Behavioral synchrony

Parent–child synchrony, or the coordination of biological and behavioral processes between parent and child during social interactions, is important for promoting healthy relationships and various aspects of youth adjustment (e.g., Feldman, 2007a, 2007b, 2010, 2015). Synchrony can be both concordant (i.e., when responses are mutually reflected across partners, referred to as "positive synchrony") or discordant (i.e., discordant responses between partners, referred to as "negative synchrony"). A large body of work has explored the presence and impact of parent–child behavioral synchrony, the dynamic and reciprocal adaptation of the temporal structure of behaviors between interactive partners (Leclère et al., 2014), in infancy and early childhood. Less research has examined physiological synchrony, the matching of biological states between interactive partners (Feldman et al., 2011), in parent–child dyads. Moreover, there is an emerging literature on behavioral and physiological synchrony beyond early childhood. Synchrony after early childhood should become more dynamic, with parents and children participating more as equal partners. Adolescence is a particularly important period to examine parent–child relationships given the expected developmental changes in autonomy, control, and collaboration, increases in parent–child conflicts, and associations between parent–child synchrony with various youth outcomes (Beveridge & Berg, 2007). This study provides a systematic review of the literature on parent–child synchrony after early childhood (i.e., ages 5–18) to: (1) examine both concordant and discordant behavioral and physiological synchrony during parent–child interactions from middle childhood through adolescence; (2) explore factors that impact parent–child synchrony; (3) explore the relationships between parent–child synchrony and youth outcomes; and (4) synthesize our current understanding of when synchrony is adaptive or maladaptive to propose directions for future research.

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Parent–Child Synchrony Across Developmental Stages

Initial research focused largely on behavioral synchrony, particularly during infancy and early childhood when synchrony reflects parent–child relationships and early attachment processes (e.g., Bowlby, 1969; Feldman, 2007a, 2007b, 2012). Parent–child synchrony is a time-based construct that changes throughout the course of development and teaches children about the dyadic nature of relationships, providing the foundation for intimacy, empathy, self-regulation, and theory of mind. It is associated with various outcomes at each stage of development (Feldman, 2020). During the neonatal period, synchrony is led by parents and involves directed gaze, expression of positive affect, vocalizations, and affectionate touch that are coordinated with the infant's moments of alertness. This early synchrony is associated with better cognitive development and fewer externalizing and internalizing symptoms across early childhood (e.g., Feldman & Eidelman, 2009). In later infancy, synchrony becomes more interactive, including the coordination of gaze, affective expressions, co-vocalizations, and touch patterns, and plays a key role in social, emotional, cognitive, and neural development (e.g., Feldman, 2007a, 2007b). During the toddler and preschool years, symbolic play skills emerge, and children begin to co-construct dialogues with parents, making synchronous dialogue increasingly social. These reciprocal interactions predict children's theory of mind abilities and development of moral stance across childhood and adolescence (e.g., Feldman, 2007a, 2007b).

Bell (2020) notes that by the end of the second year, dyadic behavioral synchrony begins to align with physiological synchrony, and this is well coupled by later childhood. Mother-infant behavioral synchrony has been found to be individually stable across early childhood and related to multiple outcomes in middle childhood (e.g., greater verbal IQ, lower behavioral problems, and greater empathy) and adolescence (e.g., empathy and emotion regulation; Feldman, 2007a, 2007b, 2015). This demonstrates the importance of early synchrony on youth outcomes later in development and reaffirms the need to study synchrony in later childhood.

Importantly, more research examining behavioral and physiological synchrony simultaneously throughout development is needed. In later childhood and adolescence, there is increased synchronous dialogue that incorporates youth's emerging capabilities for empathy, planning and cooperation, and perspective-taking (Feldman, 2020). Increased collaboration and give and take between parents and children is expected during middle childhood and adolescence (e.g., Beveridge & Berg, 2007; Chu & Powers, 1995). Adolescence is also marked by greater levels of autonomy and increases in parent–child conflict (Beveridge & Berg, 2007), which provides an important opportunity to examine how this developmental change impacts parent–child synchrony. Across developmental stages, these parent–child experiences support future social interactions and regulatory abilities through adulthood (e.g., Feldman, 2007a, 2007b, 2020). These are critical to understand, particularly the conditions under which synchrony exists and when it is adaptive or associated with risk.

Existing Reviews of Parent–Child Synchrony

Several reviews have synthesized the literature on parent–child synchrony. This work has found synchrony in both healthy dyads and dyads with parent or child psychological conditions across early childhood. The degree of synchrony is impacted by the presence of risk, such as maternal and youth psychopathology, and is associated with various youth outcomes, such as academic achievement and social and emotional adjustment (e.g., Feldman, 2007a, 2007b; Leclère et al., 2014). In addition, several challenges in the existing literature have been identified, such as differences in terminology used to describe synchrony (e.g., mutuality, reciprocity, rhythmicity, and attunement) and methodology to assess and quantify synchrony (Davis et al., 2018). Moreover, many of these reviews have focused specifically on infancy through age 5 and have examined behavioral synchrony (e.g., Feldman, 2007a, 2007b; Leclère et al., 2014).

In a meta-analysis of 10 studies examining behavioral synchrony in overall positive interactions and youth behavioral and emotional self-regulation, Davis et al. (2017) found that greater parent–child behavioral synchrony was associated with greater youth self-regulation ($r = .32$, $p < .001$, 95% CI .24, .40). This association was strongest when synchrony was assessed in children between 24 and 48 months and when self-regulation was assessed in children between 48 and 67 months. The relationship between parent–child positive behavioral synchrony and youth self-regulation was stronger when observed for mother–child dyads compared to father-child dyads. The coding method (i.e., macro- versus micro-coding of behavioral synchrony), cross-sectional versus longitudinal study comparison, and time elapsed between synchrony and self-regulation assessments did not impact the relationship between synchrony and youth self-regulation. This meta-analysis supports the relationship between parent–child behavioral synchrony and youth adjustment. Importantly, however, it did not include samples with clinical diagnoses or biological risk factors (e.g., infant prematurity), focused on behavioral synchrony in overall positive interactions specifically, and only included

10 studies. Although this meta-analysis provided valuable information, it is important to examine synchrony in positive and negative interactions in dyads that include individuals with biological and psychological risk factors to understand how synchrony is influenced by these factors.

More recently, there has been an effort to explore parent–child synchrony, including physiological synchrony, in youth after age 5. In a systematic review of 30 studies, Davis et al. (2018) examined the literature on parent–child physiological synchrony in dyads with children ages 2–18. All studies found some evidence of parent–child physiological synchrony across early childhood, middle childhood, and adolescence, with stronger synchrony found in contexts when parent and child were interacting relative to doing things separately. The magnitude and direction of synchrony generally varied according to several factors, including the physiological index being examined, the type of task used to measure synchrony, and broader contextual factors (e.g., maternal psychopathology). Physiological synchrony was strongest when using adrenocortical functioning and found in both at-risk and typically developing dyads (for an extensive review of physiological indices, see Davis et al., 2018). The evidence in the literature is mixed about whether physiological synchrony becomes stronger or weaker in the presence of risk, and these patterns seem to vary based on the physiological index that is used. The review posits that it is possible that physiological synchrony in the context of greater positive emotionality is adaptive, while physiological synchrony under conditions of elevated negative emotionality (e.g., presence of psychopathology) contributes to increased risk for youth. This is an important theory to further explore for both concordant and discordant physiological and behavioral synchrony in parent–child dyads, particularly during middle childhood and adolescence. The present review addresses this gap and also explores the relationship between behavioral and physiological synchrony based on existing literature, which has yet to be reviewed.

Conclusions and Gaps in the Literature

Taken together, the limited existing research supports the existence of parent–child synchrony in middle childhood and adolescence and suggests the continued importance of parent–child synchrony for youth development and adjustment. As there is less research on physiological synchrony than behavioral synchrony, expectations for parent–child physiological synchrony are less clear. Current research suggests that the physiological index (e.g., heart rate, skin conductance, respiratory sinus arrhythmia [RSA], cortisol]) kind of behavioral task (e.g., interacting, doing the same task independently), and partner (e.g., mother versus father) may impact the presence of physiological synchrony. Some research has begun exploring physiological synchrony in the context of risk, typically indexed by the presence of psychopathology in parents or children. Study findings suggest that the emotional climate of the interaction, presence or absence of risk (e.g., parent and youth psychopathology), and type of synchrony (e.g., concordant or discordant) may contribute to whether parent–child synchrony is adaptive or maladaptive for youth. For instance, concordant synchrony in the context of heightened negative emotionality, such as with parental psychopathology or distress, may increase risk for negative youth outcomes, such as poorer self-regulation. There is much work to be done to better understand the impact of contextual factors (e.g., parent and youth psychological symptoms, parent behaviors, parent self-regulation and distress tolerance) on both behavioral and physiological synchrony. This research is essential given the associations between parent–child synchrony and youth outcomes. Understanding the factors that make synchrony adaptive versus associated with increased risk could provide important information for the prevention of, or interventions for, youth psychopathology, such as targeting parent–child synchrony to enhance youth resilience in the context of risk.

Overview of the Present Review

In sum, extensive literature has examined behavioral synchrony in parent–child dyads during infancy and early childhood and how this relates to youth outcomes, as well as some factors that impact the presence and direction of synchrony (e.g., parental or youth psychopathology, developmental risk factors). Additional research is needed to understand behavioral synchrony in negative contexts, such as during conflict, or in the context of risk, and in parent–child dyads with older youth. Moreover, less is understood about physiological synchrony in parent–child dyads. In addition to examining synchrony across contexts, the current review prioritized examining parent–child synchrony during interactions, rather than when parents and children completed independent tasks, to capture and understand how dynamic responses in parents and their children change over time and impact youth adjustment. Thus, the present systematic review examined concordant and discordant physiological and behavioral synchrony during parent–child dyadic interactions with youth ages 5 to 18 in both clinical and non-clinical populations. In addition, the review aimed to synthesize our current understanding of when synchrony is adaptive or associated with risk and to set the stage for future research in this area.

Method

Inclusion Criteria and Search Parameters

Studies eligible for inclusion in this review examined the association between parent–child synchrony after early childhood (i.e., ages 5 to 18). Systematic searches of the literature were conducted in Web of Science, PsycINFO, and PubMed, where multiple terms were required to appear in the title, abstract, or as a keyword in journal articles published in English only. The specific search was "("mother–child" OR "parent–child") AND ("synchrony" OR "interaction" OR "mutuality" OR "reciprocity" OR "rhythmicity" OR "harmonious interaction" OR "turn-taking" OR "shared affect" OR "co-regulation" OR "attunement" OR "linkage" OR "co-variation" OR "concordance" OR "collaboration" OR "cooperation") AND ("early childhood" OR "middle childhood" OR "adolescence")."

Eligibility of Identified Studies

The searches yielded 2269 records identified through database searching (970 from Web of Science; 659 from PsycINFO; 640 from PubMed). Thirteen additional records were identified through examination of relevant meta-analytic and literature reviews. After duplicates were removed, 1468 unique records were screened for inclusion via abstract review. Of these, 1407 were excluded due to topic irrelevance (e.g., parents and children were interacting, but synchrony was not measured), age of the sample (i.e., age 5 and younger), or manuscript type (review papers rather than empirical studies). Of the remaining 54 articles assessed for eligibility through full-text review, seven articles were excluded because they did not examine synchrony during parent–child interactions (e.g., explored family functioning or respect/recognition) or were not dynamic (i.e., parents and children were not directly interacting). In addition, ten studies were excluded because they reviewed synchrony in non-interactive contexts, such as when sitting next to each other but not interacting, when completing tasks independently, affect/behavior during interactions but not necessarily in response to each other, or "synchrony" in moods or experiences throughout the day in daily diary studies. These studies were briefly reviewed before the main synthesis of articles as they had relevant methodological considerations but did not contribute directly to the present review. As such, 37 empirical articles were included in the qualitative synthesis. Figure 1 shows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for the literature search and decisions regarding inclusion.

Results

Brief Overview of Studies not in Main Synthesis

Ten studies were identified that examined synchrony in non-interactive contexts. Given the present review's focus on parent–child synchrony during interactions, these studies were not included in the main synthesis but will be reviewed briefly to highlight alternative methods for studying synchrony. Some studies examined synchrony while parents and children completed, or observed their partner completing, tasks. In general, these studies support parent–child synchrony and identified some factors that appear to impact the degree of synchrony, such as child age and degree of over-controlling parenting (Borelli et al., 2019) and parent psychopathology (Gray et al., 2018). Other studies examined neural response in mothers and children when observing each other's performance and similarly identified factors that impacted synchrony, such as maternal and child internalizing symptoms (Cosgrove et al., 2019) and family connectedness (Lee et al., 2018). Finally, two studies examined parent–child RSA synchrony when viewing positive and negative films independently and together. Creavy et al. (2020) found that synchrony was not stable across emotional contexts or conditions (i.e., joint versus independent viewing). Kiser et al. (2019) found that caregiver RSA demonstrated greater increases when viewing films together than their children, and greater caregiver RSA in the joint watching condition was associated with greater parent dysregulation and child anxiety. These studies shed light on the impact of various factors (e.g., parent over-control and emotional acceptance, emotional context of the task) on parent and child physiological synchrony during non-interactive contexts.

Other studies used naturalistic observations or daily physiological methods to examine similarities in parents and children. These studies suggest that synchrony is impacted by time spent together and levels of parental monitoring (Papp et al., 2009), maternal anxiety, family functioning (i.e., communication and roles), affective involvement, and child gender (e.g., males and mothers of males had flatter slopes; Williams et al., 2013), emotional context (Bai et al., 2016), and how well family members get along (Mercado et al., 2019).

Taken together, these studies offer a sample of the methods used in the literature to examine behavioral and physiological synchrony in parent–child dyads. Specifically, these studies examine parent–child synchrony in non-interactive contexts (e.g., when watching each other's task performance/completing tasks separately or taking daily ratings or samples and examining associations). Given the existing research suggesting that synchrony is

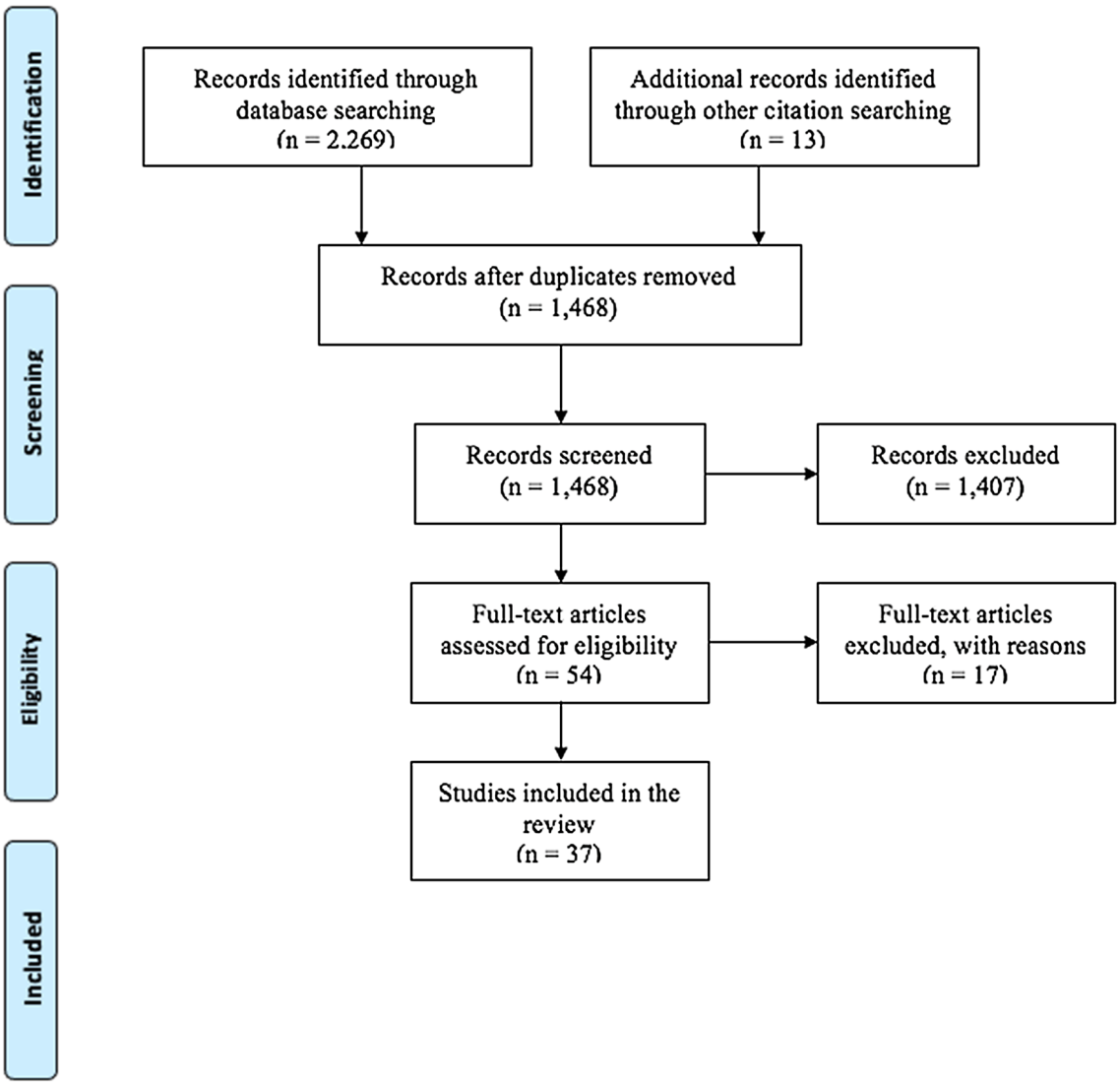

Fig. 1 PRISMA (2020) flowchart of record identification, screening, eligibility, and inclusion

greater in interactive contexts (e.g., Davis et al., 2018), this review focused on empirical studies that examined parent–child synchrony after early childhood during parent–child interactions.

Overview of Studies in Qualitative Synthesis

Of the 37 empirical articles included for review, the majority ($n = 24$) investigated synchrony between mothers and children. Of the remaining studies, 11 included both fathers and mothers, one included fathers and children only, and one included primary caregivers, which resulted in > 90% biological mothers. Parent–child physiological synchrony in community samples and clinical/high risk contexts each included five studies, and there were 16 and six studies that examined parent–child behavioral synchrony in community samples and clinical/high risk contexts, respectively. Five studies examined *both* parent–child behavioral and physiological synchrony in varying contexts. The majority of the studies ($n = 24$) included a conflict discussion to assess synchrony during; some studies ($n = 12$) included a baseline or positive discussion as well. Further study details are provided below and in Table 1, as well as effect sizes for the studies described below.

Parent–Child Physiological Synchrony in Community Samples and Associated Outcomes/Correlates

Several studies examined physiological synchrony in parents and children in community samples and how this relates to various family factors and child outcomes. Children in these studies ranged from 6 to 18 years of age.

Table 1 Summary of included study characteristics

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
Ahemaitijia et al. (2020)	Physiological	Interbeat Interval	Auto-regressive integrated moving average modeling (ARIMA)	Conflict discussion	Parent–child dyads (mothers or fathers and child)	7–12 (8.76)	89 dyads		$r = .15–.18$	Community sample
Gordis et al. (2010)	Physiological	Salivary alpha amylase (sAA)	Root-transformed area under the curve scores (ground/increase)	Relaxation/conflict discussion	Parent-adolescent triads (mothers, fathers, and children)	13–18 (15.2)	62 triads			Community sample
Han et al. (2019)	Physiological	Interbeat Interval	ARIMA	Drawing task/conflict discussion	Parent–child dyads (mothers and fathers and child)	6–12 (8.54)	150 dyads		$r = -.18$[b]; $r = .11$	Community sample
Li et al. (2020)	Physiological	Respiratory sinus arrhythmia (RSA)	Root mean square of successive differences	Conflict discussion	Parent-adolescent triads (mothers, fathers, and children)	12–14 (12.4)	191 triads			Community sample
Saxbe et al., (2014, 2015)	Physiological	Cortisol	Time-lagged models and area under the curve ground	Conflict discussion	Parent–child triads (mothers, fathers, and adolescents)	Study 1 = 13–18 (15.31), Study 2 = 15–18 (18.72)	Study 1 = 169 triads; Study 2 = 22 adolescents			Community sample
Bodner et al. (2019)	Behavioral	Positive and negative behaviors	Middle childhood attachment micro-observation coding System	Unsolvable puzzle task	Mother–child dyads	8–12 (10.3)	55 dyads			Community sample
Herbers et al. (2014)	Behavioral	Co-regulation (positive and negative behaviors)	Micro-Coding System for parent and child behaviors	Free play, clean up, conflict solving, board game, safety plan, guessing game, and puzzle	Parent–child dyads (92.7% biological mothers; rest fathers, step-parents, and grandmothers)	4–6 (5.75)	138 dyads		$r = .21–.40$[b]	Sample of families staying in emergency family shelters before kindergarten

Table 1 (continued)

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
Hinnant et al. (2013)	Behavioral	Cooperative behavior	Goal-directed partnership parent–child interaction scales: middle childhood	Cooperative puzzle and speech tasks	Mother–child dyads	10 (10.72)	89 dyads		$r = .23–.49$[b]	Community sample
Ferrar et al. (2020)	Behavioral	Verbal and nonverbal behaviors	Conflict behavior coding system (verbal behaviors) and Emotion Behavior Coding System (nonverbal behaviors)	Conflict discussion	Mother–child dyads	9–13 (10.80)	94 dyads		$r = -.33$ to $-.32$[b];	Community sample
Connell et al. (2015)	Behavioral	Affect	Simple affect coding system	Conflict and positive event-planning discussions	Mother-adolescent dyads	11–17 (13.67)	59 dyads	$r = .08$[b]; $r = .18–.19$		Community sample (both in general and families concerned about depression)
Criss et al. (2003)	Behavioral	Responsiveness, reciprocity, engagement, mutual focus, and shared affect	Synchrony coding measure developed for current study	Conflict discussion	Mother-son dyads	10	122 dyads		$r = -.28$ to $.35$[b]; $r = -.18–.07$	Low-income families who were participants in Women, Infants, and Children Nutritional? Supplement Program in Pittsburgh
Feldman et al. (2013)[a]	Behavioral	Dyadic reciprocity	Coding Interactive Behavior Manual (Global ratings)	Play at earlier visits; conflict and positive planning discussions at T3	Parent–child dyads (mother–child and father-child)	T1 = 20.5 weeks; T2 = 33.74 months; T3 = 12.68	100 (T1), 86 (T2), and 68 (T3) dyads		$r = -.19–.71$[b]; $r = -.16–.20$	Recruited from Well-Baby

Table 1 (continued)

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
Feldman (2010)[a]	Behavioral	Dyadic reciprocity	Coding Interactive Behavior Manual (Global ratings)	Play at earlier visits; conflict and positive planning discussions at T6	Mother–child dyads	T1-2 = 3 and 9 months, T3 = 2, T4 = 4 T5 = 6, T6 = 13	36 (T1-2), 33 (T3), 32 (T4-5), and 31 (T6) dyads			Recruited from Well-Baby
Kim et al. (2015)[a]	Behavioral	Mutually responsive orientation	5-point rating scale based on cooperation, emotional ambiance, and harmony	Free play, chores, preparation of snacks, parent busy, free play, and craft	Parent–child dyads (mothers & fathers, separately)	T1-6 = 38, 52, 67, 80, 100, & 123 months	T1-6 = 100, 99, 92, 90, 87, and 82, respectively		$r = .30–.41$[b]	Community sample
Levy et al. (2017)	Behavioral	Social synchrony (Coordination of Behavior)	Coded affect and behavior in pleasant interaction; Coding Interactive Behavior System for conflict	Positive event-planning and conflict discussion	Mother–child dyads	8–9 (8.87)	25 dyads		$r = .22$[b]	Community sample
Lindsey et al. (2008)	Behavioral	Mutual responsiveness and reciprocity, shared affect, and conversational equality	5-point Dyadic Rating Scale, Micro-coding of shared affect, 5-point conversation equality scale	Took turn answering questions on family life	Mother-adolescent dyads	11–13 (12.34)	268 dyads		$r = -.38$ to $.31$[b]; $r = -.12–.04$; $\Delta R^2 = .03–.04$[b]	School-based sample (recruited African American and European American families)
Deater-Deckard et al. (2004)	Behavioral	Dyadic mutuality	Parent–Child Interaction System (Global ratings)	Etch-a-sketch task	Parent–child dyads (mothers & fathers, separately)	7–9.6 (8.51)	125 dyads	r = .54–.66[b]	$r = -.50$[b]; $r = -.32$	School-based sample

Table 1 (continued)

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
Lougheed et al. (2020a)	Behavioral	Emotion dynamics	Specific Affect Coding System	5 discussions that elicited emotions (happy/excited, worried/sad, proud, frustrated/annoyed, grateful for; from questionnaire)	Mother-adolescent	13–16 (13.99)	96 dyads		Multiple $R^2 = .08$[b]; Multiple $R^2 = .03$–.09	Community
Lougheed et al. (2020b)	Behavioral	Emotion dynamics	Specific affect coding system	Conflict discussion	Mother-adolescent	13–18 (14.84)	49 dyads			Schools/local community
Main et al. (2016)	Behavioral	Emotion dynamics	Specific affect coding system	Conflict discussion	Mother-adolescent dyads	13–14 or 17–18 (14.84)	50 dyads			Schools/local community
Amole et al. (2017)	Physiological	RSA	Hierarchical linear models	Baseline, pleasant and conflict discussions	Mother-daughter dyads	[b]Range not listed (15.36)	46 dyads (23 mother and daughter MDD history, 23 never-depressed)	Control dyads: $r = .77$[b], $r = .13$; MDD dyads: $r = -.51$ to $-.40$[b]		Community/treatment clinics and randomized control trial for depressed mothers of children with psychiatric disorders
Ouellette et al. (2015)	Physiological	Salivary cortisol, hair cortisol concentration	Correlations and regressions	Stress task (salivary cortisol); hair samples at home visit	Mother-daughter dyads	T1 = 3 (salivary cortisol); T2 = 5 (life stress interview); T3 = 7 (7.62; hair samples)	60 dyads (30 lower stress, 30 higher stress)	Higher stress dyads: $r = .49$[b]; lower stress dyads $r = .25$		Community sample, completed UCLA Life Stress Interview and divided into high and low chronic stress; highest and lowest octile recruited to participate

Table 1 (continued)

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
McKillop and Connell (2018)	Physiological	RSA	Multilevel actor partner interdependence model	Fun activity planning and conflict discussions	Mother-adolescent dyads (10 father-adolescent dyads excluded)	11–17 (13.71)	59 dyads (24 depressed and 35 non-depressed)	$r = .04$		Community sample with concerns about depression, completed screen (clinical levels on CESD)
Suveg et al. (2019)	Physiological	RSA	Hierarchical linear models	Baseline, child stress task (with mother there), conflict discussion	Mother–child dyads	9–12 (10.36)	87 dyads	$r = .28–.39$[b]		Community sample, 200% below federal poverty line
Woody et al. (2016)	Physiological	RSA	Correlations and linear mixed models	Baseline, vacation-planning and conflict discussion	Mother–child dyads	7–11 (9.09)	94 dyads (44 with history of MDD, 50 with no history of MDD)		$r = -.25$- to $-.20$[b]	Community sample, depressed group met DSM-5 criteria for MDD episode during child's lifetime
Levy et al. (2019)	Behavioral	Synchrony construct made of dyadic reciprocity, mutual regulation, and interaction fluency	Coding interactive behavior manual	Free play (T1), discussions (T3)	Mother–child dyads	T1 = 2.76; T2 (not used); T3 = 9.3; T4 = 11.81	232 (T1; 148 living in warzones, 84 non-exposed); 177 (T3); 88 (T4)		$R^2 = .11$[b]	Community

Table 1 (continued)

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
Im-Bolter et al. (2015)	Behavioral	Synchrony construct made of responsiveness, mutual engagement, reciprocity, harmonious communication, and shared positive affect	5-point rating every 30 s to derive overall score	Free play	Mother–child dyads	6–10 (7.84 for clinic-referred; 8 for non-clinic)	42 dyads (19 clinic-deferred, 23 non-clinic)		Partial $r^2 = .37^b$	Community and clinic
Pratt et al. (2019)	Behavioral	Affect synchrony	Coding interactive behavior manual	Free play	Mother–child dyads	T1 = 9 months; T2 = 6; T3 = 10 (diagnoses); T4 = 11.25 (adolescent MRI)	149 dyads (46 exposed to maternal depression, 103 healthy controls)		$r = .14–.16$	Maternity ward (BDI and BAI, follow-up SCIDs for diagnoses)
Rabin et al. (2019)	Behavioral	Dyadic reciprocity	Coding interactive behavior manual	Conflict discussion	Parent-adolescent dyads (54 mothers, 6 fathers)	12–17 (13.16)	60 dyads (30 with ASD, 30 with no diagnoses)		$r = .33^b$	ASD Clinical Centers and Community
Halevi et al. (2017)	Behavioral	Affect synchrony, mutual adaptation, fluency	Coding interactive behavior manual	Free play	Mother–child dyads	T1 = 1.5–5 (2.76); T2 = 9–11 (9.3)	177 dyads (101 war-exposed, 76 control)			Community
Priel et al. (2019)	Behavioral	Affect synchrony	Coding interactive behavior manual	Free play (T2), conflict and fun day discussions (T3)	Mother–child dyads	T1 = 9 months; T2 = 6; T3 = 10	192 (T1), 156 (T2), 125 (T3)		$\eta^2_p = .04–.06^b$; $r = -.40$ to $.72^b$; $r = .06–.17$	Maternity ward (BDI and BAI, follow-up SCIDs for diagnoses)
Connell et al. (2011)	Physiological/behavioral	RSA/mutual negativity and positivity	Repeated measures ANOVAs; Simple affect coding system	Positive behavior, Conflict discussion, Positive event-planning	Mother-adolescent dyads	11–17 (13.72)	59 dyads (25 with clinical levels of depressive symptoms)			Community families concerned with depression (CESD for symptoms)

Table 1 (continued)

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
Roman-Juan et al (2020)	Physiological/ behavioral	Interbeat interval/nonverbal synchrony	Cross-correlations by applying Surrogate Synchrony approach; Motion Energy Analysis—automated code of nonverbal synchrony	Negative (from Issues Checklist) and Positive (holidays, pleasant trip, shared activity) Discussions	Father-adolescent dyads	13–16 (14.14 for low risk; 14.11 for high risk)	53 dyads			School sample (risk determined by sensitivity to punishment and self-reported anxiety [> 75th%tile high risk]; KSADS and ADIS Adult)
Woltering et al. (2015)	Physiological/ behavioral	Dyadic attunement/heart rate	Structural heteroscedastic measurement-error model to create synchrony variables for mixed model/9-point global rating scale	Positive topic about island, negative topic from Issues Checklist, positive topic about winning lottery	Mother–child dyads	7–12 (9.5 for clinical; 9.9 for non-clinical)	118 dyads (83 clinical, 35 non-clinical)			Community and Mental Health Agencies (and score above 64 on CBCL Externalizing)
Motsan et al. (2020)	Physiological/ behavioral	Joint gaze or shared positive affect/ heart rate	Micro-coded .1 s for gaze, affect, vocalization, and touch	Naturalistic interactions (T1, 3), baseline, etch-a-sketch tasks, watch past interactions (T4)	Mother–child dyads	T1 = 2.76; T2 = 7.68; T3 = 9.3; T4 = 11.57	102 dyads (53 war-exposed, 49 control)			Community

Table 1 (continued)

Author(s)	Synchrony category	Synchrony construct	Method	Task	Partners	Range of ages (mage)	Sample size	Synchrony effect sizes	Synchrony & outcomes effect sizes range	Population
Baker et al (2015)	Physiological/behavioral	Affective mutuality/electrodermal activity	Affective mutuality scale of the NICHD Early Child Care Research Network Scales/hierarchical linear models	Free play	Parent–child dyads (1 father)	4–10 (6.7)	28 dyads	$r = .40^{b}$; $r = .31$		Community sample with ASD diagnosis

Age is in years unless otherwise indicated; where effect sizes were available, we report ranges that are quantitative results for associations provided in the text; effect size ranges include mothers and fathers, where fathers were available

[a]Highlights studies that examined synchrony longitudinally

[b]Effect size of significant finding (described in-text)

Parent–Child Physiological Synchrony and Parent Factors

Ahemaitijiang et al. (2020) assessed parent–child physiological synchrony using interbeat interval (IBI) synchrony, an autonomic nervous system indicator, during a conflict discussion. They found that child age was negatively associated with synchrony. In addition, parent–child synchrony moderated the relationship between parent psychological control and emotion dysregulation and child aggressive behavior, such that the positive association between these parent and child factors was stronger for dyads who exhibited greater synchrony. This suggests that in the context of negative parent behaviors, such as psychological control and emotion dysregulation, parent–child physiological synchrony may be a risk factor for the development of youth aggression. Han et al. (2019) examined IBI synchrony in parent–child dyads during a drawing task and conflict discussion, and parent psychological control and unavailability were coded during the interactions. Parent–child physiological synchrony was negatively associated with child age and lower psychological control during the conflict discussion. In addition, physiological synchrony was related to less parent unavailability in the collaborative context (i.e., drawing task). These findings show consistent links between parenting behaviors and physiological synchrony.

Parent–Child Physiological Synchrony and Family Factors

Several studies examined physiological synchrony in triads (i.e., mother, father, and child). Gordis et al. (2010) assessed synchrony in salivary alphas amylase, a measure of the sympathetic nervous system, in mothers, fathers, and adolescents during baseline and a conflict discussion and examined how interparental aggression was associated with synchrony. Mother-adolescent synchrony was found for pre- and post-discussion assessments of salivary alphas amylase, whereas father-adolescent synchrony was found only for pre-discussion levels. In addition, families that reported interparental aggression exhibited greater father-adolescent synchrony and reduced mother-adolescent synchrony compared to those without interparental aggression. Another study examined cortisol synchrony in parent-adolescent triads before and after a conflict task and whether there were differences in synchrony based on the parent (e.g., mother versus father; Saxbe et al., 2014). Cortisol levels before the conflict were positively associated between adolescents and fathers, mothers and adolescents, and fathers and mothers. Associations between mothers and adolescents and fathers and adolescents were weaker when both parents were not biologically related to the youth. In addition, cortisol levels were more strongly associated between daughters and mothers than sons and mothers. Overall cortisol levels of mothers and adolescents and fathers and mothers were associated.

A follow-up study occurring 1–2 ($M = 1.67$) years after the discussion explored how earlier synchrony related to indices of adolescent social cognition and found that adolescents who showed stronger cortisol co-regulation with each parent showed more activation in the precuneus, posterior cingulate, and retrosplenial cortex (all linked to social cognition) to that parent when watching clips from their conflict discussion while in the MRI machine (Saxbe et al., 2015). Finally, Li et al. (2020) examined RSA synchrony in mothers, fathers, and adolescents during family conflict discussions and the impact of partner (e.g., mother, father, or child) and co-parenting conflict on synchrony. Mothers and adolescents and mothers and fathers exhibited synchrony, whereas there was no synchrony between fathers and adolescents or in mother-adolescent dyads who reported high levels of coparenting conflict. The authors suggested that parents may have been acting as a unit with mothers taking more of a lead with adolescents, although this was not empirically examined. Studies of triads suggest potential differences in physiological synchrony based on the partner and show the impact of family factors on synchrony.

Summary

Taken together, these studies generally find support for physiological synchrony in parent–child dyads with older children during conflicts and demonstrate the impact of various factors (e.g., parenting behaviors, interparental conflict and aggression) on synchrony. Some of the literature suggests that negative parenting behaviors and factors may disrupt synchrony, and some studies suggest that physiological synchrony in the context of negative parenting behaviors may relate to increased risk for youth (e.g., greater youth aggression).

Parent–Child Behavioral Synchrony in Community Samples and Associated Outcomes/Correlates

Several studies have also examined parent–child behavioral synchrony in community samples, as well as the factors that impact the degree of synchrony and the outcomes associated with synchrony. Children in these studies ranged from 4 to 18 years of age.

Behavioral Synchrony and Parent and Child Factors

In one study, Bodner et al. (2019) micro-coded positive and negative mother and child behaviors while they worked on an unsolvable puzzle alone and then with their mother and quantified the frequency and sequence of mother and child behaviors. Results showed that positive child and maternal behaviors followed each other, regardless of levels of trust. However, in dyads showing low trust and high avoidance, negative child and maternal behaviors also followed each other, suggesting a potential impact of trust and avoidance on matching of negative behaviors. Other studies examined matching of emotions in dyads. Lougheed et al. (2020a) found that greater daughter social anxiety symptoms were associated with daughters maintaining neutral expressions while their mothers regulated their own positive expressions during happy/excited discussions. In addition, lower social anxiety symptoms were associated with mothers maintaining neutral expressions while daughters up- and downregulated their own positive expressions during worried/sad discussions. Similarly, Lougheed et al. (2020b) found that poorer adolescent perspective-taking skills were associated with patterns of mothers and adolescents transitioning between mutually neutral and negative states. Finally, some studies have explored both the matching of emotional expressions and behaviors in parent–child dyads. Ferrar et al. (2020) found that the emotional climate of the interaction influenced the behaviors observed. Mothers and children were more attacking and assertive when angry and more conciliatory when sad; neutral affect predicted the most constructive behaviors; and de-escalation following sadness predicted better socioemotional adjustment in adolescence. Connell et al. (2015) also found associations between maternal and adolescent negative affect during a conflict discussion. Maternal and adolescent baseline RSA and maternal depressive symptoms predicted the overall degree and stability of negative affect over time. These studies demonstrate the impact of parent factors and emotional context on parent–child behavioral synchrony.

Behavioral Synchrony and Demographic Characteristics

Lindsey et al. (2008) found that maternal education was positively associated with mother-adolescent dyadic synchrony, shared positive and negative affect, and conversational equality, and mother-daughter dyads showed higher levels of shared positive affect than mother-son dyads. Moreover, European-American children had higher levels of dyadic synchrony and higher self-esteem than African American children. Dyadic synchrony was positively associated with adolescent self-esteem, and shared negative affect was negatively associated with prosocial behavior in European Americans, only. Deater-Deckard et al. (2004) found that mothers showed more mutuality and dyadic positive affect than fathers, daughters showed higher levels of dyadic mutuality than sons, and dyadic mutuality and positivity were greater among higher socioeconomic status households. In addition, mutuality was higher among White parents and children than Indian parents and children with half of this difference between ethnic groups being accounted for by acculturation. Greater mutuality was associated with fewer externalizing problems when coupled with dyadic positive

affect across both ethnicities. Thus, behavioral synchrony appears to be impacted by demographic factors, parent–child relationship factors, emotional climate, and self-regulatory abilities.

Behavioral Synchrony and Outcomes

Behavioral synchrony has been related to improved parent–child relationships, such as higher levels of positive and open communication and lower levels of conflict (Criss et al., 2003). In addition, Main et al. (2016) found that lower levels of concurrent mother-adolescent synchrony of negative affect was associated with higher levels of discussion satisfaction. Behavioral synchrony has also been associated with various youth outcomes, such as greater executive functioning abilities and intelligence (Herbers et al., 2014), moral reasoning and emotion regulation (Hinnant et al., 2013), and improved social skills (Criss et al., 2003). Levy et al. (2017) also examined the relationship between mother–child behavioral synchrony and gamma-band power in the MRI scanner while viewing videos of their own and other parent–child dyadic interactions. Behavioral synchrony was associated with increased gamma-band power in the superior temporal sulcus, which is important for social cognition, that was coupled between mother and child when viewing their own synchronous interactions. This points to the connection between behavioral synchrony and neural coupling in dyads in regions associated with social cognition and behavior. Thus, behavioral synchrony is generally associated with, and may help lay the foundation for, positive outcomes and relationships, but this may vary based on the emotional climate of the interaction and other contextual factors.

Longitudinal Studies of Behavioral Synchrony

Limited studies have examined behavioral synchrony longitudinally, particularly across mother–child and father-child dyads, which is critical for our understanding of the stability and expected changes in synchrony across time and partners, as well as the factors that impact synchrony and the outcomes synchrony relates to. Feldman (2010) examined mother–child reciprocity (i.e., give and receive interactions that are sensitive to microlevel verbal and nonverbal cues) over time. Maternal sensitivity, mother intrusiveness, and dyadic reciprocity were individually stable from infancy to adolescence, and greater reciprocity predicted fewer internalizing and externalizing symptoms. Feldman et al. (2013) examined reciprocity in infancy, preschool, and adolescence and how this related to children's social competence, aggression, and prosocial behavior during preschool and adolescence. Reciprocity was stable over time. Father-child reciprocity at 5 months and 3 years co-occurred with quick-paced, high positive arousal, physical manipulation, and object focus; mother–child reciprocity at 5 months and 3 years co-occurred with socially oriented expressive play; and parent-adolescent interactions did not include play or physical manipulation. Early parent–child reciprocity was predictive of social competence and lower aggression in preschool, which shaped dialogical and social skills in adolescence. Kim et al. (2015) examined mutually responsive orientation, inclusive of mutual responsiveness and reciprocity, connectedness, and shared positive affect in parents and children from 38 months through 10 years of age. Socioeconomic status was positively associated with mutually responsive orientation from 38 to 60 months. Mutually responsive orientation was associated with child security at age 8 and socialization outcomes at age 10. Mother–child mutually responsive orientation predicted mother–child security, which predicted child cooperation with maternal monitoring, and father-child mutual responsive orientation predicted father-child reciprocity. Finally, parent–child history of mutually responsive orientation predicted parent–child security, and mother–child security predicted school competence. Taken together, these studies highlight the importance of parent–child reciprocity across developmental stages.

Summary

In sum, these studies generally demonstrated parent–child synchrony in older children during conflict discussions and lab paradigms. Demographic factors, relationship factors, emotional climate, and self-regulatory abilities appear to influence the degree of synchrony. Importantly, the literature on behavioral synchrony is more extensive and includes longitudinal studies that permit a better understanding of synchrony across developmental stages. The research in this area generally supports stability of synchrony over time, though the dynamic influences evolve as children become more participatory partners. Additionally, parent–child behavioral synchrony is generally associated with positive youth outcomes; however, the emotional climate of the interaction, contextual factors (e.g., parenting behaviors), and type of synchrony (e.g., matching of emotions versus reciprocity) appear to impact the relationship between synchrony and youth outcomes.

Parent–Child Physiological Synchrony in Clinical Population/High-Risk Context

Parent–child physiological synchrony has also been examined in parent–child dyads to understand both the impact of risk factors on synchrony and the impact of synchrony on youth outcomes. Children in these studies ranged from 3 to 17 years of age.

Physiological Synchrony and Parent Factors

Several studies have examined the impact of maternal depression on mother-daughter synchrony. Amole et al. (2017) found that maternal depression was associated with lower RSA changes across discussions. Though mothers and daughters without a history of depression demonstrated synchrony during positive and not conflict discussions, mothers and daughters with a history a depression showed discordant synchrony during both discussions. Similarly, Woody et al. (2016) found concordant mother–child synchrony in RSA in dyads without a history of depression. However, mother–child dyads with a history of depression demonstrated discordant synchrony during the negative discussion, and the degree of discordant synchrony related to mothers' and children's levels of sadness. Suveg et al. (2019) found similar results in a community sample that included mother–child dyads who had family income levels 200% below the federal poverty line. In this sample, concordant RSA synchrony was found in the context of low levels of maternal depressive symptoms and child internalizing symptoms, and discordant RSA synchrony was found in dyads with higher levels of these symptoms during a child stress task and conflict discussion. McKillop and Connell (2018) also found that mother and adolescent RSA were positively associated, but maternal depressive symptoms related to a slower return to baseline RSA after the discussions and reduced synchrony at higher levels of negative affect. In addition, higher maternal negative affect was associated with higher adolescent RSA in the next epoch, as well as an attenuated response where RSA remained higher over time. Findings suggest that maternal and youth depression may disrupt physiological synchrony, as well as physiological response to stress more generally (e.g., slower return baseline).

Physiological Synchrony and Stress

Another study explored the impact of stress on parent–child physiological synchrony. Ouellette et al. (2015) found that mother-daughter hair cortisol concentrations were associated in dyads exposed to high, but not low levels of chronic stress. Associations between mothers' and daughters' cortisol were stronger at lower levels of parenting quality. Additionally, greater stress in mothers was associated with higher levels of internalizing symptoms in daughters. These results suggest that in some contexts of risk, such as negative parenting and chronic stress, physiological synchrony may relate to increased risk for negative youth outcomes.

Summary

Taken together, these studies provide an initial understanding of the impact of multiple risk factors, including psychopathology, chronic stress, and poverty on physiological synchrony. In the context of risk, parent–child synchrony appears to be disrupted and may increase risk for psychopathology. Additional research, particularly longitudinal, is critical to better understand these relationships.

Parent–Child Behavioral Synchrony in Clinical Population/High-Risk Context

Parent–child behavioral synchrony after early childhood has infrequently been explored in the context of risk. Children in these studies ranged from 6 to 17 years of age.

Behavioral Synchrony and Stress

Im-Bolter et al. (2015) found lower behavioral synchrony during play in mother–child dyads with clinical behavioral and/or emotional problems than dyads without a history of behavioral or emotional problems. In addition, lower synchrony was associated with greater parenting stress, which was associated with greater child problem behavior. Levy et al. (2019) examined how mother–child behavioral synchrony assessed at ages 2 and 9 was associated with maternal empathy, indexed by gamma activity, in dyads exposed and not exposed to trauma. Reduced mother–child synchrony was associated with less maternal gamma activity when observing vicarious pain in mothers exposed to trauma. In addition, exposure to war was related to decreased mother–child synchrony, which was related to increased mother gamma activity and child prosocial behaviors. This points to a possible impact of trauma on synchrony, as well as a connection between synchrony and mother and child empathy. Similarly, Halevi et al. (2017) found that war-exposed children and mothers had higher salivary cortisol, lower behavioral synchrony during positive event-planning and conflict discussions, and greater symptoms of psychopathology. War exposure predicted a decrease in synchrony at the third timepoint while controlling for synchrony at the first timepoint, and synchrony and child engagement at the third timepoint were related; the change from the first to third timepoint related to child externalizing symptoms. Finally, synchrony linked with child social engagement appeared to offer a pathway to reduced symptoms, demonstrating another context in which parent–child synchrony may be protective.

Behavioral Synchrony and Parent and Child Psychopathology

Pratt et al. (2019) found associations between maternal depression and decreased parent–child affect synchrony, maternal sensitivity, and child oxytocin across early childhood; these associations were longitudinally associated with reduced neural response to attachment-specific and social-general cues in preadolescence. Similarly, Priel et al. (2019) found that maternal depression was associated with decreased affect synchrony at age 6, and child psychopathology was associated with decreased affect synchrony at age 10. Maternal depression also related to decreased maternal sensitivity and child oxytocin, which predicted reduced child engagement and parent–child synchrony and higher child externalizing and internalizing problems. One study also examined differences in parent-adolescent reciprocity during a conflict in parent-adolescent dyads with and without autism spectrum disorder (Rabin et al., 2019). Parent-adolescent reciprocity was poorer in dyads with autism spectrum disorder and was positively associated with adolescents' social-conversational skills with an unfamiliar peer, suggesting a potential positive impact of parent–child reciprocity on youth social skills.

Summary

Taken together, like parent–child physiological synchrony, parent–child behavioral synchrony appears to be reduced in the context of risk. Though possibly reduced, behavioral synchrony appears to have positive effects on youth adjustment in certain contexts (e.g., better social skills in youth with autism spectrum disorder; reduced symptoms when linked with child social engagement). Additional longitudinal research exploring behavioral synchrony in the context of risk across developmental stages is needed to understand how risk factors impact synchrony over time and how synchrony relates to various youth outcomes later in development.

Simultaneous Physiological and Behavioral Synchrony in Parents and Children

A handful of studies have examined physiological and behavioral synchrony simultaneously in parent–child dyads, affording the opportunity to explore associations between these types of synchrony. These studies have all been examined in the context of risk with children ranging from 4 to 17 years of age. Connell et al. (2011) found that higher maternal depressive symptoms were associated with less change in RSA across tasks and higher mutual negative affect across positive discussion, conflict discussion, and planning for positive event in the next week. Parent and adolescent baseline RSA were associated with greater emotional flexibility and mutual positive affect and less mutual negative affect in the context of maternal depression and low adolescent RSA. Roman-Juan et al. (2020) examined physiological (i.e., IBI series) and behavioral synchrony in positive and negative interactions in father-adolescent dyads at high and low risk for anxiety, based on self-reports of paternal anxiety and adolescent sensitivity to punishment. Father-adolescent dyads at low risk for anxiety displayed nonverbal synchrony during positive interactions, whereas high risk dyads did not display synchrony in either discussion; physiological synchrony was not found for either group.

Woltering et al. (2015) found that mother–child dyads with children with clinically significant externalizing symptoms had lower levels of dyadic attunement across discussions. Mother–child heart rate synchrony was greater during positive compared to negative discussions, and dyads who demonstrated physiological synchrony showed higher levels of repair; there were no differences in physiological synchrony for clinical versus non-clinical dyads. Dyads who showed physiological synchrony also displayed the largest amount of behavioral synchrony. Similarly, Baker et al. (2015) found that greater parent–child physiological synchrony, assessed via electrodermal activity synchrony, was associated with greater parent–child behavioral synchrony during free play. The strength of this relationship was impacted by autism spectrum disorder symptoms, such that synchrony was stronger for parent–child dyads in which children had fewer symptoms.

In contrast, Motsan et al. (2020) found that mother–child dyads with post-traumatic stress disorder (PTSD) had the tightest physiological synchrony, indexed by RSA, and the lowest behavioral synchrony (i.e., joint gaze, shared affect, or verbal synchrony) during interactions (baseline, joint etch-a-sketch task, and watching videos of early interactions), whereas mother–child dyads who had been exposed to trauma but did not meet criteria for PTSD displayed the highest behavioral synchrony and lowest RSA synchrony. Among resilient dyads, moments of behavioral synchrony were associated with increases in child RSA levels. One theory proposed that as children get older, the tightly coupled mother–child physiological synchrony may need to be replaced by loosely coordinated behavioral attunement that supports the child's own physiological regulation. Additional longitudinal research measuring both physiological and behavioral synchrony, particularly after early childhood, in both community samples and in the context of risk is critical to clarify our understanding of the relationship between indices of physiological and behavioral synchrony and expected changes across development.

Discussion

Parent–child physiological (Feldman et al., 2011) and behavioral (Leclère et al., 2014) synchrony have been explored in infancy and early childhood and are associated with various aspects of youth adjustment (e.g., Feldman, 2007a, 2007b, 2010, 2015). This paper systematically reviewed the literature on parent–child synchrony after early childhood (i.e., ages 5–18) and the factors and outcomes associated with it. We also synthesized findings for when synchrony is adaptive and maladaptive or associated with risk. Taken together, existing research suggests that synchrony, particularly mother–child synchrony, becomes more interactive across later stages of development as children become more equal partners with their caregivers. Parent–child behavioral synchrony is broadly associated with positive youth outcomes, although this depends on the context; existing studies have not examined the direct relationship between physiological synchrony and youth outcomes, and longitudinal work on parent–child physiological synchrony is very limited. Both types of synchrony appear to be disrupted or altered in the context of risk. Additional research is critical to clarify the specific contexts and factors that relate to synchrony to negatively impact youth adjustment.

Synchrony After Early Childhood

Across the 37 studies included in this review, behavioral and physiological synchrony were generally found in mother–child dyads including older children. Most of these studies assessed synchrony during conflict discussions or both negative and positive discussions, and there were not fully consistent patterns based on valence. When additional factors, such as parenting behaviors or psychopathology, were considered, synchrony was found in certain emotional contexts, but across studies, clear patterns based on task or valence did not emerge. The literature was more mixed on synchrony in father-child dyads, with some results suggesting father-child synchrony (e.g., Kim et al., 2015; Saxbe et al., 2014) and other studies finding no or reduced synchrony in father-child dyads (e.g., Deater-Deckard et al., 2004; Li et al., 2020).

Across the studies, parent–child synchrony constructs tended to reflect give and take dynamics, as opposed to being more parent-led as is typical in infancy/early childhood. This is consistent with the literature suggesting developmental changes in synchrony over time, with early behavioral synchrony reflecting the parent–child relationship and early attachment processes that are more parent-led (e.g., Bowlby, 1969; Feldman, 2007a, 2007b, 2012) and increased reciprocity evolving across development (Beveridge & Berg, 2007; Chu & Powers, 1995; Feldman & Eidelman, 2009; Feldman, 2007a, 2007b, 2020). In the studies that specifically examined how age related to parent–child synchrony, some studies found that child age was negatively related to parent–child synchrony, and other studies did not find a relationship. There was some suggestion that synchrony may change as children get older, with increased, loosely coordinated behavioral synchrony, but reduced physiological synchrony. As youth develop, they become more active partners in interactions that may manifest in greater concordant behaviors. At the same time, physiology changes over the course of development and youth become better at regulating emotion and affect. Particularly in a negative context, such as during conflict or in the presence of psychopathology, behavioral synchrony may change (i.e., loosely coordinated behaviors), and physiological synchrony may be reduced. Thus, these collective changes may account for changes in synchrony across development. Few studies have examined behavioral and physiological synchrony, particularly longitudinally, which limits the ability to directly examine developmental changes.

Synchrony and Outcomes

Unfortunately, there are no studies assessing parent–child physiological synchrony and youth outcomes over time, which limits our understanding of these associations. The literature on parent–child behavioral synchrony is more extensive and suggests that behavioral synchrony is stable over time (Feldman, 2010; Feldman et al., 2013; Kim et al., 2015). In addition, research suggests that parent–child behavioral synchrony is broadly associated with positive youth outcomes, including academic, social, and emotional skills (Herbers et al., 2014; Kim et al., 2015), moral reasoning and empathy (Hinnant et al., 2013; Saxbe et al., 2015), social relationships and future synchrony with friends (Criss et al., 2003; Feldman, 2010; Feldman et al., 2013), self-esteem (Lindsey et al., 2008), and overall adjustment (Deater-Deckard et al., 2004; Lougheed et al., 2020a).

Factors That Impact Synchrony

Study findings suggest that both parent–child physiological and behavioral synchrony are impacted by various parent and child factors. Parent–child physiological synchrony appears to be disrupted or altered in the context of risk, such as parent aggression (Gordis et al., 2010), high interparental conflict (Li et al., 2020), negative emotional parenting behaviors (Han et al., 2019), and maternal depressive symptoms and negative affect (Amole et al., 2017; McKillop & Connell, 2018; Suveg et al., 2019; Woody et al., 2016).

Moreover, Baker et al. (2015) found that greater parent–child synchrony was associated with fewer autism spectrum disorder symptoms. In the context of family conflict, there is some suggestion that parent–child physiological synchrony may be protective (e.g., associated with less overall cortisol output; Saxbe et al., 2014; synchrony reflected in neural processing; Saxbe et al., 2015).

Rather than being a result of risk processes, physiological synchrony may be a risk factor for negative outcomes in the presence of negative parenting behaviors (Ahemaitijiang et al., 2020) or chronic maternal stress (Ouellette et al., 2015). Thus, based on the literature, parent–child physiological synchrony appears to either be reduced or altered in the context of risk, such as parent psychopathology and negative parenting behaviors. Additionally, in the context of risk, the presence of synchrony may be maladaptive and associated with poorer youth outcomes. In addition to the context of risk, the physiological index, developmental stage of the child, specific type of risk and synchrony, and emotional context of the interaction all appear to influence whether or not physiological synchrony is adaptive or maladaptive.

Likewise, behavioral synchrony also appears to be disrupted in the context of risk, such as low dyadic trust and attachment avoidance/anxiety (Bodner et al., 2019), war exposure (Levy et al., 2019), maternal (Pratt et al., 2019) and youth (Im-Bolter et al., 2015) psychopathology, and poorer youth perspective-taking (Lougheed et al., 2020b). In addition, parent-adolescent behavioral synchrony was reduced in dyads with children with autism spectrum disorder compared to dyads with no diagnosis (Rabin et al., 2019), and greater synchrony of negative emotions was associated with lower discussion satisfaction (Main et al., 2016). It is possible that the index of behavioral synchrony (e.g., matching affect, discordant behavioral synchrony), specific context of risk, and emotional context of the interaction similarly impacts whether behavioral synchrony is adaptive or maladaptive in the context of risk. In the context of risk, such as in the presence of parent emotion dysregulation or psychopathology, discordant or reduced behavioral and physiological synchrony may be adaptive, demonstrating positive youth self-regulation and resilience in the face of poor parent self-regulation. Moreover, in the context of external risk, such as exposure to trauma, concordant synchrony may be protective by laying the foundation for future self-regulation and resilience. In sum, both parent–child physiological and behavioral synchrony appear to be disrupted in dyads with various risk factors, including parent and child factors, and additional research, particularly longitudinal, is critical to understand whether synchrony is protective or maladaptive in the context of risk.

The existing literature has also identified other factors that appear to impact the degree of parent–child behavioral synchrony. For example, differences in parent–child behavioral synchrony were found based on ethnicity (i.e., different degrees of synchrony based on ethnic group), maternal education (i.e., greater synchrony associated with greater maternal education), child sex (i.e., higher levels with daughters; Lindsey et al., 2008), culture (i.e., stronger ties to native culture associated with lower mutuality), and socioeconomic status (i.e., positively associated with socioeconomic status; Deater-Deckard et al., 2004). With respect to these demographic and identity-related variables, it is possible that there are differences in experiences and/or behaviors related to these factors that impact synchrony. For example, the degree/type of synchrony expected in dyads may vary based on parenting practices that relate to cultural beliefs. Greater experiences of chronic stress and racial trauma in certain socioeconomic or racial/ethnic groups may impact synchrony, as chronic stress was one factor found to relate to reduced synchrony. Importantly, in more than half of the studies that included demographic information, the majority of participants were White and considered middle class or above. In addition, only two studies (Deater-Deckard et al., 2004; Lindsey et al., 2008) specifically asked questions about how synchrony may differ based on race and ethnicity, but the possible explanations for these differences (e.g., culture, parenting values, life stress) are limited. Research that is intentional about including the specific factors associated with these variables that might impact synchrony is necessary to draw conclusions.

In addition, behavioral synchrony may impact (or be impacted by) physiological regulation. Connell et al. (2015) found that higher adolescent baseline RSA related to reduced stability of shared affect at higher levels of maternal depressive symptoms, and Levy et al. (2017) found neural synchrony in mothers and children when independently viewing their own previous episodes of behavioral synchrony but not when viewing other mother–child interactions. It is possible that physiological regulation bolsters partners' behavioral synchrony. In addition, it is plausible that in the context of risk (e.g., maternal depression), greater self-regulation may be protective, and reduced or altered behavioral synchrony may be observed. Research examining physiological and behavioral synchrony simultaneously is necessary to more clearly understand the relationship between physiological responses/regulation and behavioral synchrony in various contexts.

Behavioral and Physiological Synchrony

Although many studies have examined either physiological or behavioral synchrony, few studies have assessed both physiological and behavioral synchrony simultaneously in parent–child dyads. All the existing work using both methods has been conducted in the context of risk, and the patterns of associations between these forms of synchrony

are mixed. In the context of internalizing disorders, Connell et al. (2011) found that maternal depression related to more rigid and negative parent-adolescent interactions and higher mutual negative affect, and there were interactions between maternal and adolescent RSA to predict mutual positive affect. On the other hand, Roman-Juan et al. (2020) found that father-adolescent dyads at low risk of anxiety displayed nonverbal synchrony during positive interactions, whereas high risk dyads did not display synchrony in either discussion; physiological synchrony was not found for either group. The findings of Roman-Juan et al. (2020) could relate to various factors, including the restriction to father-child dyads, the physiological index selected, or other parent and child factors. Taken together, this research is inconclusive in terms of whether indices of parent–child behavioral synchrony relate to indices of parent–child physiological synchrony.

Other studies have proposed both methodological and developmental changes that may impact the relationships between indices of parent–child physiological and behavioral synchrony. More specifically, some studies found that dyads who showed greater physiological synchrony also displayed greater levels of behavioral synchrony (Baker et al., 2015; Woltering et al., 2015). Alternatively, Motsan et al. (2020) found that mother–child dyads with PTSD had the tightest physiological and lowest behavioral synchrony, whereas mother–child dyads who experienced trauma but did not meet criteria for PTSD displayed the highest behavioral and lowest physiological synchrony. These differences could relate to different indices used for physiological (e.g., RSA, heart rate, electrodermal activity) and behavioral (e.g., joint attention, shared affect, reciprocity) synchrony. Differences in types of parent–child synchrony observed and expected could also relate to developmental changes. For example, the authors theorized that as children get older, parent–child physiological synchrony may need to be replaced by loosely coordinated behavioral attunement that supports youth self- regulation (i.e., their own physiological regulation). Unfortunately, it is difficult to have firm hypotheses given the mixed findings on synchrony and age in cross-sectional studies and the limited longitudinal research on parent–child physiological synchrony and behavioral synchrony in this age range, particularly with studies that assess both forms of synchrony simultaneously. Additional longitudinal research that measures both physiological and behavioral synchrony, particularly after early childhood, in both community samples and in the context of risk is critical to clarify our understanding of these relationships.

Summary, Limitations, and Future Directions

Ultimately, many of the studies reviewed show behavioral and physiological synchrony in parent–child dyads after infancy and early childhood and highlight multiple factors that impact the degree of synchrony, including demographic characteristics, parent and child psychopathology, chronic stress, and negative parenting behaviors. In the context of risk, both parent–child physiological and behavioral synchrony are disrupted or altered, and many of the studies suggest that synchrony may not be adaptive in this context. Findings from some studies suggest that synchrony may be protective against adverse outcomes in the context of risk, whereas other findings suggest that synchrony may exacerbate adverse outcomes in context of risk (e.g., maternal depression). It is possible that the developmental stage of the child, specific context of risk, emotional context of the interaction, and type of synchrony impact whether synchrony is adaptive or maladaptive in the context of risk. For example, concordant synchrony may not always be desirable. Discordant synchrony may be adaptive in certain contexts, such as in the presence of parent psychopathology. In the case of external risk, such as exposure to stress, concordant synchrony may be protective by laying the foundation for future self-regulation and resilience. There are also many important parenting factors (e.g., distress tolerance; Kerns et al., 2017) and behaviors (e.g., accommodation; Kagan et al., 2017) that may impact whether synchrony is adaptive and have yet to be explored. Future research that examines the contexts in which parent–child behavioral and physiological synchrony is adaptive versus maladaptive remains is critical.

This review has several strengths, such as the inclusion of both concordant and discordant behavioral and physiological synchrony and the focus on the period after early childhood when research is more limited. This addresses a gap of previous reviews and sets the stage for research examining additional relationships (e.g., synchrony and parenting behaviors in clinical and non-clinical populations) that can impact youth outcomes. Future work can enhance our understanding of when we expect and want to build parent–child synchrony and the factors that get in the way of this. Understanding potential disruptions to parent–child synchrony could help us develop more targeted interventions, including early interventions for at-risk youth. Similarly, if synchrony relates to certain maladaptive parenting behaviors in clinical and non-clinical parent–child dyads, this provides useful avenues for intervention that could improve youth outcomes, both for youth in treatment and youth more generally.

There are several other limitations in the current literature. First, despite encouragement to use consistent

terminology (e.g., Davis et al., 2018), there are still multiple terms used in the literature (e.g., synchrony versus reciprocity), making it difficult to review and synthesize findings and derive clear expectations for future work. Consistency in terminology would help build a more cohesive literature. Second, there is a large focus on infancy/early childhood and mother–child dyads specifically across ages, as opposed to studying father-child dyads or other primary caregivers. This limits our ability to generalize findings across diverse parent–child dyads. Third, more than half of the studies in this review focused on predominantly White samples. The few studies that have examined relationships between demographic factors and synchrony have found differences across racial and ethnic groups, which could reflect parenting practices across different cultural groups or other factors that have yet to be explored. There is a need for research in more diverse samples and dyads, particularly after early childhood, to truly capture and understand the implications of parent–child synchrony, including when it is adaptive and important to build versus when it is associated with risk.

Fourth, there is still much work to be done in terms of understanding contextual factors that influence and are later influenced by synchrony. A better understanding of the contexts in which parent–child synchrony is adaptive or protective, as well as those in which it is problematic, could provide additional avenues for intervention to improve youth outcomes, such as intervening on dyadic processes (e.g., parent–child interaction therapy or other similar programs; Thomas & Zimmer-Gembeck, 2007). Finally, an additional limitation in the study of physiological synchrony is that there are many physiological measures and methods used that are not equally suited to study synchrony (e.g., cortisol can be impacted by other factors). The use of various indices and the external factors that impact them is one of the reasons that less is understood about expectations for physiological synchrony in parent–child dyads. Researchers should be thoughtful when selecting physiological indices and analytic techniques for both behavioral and physiological synchrony (for a helpful review of methods and guidelines, see Bell, 2020; Davis et al., 2018). For example, physiological indices, such as RSA, that are better understood (e.g., reflects parasympathetic nervous system activity), allow for development of hypotheses and an enhanced ability to interpret findings. In sum, in addition to methodological changes, future research in more diverse samples and dyads is needed to clarify expectations for synchrony, factors that impact synchrony, and when synchrony is adaptive or protective and when it is associated with risk. There are several clear benefits to expanding this work, including using longitudinal, multi-method assessments of both behavioral and physiological synchrony in parent–child dyads across contexts.

Funding This work was supported by National Institute of Mental Health (Grant R01 MH107495; PI: Thomas M. Olino).

Declarations

Conflict of interest The authors declare that they have no competing interest.

Ethical approval The work did not involve any human subjects; this manuscript was a systematic review of the literature. Based on the guidance, the statement does not seem relevant.

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