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Observing and Promoting Normative Developmental Outcomes: Reciprocity is Key

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Observing and Promoting Normative Developmental Outcomes: Reciprocity is Key

Abstract

Background: Occupational therapists focus on caregiver-infant reciprocity, which is influenced by a host of biopsychosocial factors and is predictive of developmental outcomes across domains. It is important for early intervention professions to understand how different forms of reciprocity may predict infant development in salient domains (i.e., language, mobility, and co-occupation). Therefore, the purpose of this study was to investigate associations among related measures of development in and across age, while also exploring how reciprocity influences the acquisition of developmental milestones.

Method: We examined these important areas of development in relation to novel caregiver-infant co-occupational constructs in addition to well-established domains of reciprocity (i.e., language, touch, and emotional sensitivity). In a cohort of 16 caregiver-infant dyads, we investigated infant language, motor, and affective development at 8, 12, and 16 months of age in relation to caregiver-infant reciprocity in the same domains.

Results: Findings identify relations among domains, as well as novel, bidirectional associations among these domains, and caregiver-infant reciprocity. In particular, infant utterances, standing, and positive affect were related to caregiver sensitivity and responsivity to infant affect, touch, and/or physicality.

Conclusion: These findings suggest that aspects of caregiver-infant reciprocity may predict development in several important domains.

Comments

The authors report no potential conflicts of interest.

Keywords

infant and maternal reciprocity, development, co-occupation

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Occupational therapists working in early intervention (EI) settings promote the development of young children's independence and mastery of physical, cognitive, and social and emotional functions (Myers & Cason, 2020). Occupational therapists accomplish this by collaborating with caregivers and families through the implementation of therapeutic strategies (Myers & Cason, 2020) that influence the infant or toddler by modifying their environment (physical, social, or additional) or adjusting the demands of a developmental task (O'Brien & Kuhaneck, 2020). Furthering occupational therapy's understanding of the role of maternal-infant relationships through coaching and collaboration may be conducted through the exploration of typical development and the influence of infant maternal relationships of reciprocity across developmental domains (language, motor, sensory, and socioemotional development).

The acquisition of normative developmental milestones has been shown to predict long-term outcomes in children in areas such as intelligence, academic performance, mental health, and social skills, as well as in young adult and adult competence and opportunity for occupational advancement and success (Murray et al., 2007; Zukerman et al., 2010). Developmental milestones are quantified by observing behaviors (e.g., rolling over, crawling, walking, talking, etc.) that provide important information about emerging abilities and the kinds of inductive or facilitative experiences that infants have encountered to support their behavioral expressions. In addition, developmental delays in one domain, like motor behavior, may contribute to developmental delay(s) in other domains, including language, social interaction, and cognition (Adolph & Hoch, 2019; Ross et al., 2018; Zukerman et al., 2010). Therefore, simultaneous exploration across domains is essential to understand the ways in which everyday activities occur and support developmental change to inform practice for professionals of EI, especially occupational therapists.

Paramount in shaping these complex and transactional developmental changes across domains is caregiver-infant reciprocity (Feldman, 2007a). Reciprocity, or synchrony, attunement, coordination, mutual influence, or co-regulation, includes joint engagement between infant and caregiver and bidirectional temporal symmetry in actions and psychological states (Apicella et al., 2013; Feldman, 2007b). Early caregiver-infant reciprocity is related to cognitive, language, social, affective, and self-regulation development (Apicella et al., 2013; Feldman, 2007b). It is influenced by biological factors like circadian rhythms, physiological arousal, and hormones (e.g., oxytocin; Azhari et al., 2019; Feldman, 2007b). Risk factors for poor early reciprocity include intrauterine growth restriction, fetal cocaine exposure, preterm birth, multiple births, sibling history of autism spectrum disorder, psychiatric disorder(s) of infancy, child withdrawal, and maternal depression and/or anxiety (Azhari et al., 2019; Feldman, 2007b).

Reciprocity in the first year of life should be an essential consideration for occupational therapists working with families and their young children in EI, for multiple reasons. First, reciprocity is directly related to several major risk factors for later functional ability. For example, using a longitudinal study of 160 families, researchers found that mother-infant reciprocity at 1 and 6 months postpartum was related to child social reciprocity with friends at 3 years of age (Feldman et al., 2013).

Second, reciprocal co-occupations, such as feeding and eating, comforting, play development, and sleep, have the potential to influence the infant's emotional states, regulation, rest and sleep, cognition, and further development of the infant to self-manage such as they mature (Barnekow & Kraemer, 2005; Pizur-Barnekow et al., 2014).

Third, the developmental shift from exogenous to endogenous control (e.g., in attention and affect) may be facilitated by reciprocity (Bertenthal & Boyer, 2015). Finally, rapid development across domains impacts the nature and breadth of reciprocity (Caulfield, 1995). Thus, a better understanding of caregiver-infant reciprocity offers the potential for early interventions to improve occupational and social functioning in developing children.

Despite the importance of reciprocity for development, it remains unclear how different forms of reciprocity may be related to, and predictive of, important infant developmental outcomes over time (i.e., in domains like language, motor, sensory, and socioemotional development), and whether EI to facilitate improved caregiver-infant reciprocity may yield beneficial outcomes. Thus, the first aim of this study was to replicate previous literature supporting age-typical changes from less to more mature developmental behaviors from 8 to 16 months of age across the domains of language, motor, and affect, including exploration of caregiver-infant reciprocity. We focused on this age range given that substantial developmental change occurs during this period, specifically in the domains assessed and co-occupation (shared physicality, emotionality, and intentionality between individuals). The second aim was to preliminarily explore data from occupational therapy and other disciplines and developmental domains to aid in method development and hypothesis generation for future, larger studies. We hypothesized that the different forms of reciprocity would predict development for each domain in and across time. The novelty of our approach lies in the examination of multiple forms of caregiver-infant reciprocity (instead of just one), and their relation to infant development outcomes. Further details on the role of reciprocity variables in development can be found in Aubuchon-Endsley et al. (2020). Using the same data set, Aubuchon-Endsley et al. analyzed reciprocity variables (utterances, touch, sensitivity, and co-occupation) at 8, 12, and 16 months of age. The purpose of this study was to investigate associations among related measures of development in and across age while also exploring how reciprocity influences the acquisition of developmental motor milestones (infant sitting, standing, crawling, and walking) and communication milestones (non-canonical utterances, canonical utterances, linguistic utterances, and positive infant affect).

The knowledge acquired from an interdisciplinary perspective may inform researchers and occupational therapists in EI (occupational and physical therapists and speech-language pathologists) on new ways to identify infants for EI. In addition, an expanded understanding may guide occupational therapists and families with recommendations for enhancing infant and maternal engagement to promote the beneficial outcomes of reciprocity.

Method

The study was approved by Eastern Carolina University, where data were collected, and exempted by the human subjects committee at Idaho State University, where data were archived and analyzed. All of the caregivers gave voluntary, informed written consent. An overview of all methods and procedures are provided below. For additional details, see Aubuchon-Endsley and colleagues (2020).

Participants

Caregivers with infants 4 to 7 months of age were recruited to attend monthly 1-hr free play sessions in a lab designed to simulate a home setting (e.g., including stuffed animals, toys, seating, etc.). The caregivers included parents and/or those involved in primary caretaking. Mothers were often the caregivers (88% of the time), with other caregivers including fathers and grandparents (12% of the time). Inclusion criteria consisted of no significant history of perinatal complications, healthy infants, primarily

English spoken in the home, willingness and ability to travel to the lab monthly, and a plan to remain in the region for the next 2 years. All of the families who completed consent participated for the duration of the study (1 year). The participants consisted of nine female and seven male infants. Thirteen infants were Caucasian (eight female, five male), one female infant was African American, one male infant was Asian American (father of East Indian descent and mother of Vietnamese and Hawaiian descent), and one male infant was Palestinian. The caregivers reported approximate yearly household incomes between $50,000–$100,000.

Materials and Procedures

Video and Audio Recordings

A 10’10” x 13’3” lab space was used for data collection. The lab contained eight Sony EVI-D70/W wall-mounted cameras with pan and tilt capabilities. To maximize opportunities to visualize the participants, three of the four walls contained 90 cm x 120 cm mirrors. Video and audio were relayed to a control room. During recordings, lab staff in the control room attempted to record two of the eight camera angles with the best view of (a) the infant’s face and (b) the caregiver-infant interaction. There were instances when the infant or caregiver were not visually captured in recordings, such as when the infant moved quickly across the room and it took lab staff time (typically < 10 s) to catch up with recording equipment. Each recorded session lasted 60 min.

Data Collection

The middle 20 min of each recording at infant ages 8, 12, and 16 months were used to code behaviors by the interdisciplinary research team. The middle 20 min were used to begin data collection after the infant and care provider adjusted to the free-play session and to end data collection before excessive familiarity or infant fatigue influenced behaviors. Each discipline’s research lab only coded the observed behaviors most relevant to the discipline (see Table 1).

Table 1

Categories and Variables Coded by Research Labs

Discipline Coding the Variable	Occupational Therapy	Speech-Language Pathology	Clinical Psychology	Physical Therapy & Experimental Psychology
Developmental Variables (Duration in seconds)		Infant utterances	Positive infant affect	Posture, Locomotion
Reciprocity Variables (Frequency of occurrence)	Physicality, Emotionality, Intentionality	Caregiver utterances	Caregiver sensitivity	Reciprocal touch

Coding Developmental Variables. Infant utterances were coded as non-canonical, canonical, or linguistic. Non-canonical was coded for marginal babbling, defined as fuzzy sounding consonant and vowel productions with imprecise articulation, slow transitions, and an immature quality. Canonical utterance was coded when well-formed babbling occurred, with fully-resonant nuclei and clearly articulated consonants, timely transitions between the two, and a mature sound. Linguistic utterance was coded for any utterance interpreted as a word by an unfamiliar listener. Infant posture was coded as sitting or standing (Iverson & Wozniak, 2007; Soska et al., 2015). Infant locomotion was coded as crawling or walking. Infant affect was continuously coded as duration of positive affect assessed through vocalizations

(e.g., laughter, squealing), facial expressions (e.g., smiling), and body movements (see Leerkes & Zhou, 2018).

Coding Reciprocity Variables. Caregiver utterances were coded when directed to the infant as indicated verbally (by semantic content) or nonverbally (through eye gaze). The caregivers were coded as insensitive, ambiguous or moderately sensitive, or sensitive to infant affect. Insensitive behavior was defined as negative caregiver behavior regardless of infant affect, distracted caregiver behavior when infants were positive or negative in affect, and caregiver monitoring while infants experienced negative affect. Ambiguous or moderately sensitive was defined as distracted caregiver behavior when infants displayed neutral affect, persistent ineffective caregiver behavior regardless of infant affect, caregiver monitoring of infant positive affect, and routine care during infant negative affect. Sensitive was coded for caregiver monitoring during neutral infant affect.

Reciprocal touch between the caregiver and infant was coded as infant-initiated or caregiver-initiated. Reciprocal touch could have actively changed the infant's posture or locomotion (such as in the case of the caregiver picking up the sitting infant and helping the infant stand), not changed the infant's posture or locomotion (such as in the case of the infant touching the caregiver while crawling over her), or physically prevented the infant's engagement in locomotion or switch in posture (such as in the case of the caregiver placing a restrictive hand on the infant's shoulder to prevent the infant from falling off of a chair).

The co-occupation reciprocity constructs included functional behaviors depicting physicality, emotionality, and intentionality (Pickens & Pizur-Barnekow, 2009). Physicality was coded as reciprocal physical behavior between the infant and caregiver. This included holding or carrying, physical redirection, physical play, and/or feeding. Emotionality was coded as reciprocal responsiveness to emotional tone and included purposeful play vocalizations, participation in communication, and nurturing. Intentionality was coded as an understanding of the shared purpose and role during co-occupation, such as while exploring, during teaching moments, and during feeding activities (Pickens & Pizur-Barnekow, 2009).

Coding Software and Reliability. Continuous coding of behaviors occurred in Action Analysis Coding and Training (1996), Datavyu (Datavyu Team, 2014), or Mangold INTERACT (Mangold, 2017) software depending on the research laboratory. Intra and interrater reliability ranged from $\kappa = 0.81–0.96$ for affective and co-occupation domains and Pearson product-moment coefficients for intra and interrater reliability ranged from $r = 0.87–0.98$ for motor domains. For language variables, consensus coding was used, with at least two of 10 coders working together at all times, in case there were questionable boundary placements or code assignments needed discussion. All boundaries and codes were checked by a third coder prior to inclusion for data analysis.

Data Analysis

Spearman correlation coefficients were used to examine relations in developmental variables across domains and across development and reciprocity variables. Time points were investigated individually and via 8–16 month change scores. Repeated measures analyses of variance (ANOVAs) were used to investigate changes in development from 8–16 months. Although none of the Mauchly's Tests of Sphericity were statistically significant, we used a Greenhouse-Geisser correction because of the small sample. Pairwise comparisons with Bonferroni corrections were used to determine the direction and significance of effects across time points. Absolute change scores were calculated by subtracting variable

data at 8 months from variable data at 16 months (Zhang & Han, 2009). Significance level (p) was set at .05.

Results

Table 2 provides descriptive statistics for developmental and reciprocity variables, highlighting patterns of change in infant development and caregiver-infant reciprocity, respectively. Tables 3 and 4 provide statistically significant correlations for all variables.

Table 2

Descriptive Statistics for Development and Reciprocity Variables Across Age

Variables		Descriptive Data					
		8 Month		12 Month		16 Month	
		Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
Developmental Variables (Duration in seconds)	Sitting	754.0	317.0	482.5	233.3	397.0	306.9
	Standing	169.0	197.6	286.2	208.2	465.5	240.7
	Crawling	19.7	27.0	27.5	21.0	1.0	3.1
	Walking	0.4	1.7	50.9	94.6	143.6	79.1
	Infant Non-Canonical Utterance	52.9	26.7	61.9	39.3	60.1	32.4
	Infant Canonical Utterance	2.6	4.8	8.3	9.9	16.3	11.9
	Infant Linguistic Utterance	0.3	1.0	1.9	4.5	4.5	5.9
	Positive Infant Affect	121.6	76.8	74.8	68.0	110.1	117.4
Reciprocity Variables (Frequency of occurrence)	Infant-Initiated Touch	10.5	7.8	8.6	4.7	8.0	6.0
	Caregiver-Initiated Touch	28.3	13.6	17.8	11.4	15.9	9.7
	Caregiver Directed Utterance	178.0	52.0	195.4	78.5	163.9	56.3
	Caregiver Sensitivity to Infant Affect	101.3	21.5	84.4	29.1	81.1	29.0
	Reciprocal Physicality	17.4	8.3	16.4	9.6	10.9	6.9
	Reciprocal Emotionality	11.2	5.5	13.0	10.9	9.1	5.6
	Reciprocal Intentionality	14.1	8.9	14.8	7.3	15.6	7.1

**Note.* All developmental variables represent duration (in seconds), while all reciprocity variables represent frequencies of occurrence across the middle 20 min of a free play observation of caregiver and infant in a laboratory setting adjusted to look like a child's nursery.

Infant Development from 8 to 16 Months

From 8–16 months, more sophisticated canonical [$F(1.8235, 93.095) = 8.894$, $p = 0.001$, $\eta^2_{\text{partial}} = 0.372$] and linguistic [$F(1.539, 23.078) = 3.949$, $p = 0.043$, $\eta^2_{\text{partial}} = 0.208$] utterances increased, with significant differences between 8–16 month values only ($p_{\text{canonical}} = 0.003$, $p_{\text{linguistic}} = 0.024$). There were no differences in duration of non-canonical utterances or positive affect over time.

With increasing infant age, durations of sitting [$F(1.986, 29.793) = 8.412$, $p = 0.001$, $\eta^2_{\text{partial}} = 0.359$] and crawling significantly decreased [$F(1.738, 26.072) = 9.465$, $p = 0.001$, $\eta^2_{\text{partial}} = 0.387$], while durations of standing [$F(1.745, 26.182) = 9.206$, $p = 0.001$, $\eta^2_{\text{partial}} = 0.380$] and walking [$F(1.767, 26.500) = 18.979$, $p < 0.001$, $\eta^2_{\text{partial}} = 0.559$] significantly increased. There were significant differences between 8–16 month durations of crawling ($p = 0.031$), standing ($p = 0.007$), and walking ($p < 0.001$), as well as 12–16 month durations ($p_{\text{crawling}} < 0.001$, $p_{\text{standing}} = 0.022$, $p_{\text{walking}} = 0.011$). There were no differences between 8–12 month values. For sitting, there were significant differences between 8–12 month durations ($p = 0.025$) and 8–16 month durations ($p = 0.005$), but no difference between 12–16 month values.

Relations Across Developmental Domains

Table 3 includes Spearman ρ and p values among infant developmental variables across age. Observed statistically significant results are as follows. Infant posture (i.e., sitting and standing) predicted greater duration of later locomotion (i.e., crawling and walking). There were positive bidirectional

relations among infant posture and locomotion and infant (a) utterances and (b) affect across age. Although more sophisticated infant canonical utterances at 8 months were related to more positive infant affect at a later age, less developmentally mature non-canonical utterances were related to less positive affect.

Relations Among Developmental and Reciprocity Variables

Table 4 includes Spearman ρ and p values among infant developmental and reciprocity variables across age. Observed statistically significant results are as follows.

Table 3

Statistically Significant Correlations Among Infant Developmental Variables Across Age

Correlated Variables				**Spearman ρ**	**Sig. p**
Variable 1	**Age in Months**	**Variable 2**	**Age in Months**		
Sitting	8	Infant Canonical Utterance	12	0.609*	0.01
	12	Crawling	16	0.499*	0.05
		Infant Canonical Utterance	8	0.541*	0.03
	16	Standing	16	-0.794**	0.0002
Standing	8	Infant Non-Canonical Utterance	16	-0.721**	0.002
		Positive Infant Affect	8	0.700**	0.003
	12	Crawling	12	-0.587*	0.02
		Walking	12	0.577*	0.02
		Infant Linguistic Utterance	12	-0.567*	0.02
	16	Positive Infant Affect	12	-0.547*	0.03
Crawling	8	Positive Infant Affect	16	0.548*	0.03
	12	Walking	12	-0.793**	0.0002
		Infant Linguistic Utterance	12	0.555*	0.03
	16	Infant Canonical Utterance	8	0.591*	0.02
Infant Non-Canonical Utterance	8	Infant Linguistic Utterance	12	0.583*	0.02
	16	Infant Canonical Utterance	12	0.515*	0.04
		Positive Infant Affect	8	-0.632**	0.01
Infant Canonical Utterance	8	Infant Linguistic Utterance	12	0.527*	0.04
		Positive Infant Affect	16	0.577*	0.02
	12	Infant Linguistic Utterance	12	0.719**	0.002

**Note.* All infant developmental variables represent duration (in seconds). For clarity and ease of interpretation, only ages with statistically significant relations among respective variables were included. *$p < .05$, **$p < .01$

Infant standing duration was positively related to reciprocal physicality, reciprocal emotionality, caregiver sensitivity to infant affect, infant-directed caregiver utterances, and infant-initiated touch. Infant-initiated touch and caregiver utterances directed at the infant were also related to infant walking. Infant sitting duration was positively related to reciprocal intentionality and negatively related to reciprocal emotionality. Infant crawling was positively related to reciprocal intentionality, infant-directed caregiver utterances, and caregiver sensitivity to infant affect. More mature infant utterances were positively related to reciprocal emotionality, caregiver sensitivity to infant affect, and caregiver-initiated touch over time, but negatively related to reciprocal physicality. Positive infant affect was related to infant-initiated touch, reciprocal emotionality, and reciprocal physicality.

Change Scores

Developmental Variables

Increased infant standing duration from 8–16 months was significantly related to increased duration of infant positive affect (ρ = 0.594, p = 0.015).

Development and Reciprocity Relations

Increased frequency of caregiver-initiated touch from 8–16 months was significantly related to increased duration of infant linguistic utterances over this time (ρ = 0.660, p = 0.005). Increased frequency of caregiver sensitivity to infant affect from 8–16 months was significantly associated with increased duration of infant canonical utterances over this time (ρ = 0.532, p = 0.034).

Table 4

Statistically Significant Correlations Among Infant Developmental and Caregiver-Infant Reciprocity Variables Across Age

Developmental Variables	Age in Months	Caregiver-Infant Reciprocity Variables	Age in Months	Spearman ρ	Sig. p
Sitting	16	Reciprocal Physicality	16	0.500*	0.048
		Reciprocal Emotionality	8	-0.506*	0.046
Standing	8	Caregiver Sensitivity to Infant Affect	16	-0.512*	0.043
	12	Caregiver Directed Utterance	8	0.524*	0.037
		Caregiver Sensitivity to Infant Affect	8	-0.601*	0.014
		Reciprocal Physicality	8	0.551*	0.027
		Reciprocal Physicality	12	0.552*	0.027
	16	Infant-Initiated Touch	16	-0.515*	0.041
		Reciprocal Physicality	16	-0.574*	0.020
		Reciprocal Emotionality	8	0.673**	0.004
Crawling	12	Caregiver Directed Utterance	8	-0.519*	0.039
		Caregiver Sensitivity to Infant Affect	8	0.608*	0.012
		Reciprocal Intentionality	8	-0.546*	0.029
Walking	12	Infant-Initiated Touch	16	-0.582*	0.018
		Caregiver Sensitivity to Infant Affect	8	-0.595*	0.015
	16	Caregiver Directed Utterance	16	0.538*	0.031
Infant Non-Canonical Utterance	8	Reciprocal Emotionality	12	-0.536*	0.032
	12	Caregiver-Initiated Touch	8	-0.509*	0.044
		Caregiver Sensitivity to Infant Affect	12	0.564*	0.023
Infant Canonical Utterance	8	Caregiver Sensitivity to Infant Affect	16	0.528*	0.035
	12	Caregiver Sensitivity to Infant Affect	8	0.650**	0.006
	16	Caregiver Sensitivity to Infant Affect	12	0.508*	0.044
		Caregiver Sensitivity to Infant Affect	16	0.567*	0.022
Infant Linguistic Utterance	8	Caregiver Sensitivity to Infant Affect	16	0.537*	0.032
		Reciprocal Emotionality	12	0.529*	0.035
	12	Infant-Initiated Touch	12	0.513*	0.042
	16	Reciprocal Physicality	12	-0.508*	0.044
Positive Infant Affect	8	Infant-Initiated Touch	12	0.653**	0.006
	12	Caregiver Sensitivity to Infant Affect	12	0.533*	0.034
		Caregiver Sensitivity to Infant Affect	16	0.515*	0.041
		Reciprocal Physicality	16	0.772**	0.0005
	16	Caregiver Sensitivity to Infant Affect	16	0.694**	0.003
		Reciprocal Emotionality	16	0.824**	0.0001

**Note.* All infant developmental variables represent duration (in seconds), while all caregiver-infant reciprocity variables represent frequencies of occurrence across the middle 20 min of a free play observation of caregiver and infant in a laboratory setting adjusted to look like a child's nursery. For clarity and ease of interpretation, only ages with statistically significant relations among respective variables were included. *p < .05, **p < .01

Discussion

Through this retrospective longitudinal study, we aimed to examine multiple developmental domains (language, motor, and affective) concurrently with caregiver-infant reciprocity. Although the small homogeneous sample size in the present study limits generalizability of findings, our purpose was preliminary exploration of data across disciplines and developmental domains to aid in method development and hypothesis generation for future research. Therefore, the results help direct the interprofessional research foci to gain a holistic understanding of child development and early environment impacts. We present an important first step toward examining relationships between developmental and reciprocity variables broadly that may inform how caregiver and infant interactions could be an emphasis for EI.

The results, although preliminary, are essential to informing methodology and constructs and variables to investigate in follow-up studies. Furthermore, correlation results should be interpreted without causation and with the possibility of third variables that can be considered as prospective covariates in future studies, some of which are discussed below. Nonetheless, these findings facilitate hypothesis generation for future testing and provide clarity on method development for multi-disciplinary teams to examine developmental domains and reciprocity. This work provides first steps toward that end.

Development from 8–16 Months

Our findings were consistent with expected changes across developmental variables, suggesting that methodology used (i.e., a brief 20-min middle observation period) adequately captured key features of development from 8–16 months. For example, we found that the duration of sitting and crawling decreased, while the duration of walking increased. We also found that less sophisticated non-canonical utterances decreased, while canonical and linguistic utterances increased. Future studies should test the statistical and clinical significance of these changes using larger and more diverse samples, with an eye toward quick and brief sampling methods and suitability for testing intervention design and effectiveness.

Overlapping Developmental Variables

From 8–16 months of age, early infant posture predicted future locomotion, infant utterances, and affect. This is consistent with previous research demonstrating overlap in infant developmental trajectories among these domains (Iverson, 2010). In addition, infants who are developing typically or atypically in one domain are more likely to develop in the same manner in another domain. For example, significant associations among early language and subsequent affective variables may occur because infants with greater communication abilities elicit and receive more attention (Markus et al., 2000), which may result in increased positive affect. This will be important for future studies to examine with clinical populations.

Caregiver-Infant Reciprocity and Infant Development

There also was significant overlap between developmental and reciprocity variables, suggesting that caregiver-infant interactions may impact, and be impacted by, infant development. Because the developmental variable infant utterances were positively associated with the reciprocity variables caregiver-infant affect and touch, but negatively associated with the reciprocity variable caregiver-infant physicality, one potential explanation is that caregivers who appropriately tend to infant emotional needs may be uniquely contributing to infant language development. There is substantial research to support an association between sensitive or responsive caregiving and advanced language outcomes (Hirsh-Pasek & Burchinal, 2006; Mesman et al., 2012). In the present study, these same aspects of caregiver-infant reciprocity (i.e., affective, touch, and physicality) were also positively related to the developmental

variable infant positive affect, further emphasizing the impact that caregivers and infants both have on shaping early expression and emotional experiences. If future research supports these findings, early interventions to promote caregiver-infant reciprocity may be used to influence developmental trajectories.

The results suggest that from 8–16 months, infant standing may be more reliably related to caregiver-infant reciprocity variables than other posture and locomotion measures. This may be because early, physically-assisted standing at 8 months requires interaction with the caregiver, since postural balance and control mechanisms are not well-developed to independently support standing. Reciprocity variables may be indicators of how often a caregiver provides the infant with opportunities to practice standing and locomotor behaviors that are more advanced than the infant's current physical abilities. As such, it should not be surprising that cultural differences in child rearing practices (bathing, clothing, handling, etc.) influence motor development and the onset of motor milestones (Adolph & Hoch, 2019). The results from the current study suggest that further investigation of the relationship between domains of caregiver-infant reciprocity with posture may be a fruitful way to explore the influence of caregiver-infant reciprocity on infant development and its potential for emphasis as a target during EI.

In addition, novel reciprocity variables (i.e., the co-occupational domains of physicality, emotionality, and intentionality) were related to infant developmental outcomes in language, motor, and affective domains. This suggests that these caregiver-infant reciprocity variables are important to consider in relation to infant development (Pickens & Pizur-Barnekow, 2009; Whitcomb, 2012), though more studies are needed to examine the unique effects that they may have both acutely and across time. This future work is important because it may assist in integrating occupational therapy theory and constructs with interdisciplinary conceptualizations of caregiver-infant reciprocity to better inform our understanding of infant development and EI practice.

Limitations

The study design created a number of limitations that influence the generalizability of the findings to typically developing populations. The small homogeneous sample size of 15 infant and maternal dyads limits interpreting the data as reflective of a larger population of infants and caregivers. In addition, the laboratory and observation space was unfamiliar to the participants and could have influenced the frequency and duration of behaviors. The caregivers may have been more motivated to engage with infants and toddlers than if they were in a more familiar environment. In addition, one participant had an older sibling with Autism and demonstrated aspects of atypical development.

Future Research

Researchers should examine the influence of caregivers' sensitivity, responsiveness to infant affect, and touch and physicality supporting infants (especially as they attempt to manipulate their posture and locomotion) on variations in developmental trajectories. Further research of existing and novel coding schemes during free play sessions may further increase options for better understanding these findings and testing their clinical use. In addition, well-controlled longitudinal studies are needed to model overlapping trajectories among caregiver-infant reciprocity and development, given the complexity of their associations.

Despite known fluctuations and increasing complexity, it is clear that patterns emerge across developmental domains and infant age. Continued exploration into how caregiver-infant reciprocity supports development across domains is important because it may lend perspective into the development of coordination across domains. For example, if reciprocity variables are more stable over time than

developmental variables, such that the quality and/or frequency of early maternal-infant interactions persist through toddlerhood, it may mean that interventions aimed at enhancing caregivers' skills in these important reciprocal behaviors will have lasting effects.

Implications for Occupational Therapy Practice

- Occupational therapy professionals are well suited to screen and observe developmental domains (motor, language, sensory, cognitive, etc.) through an infant/maternal reciprocity lens. This can be accomplished through the constructs of co-occupation (emotionality, physicality, and intentionality).
- Focus on the infant/maternal interaction may be a valuable mechanism to support development and the habilitation skills of the infant or toddler receiving skilled services from EI occupational therapists.
- Coding 20-min observations via three different time points revealed developmental progression that may be used to track infants and toddlers who may be at risk for developmental delays.
- Structured behavioral observations coding behavior of the reciprocal interactions of infants and toddlers and their caregivers as well as developmental milestones may assist newer occupational therapists in developing their clinical observation and reasoning skills for the EI setting.
- Video observation analysis may be used by more experienced occupational therapists when standardized norm-referenced assessments are not available or are too costly.
- Collaborating with caregivers using video observation analysis may allow the caregiver to recognize reciprocity-based behaviors and implement strategies that may further enhance development in their infant or toddler. In addition, sharing coded video observation information (frequency and duration) with the caregiver at the end of an Individualized Family Service Plan may further allow caregivers to see progress that may be difficult to see on a day-to-day basis.
- Observing and measuring developmental related behavior via video analysis in diverse contexts may support contextual-based evaluations to identify how potential delays or impairments translate to functional deficits in natural environments. This can be accomplished through multimedia-based software (Zoom, Skype, Google Chat, etc.) via computers, tablets, and/or cell phones, recorded by the caregiver, and/or the EI occupational therapist.

Conclusion

Although the current study was limited to a small homogeneous sample size, the findings contribute to the literature by replicating overlap in developmental domains from infancy to toddlerhood and supporting novel, bidirectional associations among multiple domains of infant development and caregiver-infant reciprocity. This overlap is consistent with a developmental dynamic systems approach (Smith & Thelen, 2003) in that changes occur with elements of posture, locomotion, utterances, affect, co-occupation, and caregiver-infant reciprocity acting as a cooperative system. Overall, the results suggest that as infants develop into toddlers, their changing constellation of behaviors and needs signal caregivers to shift caregiver-infant reciprocal behaviors, which further support development. Identifying aspects of caregiver training to promote caregiver-infant reciprocity may provide a new option for EI for children and lead to more successful and long-term functional outcomes.

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