THE ROLE OF NEGATIVE AFFECTIVITY IN THE RELATION BETWEEN MATERNAL MIND-MINDEDNESS AND TODDLERS' LANGUAGE OUTCOMES

by

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(Under the Direction of Janet E. Frick)

ABSTRACT

Multiple caregiving attributes are known predictors of children's language outcomes. However, the relation between mind-mindedness, caregivers' propensity to represent their children as individuals with mental states, and children's vocabulary, is not clearly understood. This study examined the association between maternal mind-mindedness and toddlers' vocabulary outcomes, and, within a Differential Susceptibility framework, investigated a potential moderating role of toddlers' negative affectivity. Overall, results did not support the study hypotheses, as mind-mindedness was not related to receptive or expressive vocabulary, nor was there an interaction between mind-mindedness and negative affect in accounting for differences in expressive vocabulary. However, exploratory analyses revealed a positive association between mind-mindedness and expressive vocabulary that approached significance for the 24-month age group. These findings suggest that a relation between mind-mindedness and children's language abilities may not emerge until approximately 24-months, and that further investigation is needed to elucidate a potential moderating role of children's temperament.

INDEX WORDS: Mind-mindedness (MM), Negative affect, Expressive vocabulary, Receptive vocabulary

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CHAPTER 1

INTRODUCTION

Children's language outcomes are pivotal to their development, paving the way for other abilities. Early receptive and expressive vocabulary predict theory of mind and prosocial behavior, among other outcomes, in later childhood (Ebert, 2020; Girard et al., 2016). Given the importance of children's language abilities for their overall development, it is imperative to understand the factors that contribute to differences in them. Prior research has emphasized that many of these contributing factors are environmental and involve caregivers.

Caregivers' Attributes and Children's Language Development

Various environmental factors are related to children's linguistic abilities, and previous research has demonstrated that some of which are demographic. For example, a number of studies have found that parents' level of education and age are both positively predictive of children's language development (e.g., Bornstein et al., 1998; McDonald et al., 2014). Additionally, a few investigations in community samples have examined the relation between children's time apart from their primary caregivers, such as their weekly hours in childcare, and their language development, and results have indicated a negative association (e.g., Miser & Hupp, 2012). Broadly, it is apparent that a variety of caregivers' characteristics explain differences in children's linguistic competence.

Caregiving Behaviors and Children's Language

In addition to demographic factors, caregivers' speech (e.g., Tamis-Lemonda et al., 2014) and rearing behaviors (e.g., Madigan et al., 2023) play a large role in their children's language

learning. A body of literature has sought to understand how caregivers' linguistic input contributes to children's vocabulary. Investigations spanning several decades have documented that children who hear more word tokens (that is, overall number of words; Golinkoff et al., 2019) in their homes demonstrate more vocabulary growth and optimal language outcomes than those who experience less overall linguistic input (e.g., Huttenlocher et al., 1991; Hart & Risley, 1995). However, more recent findings have shown that the quality of caregivers' input predicts children's language outcomes above and beyond quantity (e.g., Anderson et al, 2021; Jones & Rowland, 2017; Rowe & Snow, 2020). For example, Rowe (2012) reported that although the number of caregivers' word tokens were the highest correlate of children's vocabulary at 30 months, the number of word types (i.e. number of different words) served as a greater predictor of their language growth between 30 and 42 months. Further, certain types of child-directed speech have been shown to be especially predictive of children's language outcomes. An example is referential language, a type of child-directed speech in which caregivers expose their children to the names of objects and events in the world around them (e.g., Tamis-Lemonda et al., 2012).

In addition to the quantity and quality of child-directed speech, other caregiving attributes contribute to variability in children's vocabulary. Sensitivity, which refers to caregivers' awareness of and apt responses to their children's signals, and responsiveness, a similar construct focusing only on their responses, are known predictors of various developmental outcomes throughout childhood (e.g., attachment, social competence; Deans, 2020), and a number of studies have demonstrated that they play a part in children's language development (e.g., Deans, 2020; Madigan et al., 2023; Tamis-Lemonda et al., 2001). However, the mechanistic link between these constructs and children's language has not always been straightforward.

Attempting to explain this link, Tamis-Lemonda and colleagues (2014) emphasized that language development is rooted in social interaction, and that when caregivers' responses to their children are characterized by temporal contiguity and attunement, this encourages joint interaction that is conducive to word learning. In sum, prior literature has emphasized that not only the content of caregivers' speech, but also their attunement and responsiveness to their children's cues, are instrumental in facilitating children's language development. Therefore, it is plausible that a construct measuring caregivers' attunement as demonstrated *in* their speech may be a likely predictor of children's language abilities.

Mind-Mindedness (MM)

One such construct is mind-mindedness, originally conceived as a reconceptualization of sensitivity. Deemed the "cognitive substrate" of sensitivity, mind-mindedness is broadly defined as caregivers' acknowledgement of their children's mental states (Meins, 1997; McMahon & Bernier, 2017). Mind-minded caregivers treat their child as a person with thoughts and feelings, in addition to a being with needs to be met. Meins, who originally conceptualized the construct, emphasized that mind-mindedness is both representational, involving caregivers' mental representations of their children, and behavioral, translating to sensitive engagement with their children (Meins et al., 2012). Since its inception, studies have sought to determine whether mind-mindedness is a stable cognitive-behavioral trait in caregivers, or whether it may change as a function of temporal, relational, or contextual factors, and evidence has been mixed (e.g., Meins et al., 2002; Meins et al., 2014; Illingworth et al., 2016; Longobardi et al., 2024).

The primary operationalization of caregivers' mind-mindedness, measured either through an interview or observations of caregiver-child interactions, is their use of mind-related comments, which are those that signal an acknowledgment of their child's current mental state

(Meins & Fernyhough, 2015). Mind-related comments include appropriate and non-attuned subtypes (Meins et al., 2012). Appropriate comments are in accordance with children's cues that signal their mental states (e.g., "You want the book," as the child reaches for the book), while non-attuned comments (e.g., "You want the book" as the child reaches for a ball) are misaligned with children's signals. Importantly, appropriate and non-attuned mind-related comments are orthogonal, such that it is possible for a caregiver to say a high number of both in an interaction (Meins et al., 2012).

A body of research has demonstrated that caregivers' mind-mindedness is pivotal for children's socioemotional development, such as their attachment classification. In a seminal study, Meins and colleagues (2001) found that mothers' proportions of appropriate mind-related comments explained more variance in children's later attachment security than maternal sensitivity, which had long been viewed as the most robust predictor of children's attachment. Further, Meins et al. (2012) reported that in a diversified sample, mothers' appropriate mind-related comments were the greatest predictors of secure versus insecure, as well as organized versus disorganized, attachment classifications. Interestingly, in this same study, mothers' non-attuned mind related comments were better differentiators between insecure-avoidant and insecure-resistant classifications, such that mothers who made more non-attuned mind-related comments were more likely to have children with an insecure-resistant classification.

Beyond attachment classification, mind-mindedness has been shown to predict multiple developmental outcomes in children. Among the most widely studied and replicated is the role of mind-mindedness in predicting children's theory of mind (e.g., Meins et al., 2002; Laranjo et al., 2010; Meins et al., 2013; McMahon & Bernier, 2017). Additionally, links between early mind-mindedness and broad outcomes, such as children's cognitive school readiness, have also been

explored and established. For example, Bernier and colleagues (2017) found support for a mediation model in which mothers' mind-mindedness when children were one year of age predicted their cognitive school readiness in kindergarten through their language and effortful control in toddlerhood. Overall, empirical evidence supports that caregivers' mind-mindedness predicts not only infant attachment, but multiple developmental outcomes in childhood, although gaps in understanding, such as the nature of the relation between caregivers' mind-mindedness and children's language outcomes, remain.

Mind-Mindedness and Language Outcomes

A form of child-directed speech, appropriate mind-related comments offer children quality linguistic input that is attuned to their mentalizations. Therefore, it has been proposed that mind-mindedness may bolster children's language outcomes because caregivers' appropriate mind-related comments provide children with links between their current thoughts, feelings, and desires, also often involving referents in their environment, and the words for them (Laranjo & Bernier, 2013). However, mixed results have characterized the limited body of literature examining whether mind-mindedness accounts for differences in children's vocabulary, as described below.

Several prior investigations have found caregivers' appropriate mind-related comments to positively predict children's vocabulary outcomes. For example, Laranjo and Bernier (2013) reported that mothers' appropriate mind-related comments measured when infants were 12 months of age were related to their expressive vocabulary abilities at age two, and that mind-related comments pertaining to cognitions were especially predictive. Additionally, Constantini and colleagues (2017) assessed mind-mindedness in mothers of 12-month-old infants and found that it significantly contributed to toddlers' increase in expressive vocabulary between 24 and 36

months. Interestingly, they also examined children's birth condition as a moderator and reported that appropriate mind-related comments were especially predictive of vocabulary growth for children who had been born preterm. Further, in two investigations, Meins and colleagues (2013a, 2013b) reported that mothers' appropriate mind-related comments measured in infants' first year of life were associated with their receptive vocabulary abilities and a measure of their overall language abilities at two years of age, and that a higher proportion of non-attuned mind-related comments was predictive of lower internal state language (i.e. language related to mental states). In sum, several prior investigations have pointed to a positive relation between appropriate maternal mind-related comments and both expressive and receptive vocabulary outcomes.

However, other studies have not found mind-mindedness to be a significant correlate or predictor of children's language. For example, Nyberg et al. (2021) reported that mothers' mind-related comments when infants were nine months of age did not significantly predict concurrent language abilities at nine months or later measures at two years. It is worth noting, however, that this nonsignificant relation at nine months may have occurred due to children's nascent receptive and expressive vocabulary at this age. Additionally, Longobardi and colleagues (2022) did not find a concurrent association between mothers' appropriate mind-related comments and toddlers' expressive vocabulary at 16 months of age. However, this investigation was conducted with a small sample, so although a positive correlation was reported, this study may have been underpowered to detect significant effects. Furthermore, Longobardi and colleagues (2018) found that while mothers' appropriate mind-related comments measured when children were 16 months predicted their internal state language at 20 months, mind-mindedness did not explain differences in overall expressive vocabulary. Taken together, although several studies have

reported null results when examining mind-mindedness and language outcomes, it remains possible that these findings may be attributable to sample or age-related factors, warranting further exploration.

Temperamental Contributions to Language Outcomes

In addition to environmental factors, inherent differences in children such as temperament contribute to language outcomes. Temperament is defined as individual differences in reactivity, responses to changes in the environment, and regulation, processes to moderate reactivity (Rothbart & Derryberry, 1981). Broadly, temperament is typically divided into three domains: negative affect- characterized by distressed and angry reactions to environmental situations; surgency/extraversion- marked by high levels of impulsivity, motor activity, and positive emotional affect; and effortful control- conceptualized as the capability to appropriately regulate impulses and emotions (Rothbart et al., 1994; Gartstein & Rothbart, 2003). Children begin to display some indicators of temperament by six months of age, but they become more prevalent and stable throughout the first two years of life (Rothbart, 2007; Evans & Rothbart, 2007).

Differences in temperament measured in the first two years of life predict behavioral, emotional, and cognitive outcomes in childhood (Kagan, 1997; Lemelin et al., 2006; Peterson et al., 2018). Further, a body of research has highlighted the contribution of temperamental characteristics to differences in children's language outcomes. High levels of positive affect, attentional control, and extraversion, all characteristics of surgency and effortful control, are known predictors of higher language abilities (Laake & Bridgett, 2014; Pérez-Pereira et al., 2016). Understanding the relation between negative affectivity and language outcomes, however, has remained elusive. Some investigations (Bruce et al., 2023) have reported that higher negative

affectivity is related to lower expressive and receptive vocabulary. These findings have been explained with the reasoning that caregivers' responses to children's negative affectivity often involve soothing and physical contact rather than quality child-directed speech, and therefore, children who commonly display negative affectivity (e.g., crying, fussing) do not receive the quality linguistic input that is conducive to optimal language outcomes. On the other hand, other studies have found a positive relation between children's negative affect and language outcomes (Moreno & Robinson, 2005; Spinelli et al., 2018), proposing that displays of negative emotionality may provide children with additional opportunities for discourse with their caregivers. Taken together, these findings suggest that the relation between negative affectivity and language outcomes may depend on the nature of caregivers' responses to their children's negative reactivity. However, prior studies examining whether children's negative affect may moderate the relation between caregiving behaviors and children's language outcomes have been scarce.

Differential Susceptibility Theory

A limited number of studies, driven by the Differential Susceptibility Theory, have explored whether children's temperamental factors interact with parental caregiving behaviors to explain differences in children's language outcomes.

The Differential Susceptibility Theory (Belsky, 2005) was developed to explain why some individuals show more susceptibility to their environment than others. Empirical evidence has long suggested that for individuals who are highly sensitive to environmental influences, supportive environments are especially beneficial, and challenging environments particularly detrimental, to various outcomes (Pluess & Belsky, 2010). Explaining this variation in susceptibility with an evolutionary framework, Differential Susceptibility Theory posits that

because the future is inherently uncertain, natural selection has shaped humans such that some individuals are more susceptible to environmental influences (e.g., caregiving quality) than others. Since the development of the theory, several genetic and behavioral factors have been identified as markers of heightened susceptibility (Pluess & Belsky, 2010). One of these is temperament, such that individuals with high negative emotionality, or more broadly, those who have a traditionally "difficult" temperament, have been shown to have heightened susceptibility to environmental perturbations. To explain this heightened sensitivity mechanistically, Pluess and Belsky (2010) suggested that individuals with difficult temperaments' nervous systems may be especially reactive to environmental events.

Several studies using a Differential Susceptibility framework have found parenting behaviors and difficult temperament, characterized by high emotionality and reactivity, to interact in predicting academic achievement and language outcomes. For example, Pluess and Belsky (2010) reported an interaction between maternal sensitivity and temperament in predicting school-aged children's academic performance, such that for children with difficult temperament, those with highly sensitive mothers performed among the best on reading, math, and picture vocabulary tasks, while those with insensitive mothers scored the among the worst. Additionally, van den Berg and Bus (2015) found that highly reactive toddlers who engaged in BookStart, a language development intervention involving parent-child interaction, displayed especially high vocabulary outcomes at 15 months of age. On the other hand, highly reactive toddlers who did not receive the Bookstart intervention reported lower vocabulary outcomes. Further, Laake & Bridgett (2018) reported that among toddlers high in negative affectivity, those with highly intrusive mothers had very low language scores. Although evidence from prior studies driven by the Differential Susceptibility Theory suggests that parenting behaviors and

temperamental factors may interact in predicting language outcomes, these investigations are limited in number and scope. To this end, potential interactions between mind-mindedness and difficult temperament, namely negative affectivity, in predicting toddlers' language outcomes have yet to be explored.

Gaps in Knowledge

While previous research has examined the association between caregivers' mind-mindedness and children's language outcomes, gaps in knowledge remain that the current study seeks to address. For example, the concurrent relation between maternal mind-related comments and 12-month-old toddlers' receptive vocabulary abilities remains uninvestigated. This potential link is important to explore because at this age, toddlers' expressive language abilities are typically limited, but their receptive vocabulary has started to develop (Reilly et al., 2008). Additionally, a gap remains in examining concurrent measures of maternal mind-related comments and expressive language at 12-, 18-, and 24-months of age, separately and together while controlling for toddlers' age. Although prior findings have been mixed regarding the significance of the association between appropriate mind-related comments and expressive vocabulary outcomes, an aim of the current study is to explore this relation further to improve clarity. Further, a gap in knowledge currently exists in understanding whether the relation between maternal mind-related comments and children's vocabulary may be moderated by toddlers' negative affectivity. Given that a significant interaction effect has emerged in some previous studies between maternal behaviors and children's difficult temperament in predicting language outcomes (e.g., van de Berg & Bus, 2015, Laake & Bridgett, 2018), this potential interaction is important to explore with mind-mindedness. Lastly, prior studies' observational measures of mind-mindedness have been somewhat limited in ecological validity, with none

coming from recordings of dyads' naturalistic interactions in their home environment. Therefore, an investigation that measures mind-mindedness in a highly ecologically valid context will be informative.

The Current Study

This study examines the relation between maternal mind-mindedness and toddlers' language outcomes, as well as investigating the moderating role of negative affectivity. In addition to this primary objective, associations between both temperamental and demographic variables and vocabulary outcomes are explored. Video and survey data from the Play and Learning Across a Year (PLAY) and Science of Everyday Play (LEGO) projects, two studies of children's interactions with their mother in their home environment, are utilized for the current study, which asks two research questions:

1. What is the association between the proportion of maternal mind-related comments and receptive vocabulary in 12-month-old infants and expressive vocabulary in 12-, 18-, and 24-month-old toddlers?

2. Do maternal mind-related comments and toddlers' negative affect interact to predict differences in 12-, 18-, and 24-month-old toddlers' expressive vocabulary?

This investigation has the following hypotheses:

H1: There will be a positive relation between mothers' proportions of appropriate mind-related comments and receptive vocabulary in 12-month-old infants, and expressive vocabulary in 12-, 18-, and 24-month-old toddlers while controlling for their age.

H2: Maternal mind-related comments and toddlers' negative affect will interact to predict expressive vocabulary in 12-, 18-, and 24-month-old toddlers. Specifically, among toddlers who are high in negative affect, toddlers whose mothers' proportions of appropriate mind-related

comments are high will have particularly high expressive vocabulary abilities, while toddlers whose mothers' proportions of appropriate mind-related comments are low will have especially low vocabulary abilities.

CHAPTER 2

METHOD

Participants

All participants in the current study were part of the Science of Everyday Play (LEGO) Project, which was conducted by New York University, and the University of Georgia and Georgetown University collecting sites from the Play and Learning Across a Year (PLAY) Project. Although separate projects, the PLAY and LEGO studies are both investigations of children's interactions with their mother in their home environment, using very similar experimental protocols for recordings of naturalistic interactions and surveys. Several inclusion criteria for children preceded participation in both studies. First, children were required to be approximately 12-, 18-, or 24-months of age. Additionally, they must have been born at term and could not have disabilities of which their mothers were aware. Due to both studies' cross-sectional design, participants in the PLAY project participated in only one study visit, and participants in the LEGO project participated in two visits within a week of each other. All data for this project are available to researchers via Databrary.org, and are part of a larger behavioral research open data initiative.

Because measures that accurately assessed multilingual toddlers' vocabulary were not included for all sites, all dyads from the original PLAY and LEGO datasets who spoke languages other than English were excluded from the current sample. A total of 94 mother-child dyads comprised this study's sample, with 27 from the University of Georgia, 26 from New York University, and 41 from Georgetown University. The age composition of children consisted of

39 12-month-olds, 28 18-month-olds, and 27 24-month-olds (M = 17.4, SD = 4.8), and most toddlers were girls (n = 50). Children's race and ethnicity were not collected for LEGO participants, and thus, are not available for the current sample. See Table 1 for sociodemographic characteristics of mothers.

Materials

PLAY

During PLAY visits, a camera and tripod were used to record all interactions. A decibel meter microphone measured environmental noise levels, and a laser device computed room measurements in each household. For the structured play session, a yoga mat and a tote bag with a small set of toys were supplied. Specifically, the toys consisted of a plastic dish set and two pretend animals. To administer consent forms and questionnaires, the experimenter used a tablet with the Kobo toolbox application and brought paper copies of the forms in the case of complications with the tablet. The experimenter provided mothers with printed answer scales for the questionnaires.

LEGO

A smaller set of materials was brought to each LEGO visit. The experimenter used a camera to record all parts of visits and an application on a tablet to measure environmental noise levels. Finally, the experimenter administered consent forms and recorded mothers' survey responses on paper.

Procedure

PLAY

For mothers who had expressed interest in the study, the experimenter conducted a recruitment call to determine participant eligibility. Upon meeting eligibility criteria, mothers

answered a demographic questionnaire and scheduled their home visit. Visits were scheduled at a time in which the mother-child dyad were the only individuals present in their home.

To begin PLAY home study visits, mothers completed consent forms. After the completion of the forms, a video-recorded one-hour session of the dyads' naturalistic interactions ensued. At the start of this segment, the experimenter instructed dyads to interact as they normally would in the home environment, with no guidelines on how or where to interact if they remained inside. The amount of environmental noise was measured with a decibel meter. At the conclusion, the experimenter conducted a walkthrough of rooms in the house, video recording and capturing measurements of all rooms.

Mother-child dyads then participated in a five-minute video-recorded structured play session, during which they were instructed to play with a standardized set of toys on a yoga mat. Finally, the experimenter guided mothers through several questionnaires in an interview style. Questionnaires assessed child characteristics such as vocabulary outcomes, temperament, and locomotor development, and family characteristics such as maternal prenatal and postnatal health, parental division of labor, and family-level media use. The surveys were given in the form of video-recorded interviews, and the experimenter also marked answers to the questionnaires on a tablet. After study visits, mothers were compensated with a $50 gift card.

LEGO

The experimenter conducted two home visits within one week for all dyads that had met eligibility criteria. Upon completion of consent forms, each visit consisted of a two-hour video recorded naturalistic play session, where dyads' only instruction was to act as they usually would at home. During either the first or second visit, mothers completed demographic, vocabulary, and

temperament questionnaires in an interview form. At the conclusion of the second study visit, mothers received a $75 gift card.

Although LEGO and PLAY visits included similar sessions of naturalistic interactions and surveys, there were minor differences in protocol between the studies. First, all PLAY subjects participated in only one home visit. On the other hand, LEGO participants completed two visits within a week of each other that both included a naturalistic play session, and they answered surveys during one of the visits. Second, natural play segments during PLAY sessions lasted one hour, while LEGO naturalistic play sessions were each two hours. Finally, PLAY participants completed a shorter form of the MacArthur-Bates Communicative Development Inventory (MBCDI; Fenson et al., 2007), while LEGO participants filled out a longer form, which includes most words from the shorter form. To account for these differences in protocol, the current study utilized data from only the first hour of naturalistic play per LEGO subject and used only the MBCDI words that matched between PLAY and LEGO word lists.

Measures

Data from videos of the dyads' naturalistic interactions was used to measure maternal mind-mindedness, and survey data collected during each study visit evaluated toddlers' vocabulary and temperamental characteristics.

Maternal Mind-Mindedness

The Mind Mindedness Coding Manual was used for all measures related to maternal mind-mindedness (Meins & Fernyhough, 2015). First, the total number of mothers' mind-related comments was determined. Following the coding manual, maternal mind-related comments were directed at their child and included state terms in one or more of the following categories: Desires and Preferences (e.g., "Do you like this toy?"), Cognitions (e.g., "Do you remember

going to the movies?"), Emotions (e.g., "You are anxious today"), Epistemic states (e.g., "Are you joking with me?"), and imitations of their child speaking (e.g., "I am getting the book, Mommy!"). After determining the total number of mind-related comments, each comment was classified as either appropriate or non-attuned. Mothers' mind-related comments were considered appropriate if they met any of the following conditions: it was deemed by the research assistant to be attuned to the child's current mental state (e.g., "You like that candy" as the child reaches for the candy); it linked the present activity with relevant past or future activities (e.g., "Remember, we went to the grocery store last week" as the child plays with a toy grocery cart); it ended a pause in the interaction ("Do you want to play with this?" while the child is not engaged with anything). If a mind-related comment did not fit any of these criteria, it was considered non-attuned.

Child Expressive and Receptive Vocabulary

Toddlers' vocabulary was evaluated with the MacArthur-Bates Communicative Development Inventories (MBCDI; Fenson et al., 2007). In 12-month-olds, receptive vocabulary was measured with an inventory in which mothers specified how many words their child could understand or understand and say from a list of 149. Expressive vocabulary was assessed in all age groups with a survey wherein mothers indicated how many words their child could understand and say from a list of either 149 (12-month-olds) or 159 (18- and 24-month-olds). Prior to data analysis, small discrepancies in the number and content of words presented to toddlers existed between sites. Therefore, words that differed between sites were removed prior to analyses, and the final lists of 149 and 159 words matched. The MBCDI has demonstrated good validity (Heilmann et al., 2005) and was scored for the proportion of expressive and receptive vocabulary words.

Child Temperament

The Rothbart Early Child Behavior Questionnaire-Very Short Form (ECBQ-VSR; Putnam & Rothbart, 2006) was used to measure toddlers' temperament. This survey consisted of a total of 36 items in which parents were instructed to indicate how often each statement had characterized their child in the past two weeks, from "Never" to "Always." The ECBQ-VSR included three subscales, Negative Affectivity, Surgency, and Effortful Control, each containing 12 items. Items from the Negative Affectivity subscale included "During everyday activities, how often did your child become bothered by sounds while in noisy environments?" and "When told "no", how often did your child become sadly tearful?". The Surgency subscale consisted of items such as "While playing outdoors, how often did your child choose to take chances for the fun and excitement of it?" and "While participating in daily activities, how often did your child seem full of energy, even in the evening?," and the Effortful Control included items like "When engaged in an activity requiring attention, such as building with blocks, how often did your child tire of the activity relatively quickly?" and "During everyday activities, how often did your child pay attention to you right away when you called to him/her?". The ECBQ-VSR has displayed satisfactory psychometric properties in prior studies (Sleddens et al., 2012). In the current study, however, the Negative Affectivity ($\alpha = .62$), Surgency ($\alpha = .61$), and Effortful Control ($\alpha = .64$) subscales exhibited lower internal consistency than is optimal (e.g., Davison et al., 2019).

Analytic Plan

Preliminary Data Processing

Data processing procedures preceded all data cleaning and analyses. First, the timestamps of 10-minute video segments in which both the mother and toddler were in frame were noted from the entirety of each one hour PLAY and the first hour of each LEGO naturalistic

interaction. One 10-minute video segment was randomly selected and cropped for each dyad. The R package Audio.whisper (Wijffels, 2024) was used to provide a rough transcription of each 10-minute file. The principal researcher or a trained research assistant then meticulously edited the original transcripts to match mothers' speech by re-watching and re-listening to the entire 10-minute file. Following a suggestion in the Mind-Mindedness Coding Manual (Meins & Fernyhough, 2015) and other studies coding for mind-related comments (e.g., Longobardi et al., 2016, 2024), the transcripts were separated into comments based on a minimum of exactly one-second temporal pauses in mothers' speech. Because the Mind Mindedness coding manual did not provide rules for transcript editing beyond these segmenting suggestions, additional rules for the current project's transcription were developed by the research team (See Appendix B). Using intraclass correlation coefficients for absolute agreement (ICC 3; Koo et al., 2016), interrater reliability for the segmenting of comments was calculated between one trained research assistant blind to study hypotheses and the principal researcher for 23% of subjects, split into several batches. The average ICC value for comment division was excellent, ICC = .95, $F(21, 21.9) = 36.9$, $p < .001$, 95% CI [0.88, 0.98].

Finalized transcripts that had been divided into comments were used to code for maternal mind-related comments. All subjects were coded by one trained research assistant blind to study hypotheses, and 60% were coded by the principal researcher. Files that had been completed by both the research assistant and the principal researcher were grouped into batches of five, and interrater reliability was completed for each batch. Intraclass correlation coefficients (ICC 3) were used to calculate interrater reliability for total and appropriate mind-related comments. The average interrater reliability for total (ICC = .96, $F(55, 55.2) = 52.1$, $p < .001$, 95% CI [0.94, 0.98]) and appropriate (ICC = .96, $F(55, 54.9) = 49.7$, $p < .001$, 95% CI [0.93, 0.98]) mind-

related comments was very high. Following coding, the total number and number of appropriate and non-attuned mind-related comments were divided by the number of mothers' total comments to create proportions that controlled for mothers' verbosity (e.g., Meins et al., 2013). Proportions were multiplied by 100 to transform them into percentages, and these percentages were used as predictors in analyses.

Planned Analyses

Planned analyses were pre-registered on AsPredicted.org: https://aspredicted.org/LCZ_J8F.

To assess the first research question, a series of regression analyses were pre-registered. Specifically, bivariate regressions were planned to assess the relation between maternal mind-mindedness and children's receptive vocabulary outcomes for the 12-month-old age group. Multiple regressions were proposed to test the association between maternal mind-mindedness and expressive vocabulary abilities while controlling for toddlers' age at visit. Separate analyses were planned for the proportions of total, appropriate, and non-attuned mind related comments as predictors. Additional, exploratory regression analyses were pre-registered to test effects between each subscale of the Early Child Behavior Questionnaire-Revised Very Short Form and vocabulary outcomes.

To test the second research question, moderation analyses were proposed to evaluate potential interaction effects between maternal mind-related comments and child negative affect to predict differences in expressive vocabulary. Child age was planned as a covariate. As with regression analyses, the moderated regressions were planned to test separately the total number of mind-related comments, appropriate mind-related comments, and non-attuned mind related comments as predictors.

CHAPTER 3

RESULTS

Prior to running analyses addressing each research question, a variety of data wrangling procedures and preliminary analyses were performed. First, power analyses for all pre-registered statistical tests examined the plausibility of detecting effects with the current sample. Second, procedures to detect and remove outliers, as well as data transformations for skewed variables, were conducted. Third, assumptions for analyses were tested and satisfied. Finally, a variety of descriptive statistics provided insight into characteristics of predictor and outcome variables.

Data Reduction and Processing

Power Analyses

Power analyses for each research question's pre-registered statistical tests were completed after the knowledge of the final sample size but prior to data cleaning and analyses. An effect size of .15, a power level of .80, and an alpha level of .05 were chosen for all power analyses. For bivariate regression analyses examining the association between mind-related comments and receptive vocabulary in twelve-month-old toddlers, a sample size of 47 was suggested. Therefore, the current study's sample of 12-month-olds (n = 39) was slightly underpowered to detect a medium effect size. A sample size of 58 was recommended for multiple regression analyses testing the relation between appropriate, total, and non-attuned mind-related comments and expressive vocabulary while controlling for toddlers' age, indicating that the current sample (n = 94) was well-powered to detect a medium effect size. Finally, for moderation analyses examining potential interaction effects between toddlers' negative affect

and mind-related comments in predicting expressive vocabulary, a sample size of 66 was suggested. Thus, the current sample size would likely detect a medium effect size, although small effect sizes often characterize interaction terms. In sum, power analyses determined that the current investigation was sufficiently powered to conduct most pre-registered analyses.

Data Reduction

Following guidelines from the pre-registration, participants with percentages of maternal mind-related comments at least two and a half standard deviations above or below the overall mean, or with vocabulary scores at least two and a half standard deviations above or below the mean relative to their age group, were excluded. Specifically, one participant was more than two and a half standard deviations above the mean for maternal mind-related comments, and three participants were more than two and a half standard deviations above the mean for either receptive or expressive vocabulary scores. Additionally, one 24-month-old participant from the LEGO project, which did not exclude participants with suspected disabilities (e.g., language delay) as part of their quality assurance process, had an expressive vocabulary score of zero, a score indicative of a language delay. Due to the extremity of this score, this participant was deemed an outlier. Although the original sample size (n = 94) was used to describe sociodemographic characteristics of participants, these five outliers were excluded from all analyses (n = 89).

To assess normality of predictor and outcome variables, histograms were created. The proportions of total and appropriate maternal mind-related comments, as well proportions of receptive vocabulary words, were normally distributed. However, the proportion of non-attuned comments had an inflated number of zeros, so it was collapsed into a dichotomous variable. Specifically, it was contrast coded as -1 for all participants with a proportion of 0 (n = 85) and 1

for participants with at least 1 non-attuned comment (n = 4). Lastly, the proportion of expressive vocabulary words was right skewed, necessitating a logarithmic transformation. Transformed proportions of expressive vocabulary scores were used as outcome variables in analyses.

Assumptions

Assumptions were examined for every statistical test. Assumptions of Analysis of Variance (ANOVA), such as normality and homogeneity of variance, were satisfied. Additionally, all assumptions of bivariate and multiple regression, including independence, normality of residuals, homoscedasticity of residuals, and an absence of multicollinearity were met for most models. In the model examining appropriate mind-related comments and expressive vocabulary for the 24-month age group, issues of heteroscedasticity did not arise, but four negative residuals greatly stood out in diagnostic plots, causing a skew in residuals. When these points were removed from the model, normality of residuals was achieved, and the subsequent regression model's results reached significance (See Appendix C). However, these points were retained in the current study's model, as removing them would be outside the pre-registered plan for excluding outliers.

The assumption of normality was violated for the contrast-coded non-attuned mind-related comments variable due to the inflation of zeros. Therefore, although included in the pre-registration, analyses with non-attuned mind-related comments as predictors were not completed, as they would not accurately assess the relation between the presence of non-attuned comments and vocabulary outcomes. This low proportion of non-attuned comments was consistent with some prior studies coding for non-attuned mind-related comments with community samples (e.g., Longobardi et al., 2018).

Descriptive Statistics

A variety of descriptive statistics including predictor, outcome, and demographic variables were calculated. See Table 2 for a summary of variable characteristics.

Maternal Words and Total Comments

During the 10-minute natural play segments, mothers said between 50 and 1082 word tokens ($M = 481.5$, $SD = 215.4$) and between 15 and 180 total comments ($M = 96.6$, $SD = 28.2$). One-way ANOVAs were completed to examine whether mothers' total number of comments differed by child age group or sex, respectively. Results revealed that mothers' total comments did not significantly differ by child age group, $F(2, 86) = 0.14$, $p = .873$, with mothers of 12-month-olds saying slightly fewer comments ($M = 94.7$, $SD = 28.6$) than those of 18- ($M = 98.2$, $SD = 28.3$) and 24-month olds ($M = 97.6$, $SD = 28.6$). Mothers' total comments also did not differ by child sex, $F(1, 87) = 0.05$, $p = .817$, with mothers of girls ($M = 97.2$, $SD = 29.3$) making slightly more comments than mothers of boys ($M = 95.8$, $SD = 27.3$).

Additionally, one-way ANOVAs tested whether the number of mothers' word tokens varied by child age group or sex. The number of mothers' word tokens did not significantly differ by their children's age group, $F(2, 86) = 1.91$, $p = .156$, although the mean number of tokens for mothers of 12-month-olds ($M = 429.3$, $SD = 205.9$) was lower than that for mothers of the 18- ($M = 519.5$, $SD = 237.5$) or 24-month-olds ($M = 518.2$, $SD = 197.4$). Finally, mothers' word tokens did not differ by child sex, $F(2, 86) = 0.04$, $p = .837$, with mothers of boys ($M = 486.7$, $SD = 215.7$) saying only slightly more word tokens than mothers of girls ($M = 477.2$, $SD = 217.4$).

Maternal Mind-Related Comments

Consistent with prior studies (e.g., Helmerhorst et al., 2019; Longobardi et al., 2022), an average of approximately 13% of mothers' total comments were coded as appropriate mind-related comments (M = 12.5, SD = 6.4). The average percentage of total mind-related comments was also close to 13% (M = 12.7, SD = 6.3), while that of non-attuned mind-related comments was close to zero (M = 0.1, SD = 0.8).

Zero-order correlations between the proportion of appropriate mind-related comments and both maternal and child characteristics are presented in Table 3. To test for potential differences in appropriate mind-related comments by toddlers' sex, a one-way ANOVA was completed. Results indicated that appropriate mind-related comments did not differ significantly as a function of child sex, $F(1,87) = .40$, $p = .571$, with mothers of boys (M = 12.1, SD = 5.7) and girls (M = 12.9, SD = 7.0) saying similar numbers of appropriate mind-related comments. Additionally, a one-way ANOVA tested for potential differences in mind-related comments by toddlers' age group. The proportion of appropriate mind-related comments also did not significantly vary by toddlers' age, $F(2,86) = .24$, $p = .786$, with mothers of 12-month-olds saying slightly fewer mind-related comments (M = 12.0, SD = 6.6) than those of 18- (M = 12.9, SD = 6.6) or 24-month-olds (M = 12.9, SD = 6.6).

Toddlers' Receptive and Expressive Vocabulary

Although expressive vocabulary scores were transformed to satisfy regression assumptions and were included in all regression analyses, raw scores were used for initial descriptive statistics. Mothers of 12-month-olds reported that their toddlers could understand a mean of approximately 23% of the vocabulary words in the MBCDI (M = 23.5, SD = 14.2). When separated by age group, toddlers' means of expressive vocabulary percentage scores for

12-, 18-, and 24-month age groups were around 2% (M = 2.5 , SD = 2.1), 21% (M = 20.7, SD = 12.3), and 54% (M = 54.0, SD = 23.5), respectively.

To test for significant differences in the proportion of expressive vocabulary words by child age group, a one-way ANOVA was run. As expected, the proportion of expressive vocabulary words significantly differed by toddlers' age group, $F(2,86) = 185.8$, $p < .001$. A Tukey's post-hoc test revealed that all three age groups' expressive vocabulary varied significantly from one another, ps < .001.

Research Question 1

Bivariate and multiple regressions were used to evaluate the first research question, examining the relation between maternal mind-related comments and receptive and expressive vocabulary outcomes. Results indicated that the proportion of appropriate mind-related comments was not significantly related to the proportion of receptive vocabulary words in the 12-month-old sample, $b = .38$, $t(35) = 1.07$, $p = .291$. Additionally, the proportion of total mind-related comments, $b = .39$, $t(35) = 1.06$, $p = .297$, was not associated with receptive vocabulary. See Figure 1 for a scatterplot of the relation between the proportion of appropriate mind-related comments and the proportion of 12-month-olds' receptive vocabulary.

Next, the association between the proportion of maternal mind-related comments and expressive vocabulary was examined using multiple regression, including toddlers' age at visit as a covariate that was first entered into the regression equation. As expected, child age at visit was significantly related to the proportion of expressive vocabulary words, $b = .25$, $t(86) = 19.52$, $p < .001$, and explained 81% of the variance in expressive vocabulary scores, $R^2 = .81$, $F(1,87) = 381$, $p < .001$. When appropriate mind-related comments were added to the regression equation, results indicated that they did not account for significant additional variance in the proportion of

expressive vocabulary words, $R^2\Delta = .01$, $F(2,86) = 0.55$, $p = .460$. Figure 2 displays the scatterplot of the overall association between the proportion of appropriate mind-related comments and the proportion of expressive vocabulary words, holding child age constant. The proportion of total mind-related comments also did not contribute to additional significant variance beyond that accounted for by child age at visit, $R^2\Delta = .01$, $F(2,86) = 0.40$, $p = .530$.

Research Question 2

The second research question asked whether toddlers' negative affect moderated the relation between maternal mind-related comments and toddlers' expressive vocabulary (see Figure 4). To test this question, moderated regression analyses in which expressive vocabulary scores were regressed onto maternal mind-related comments, child age at visit, child negative affect, and an interaction term between maternal mind-related comments and child negative affect were completed. All predictor variables were centered prior to analyses.

The interaction term between negative affect and appropriate mind-related comments was not significant, ($b = -.01$, $t(83) = -.43$, $p = .671$), and did not account for significant additional variance in expressive vocabulary, $R^2\Delta < .01$, $F(4,84) = 0.18$, $p = .671$. Additionally, interaction terms were not significant when a moderation was run with total mind related comments ($b = -.01$, $t(83) = -.40$, $p = .689$) and did not explain additional variance beyond that accounted for by other predictors, $R^2\Delta < .01$, $F(4,84) = 0.16$, $p = .689$. Due to the non-significance of these interaction terms, simple slopes were not probed.

Exploratory Analyses

In addition to the pre-registered analyses for each research question, several additional exploratory analyses were completed.

Mind-Related Comments and Expressive Vocabulary Scores by Child Age Group

As an extension of the first research question's pre-registered analyses, bivariate regressions tested the relation between the proportion of mind-related comments and expressive vocabulary within each age group. For the 12-month age group, there was not an effect of appropriate (b = .01, t(35) = .81, p = .425) or total (b = .01, t(35) = .73, p = .467) mind related comments on the proportion of expressive vocabulary words. This association was also not significant for the 18-month age group for appropriate (b = -.01, t(24) = .61, p = .547) or total (b = -.01, t(24) = -.61, p = .547) mind-related comments. When tested in the 24-month age group, there was a positive association that approached significance between the proportions of appropriate, b = .03, t(24) = 1.88, p = .073, and total, b = .03, t(24) = 1.88, p = .073, mind-related comments and the proportion of expressive vocabulary words. See Figure 4 for a scatterplot of relation between the proportion of appropriate mind-related comments and the proportion of expressive vocabulary words by child age group.

Temperament Subscales and Vocabulary Scores

Bivariate regression analyses examined the relation between each subscale of the ECBQ-VSR and vocabulary scores. There was not a significant relation between Negative Affectivity (b = 3.68, t(35) = .84, p = .408), Effortful Control (b = 4.38, t(35) = 1.50, p = .144), or Surgency (b = .39, t(35) = .12, p = .903) and receptive vocabulary scores. This association was also not significant for expressive vocabulary scores with the Negative Affectivity (b = .001, t(85) = .003, p = .997), Effortful Control (b = .06 , t(85) = .58, p = .564), or Surgency (b = -.01, t(85) = -.22, p = .826) subscales with child age at visit as a covariate. None of the temperament dimensions explained any additional variance beyond that which was explained by child age at visit.

Demographic Predictors of Expressive Vocabulary Scores

Several demographic predictors of expressive vocabulary were explored. Due to the need to account for child age in the current sample, child age at visit was entered into regression equations first, followed by adding each demographic variable into a separate equation. As previously mentioned, child age alone explained 81% of the variance in expressive vocabulary, $R^2 = .81$, $F(1,87) = 381$, $p < .001$. When children's time spent with other caregivers (e.g., grandparent, childcare) was added to the equation, children's time with other caregivers was negatively associated with vocabulary scores and accounted for 1.02% more variance in expressive vocabulary scores beyond that accounted for by child age, $R^2\Delta = .01$, $F(2,83) = 4.41$, $p = .039$. See Figure 5 for the scatterplot of children's time with other caregivers and expressive vocabulary, holding child age constant. Second, maternal age was tested as a predictor (See Figure 6), and there was a negative association that approached significance, although it did not account for variance in expressive vocabulary beyond child age, $R^2\Delta < .01$, $F(2,82) = 3.48$, $p = .065$. Lastly, mothers' highest level of education was investigated as a predictor and was not associated with expressive vocabulary when age was held constant, $R^2\Delta < .01$, $F(2,85) = .40$, $p = .529$.

CHAPTER 4

DISCUSSION

The current study examined the relation between maternal mind-mindedness and toddlers' receptive and expressive language. Additionally, it aimed to explore a potential interaction between mind-mindedness and toddlers' negative affectivity in predicting vocabulary outcomes. Lastly, exploratory analyses sought to investigate whether associations between both demographic and temperamental factors and vocabulary scores replicated findings of prior studies. Although hypotheses were not supported, findings from the pre-registered analyses add to prior literature investigating maternal mind-mindedness and toddlers' vocabulary. Moreover, they highlight the need for a clearer understanding of the circumstances in which a relation between mind-mindedness and language outcomes appears, and more broadly, knowledge of whether mind-mindedness is a contextually stable construct.

Hypothesis 1

For the first research question, it was hypothesized that there would be a positive association between maternal mind-related comments and toddlers' receptive and expressive vocabulary. This hypothesis was not supported. Appropriate maternal mind-related comments were not related to receptive vocabulary outcomes in 12-month-old toddlers, expressive vocabulary in all age groups while controlling for toddlers' age, or expressive vocabulary in the 12- or 18-month age groups when tested individually. However, when the relation between mind-related comments and expressive vocabulary was tested separately for the 24-month age group, there was a positive association that approached significance. Given the mixed nature of

prior research investigating these constructs, these results were consistent with some studies (e.g., Nyberg et al., 2021; Longobardi et al., 2022) and contradictory to others (e.g., Bernier et al., 2017; Constantini et al., 2018), as detailed below.

A closer examination of previous research investigating mind-mindedness and children's language outcomes may provide an explanation for these null results. Although prior studies have yielded mixed findings, the majority with significant results have used longitudinal designs, typically measuring maternal mind-mindedness during children's first year of life and vocabulary outcomes when children reach at least 24 months of age (e.g., Bernier et al., 2017; Constantini et al., 2018). To this end, the current results corroborate those of Nyberg and colleagues (2021) and Longobardi et al. (2022), who also used concurrent cross-sectional samples to investigate this relation. Nyberg et al. (2021) reported a nonsignificant association between mind-mindedness in mothers and fathers and expressive and receptive vocabulary at 9 at months of age. Additionally, Longobardi and colleagues (2022) did not find a significant relation between maternal mind-mindedness and expressive vocabulary at 16 months, albeit with a small sample size.

Importantly, prior investigations with significant, concurrent findings have had sample or design differences from the current study. Lundy and Fyfe (2015), who reported positive correlations between mind-mindedness and measures of both receptive and internal state language, examined this relation when children were 48 months of age, a considerably older sample than that of the current study or previously cited literature. Relatedly, several studies investigating parents' mental state language, a broader category of child-directed speech related to mental states, and language outcomes (e.g., Symons et al., 2006; Taumoepeau & Ruffman, 2008; McQuaid et al., 2008) found significant, concurrent associations but used children's

internal state words (e.g., Taumoepeau & Ruffman, 2008) as an outcome rather than overall expressive or receptive language. Therefore, it is possible that a concurrent association is specific to certain types of children's language (e.g., internal state language) or appears only at later ages than the current sample. Taken together, these prior findings partially align with the current results, where an association between mind-mindedness and expressive vocabulary that approached significance emerged for the oldest age group.

Multiple reasons might explain why the relation between mind-related comments and expressive vocabulary approached significance only for the 24-month age group. First, this group's vocabulary scores displayed much more variability (*SD* = 23.6) than either the 12- (*SD* = 2.1) or 18-month (*SD* = 12.3) age groups. Therefore, it is possible that there was not enough variability in the younger two age groups' vocabulary scores to be sensitive to influences of maternal mind-related comments. Second, prior research (e.g., Stipek et al., 1997) has demonstrated that self-recognition, an understanding of oneself as an individual with characteristics such as physical attributes, preferences, and actions, increases between 18 and 24 months of age. In the latter half of their second year, toddlers' more fully-developed self-recognition may allow them to better understand their mothers' mind-related comments, which often reference their child's characteristics. As a result, it is plausible that in this study, 24-month-olds' self-recognition allowed them to comprehend that their mothers' appropriate mind-related comments pertained to their individual, current mental states and subsequently, make connections that translated to their expressive vocabulary scores.

In summary, although the first hypothesis was not supported overall, results have multiple implications. First, when compared to prior literature, they indicate that a concurrent relation between mind-mindedness and language might exist only in older children than the

current sample or with certain types of language (e.g., internal state language) as an outcome. Second, the association between maternal mind-mindedness and vocabulary outcomes may be understood better predictively than concurrently. Future investigations should build on these implications for a greater understanding of the conditions in which significant relations between mind-mindedness and child language outcomes exist.

Hypothesis 2

Driven by the Differential Susceptibility Theory, the second hypothesis predicted that a relation between maternal mind-related comments and toddlers' vocabulary outcomes would be stronger for toddlers high in negative affectivity. Specifically, for these toddlers, those with mothers who made a high proportion of appropriate mind-related comments would display especially high scores on a measure of expressive vocabulary, while those whose mothers made a low proportion of appropriate mind-related comments would have particularly low scores. This hypothesis was not supported, as no interaction effect was found between mind-related comments and negative affectivity in predicting expressive vocabulary. This result contradicts prior findings that have found parenting behaviors to interact with "difficult" or negatively emotional temperamental characteristics in explaining vocabulary outcomes (Pluess & Belsky, 2010; van den Berg & Bus, 2015; de Bondt & Bus, 2022).

Multiple reasons may explain this result. First, a lack of main effects between toddlers' temperament and language outcomes was overall inconsistent with prior literature (e.g., Kucker et al., 2021). More specifically, many previous studies have demonstrated that both surgency and effortful control are positively related to language outcomes (e.g., Laake & Bridgett, 2014; Garello et al., 2012). Although prior literature examining negative affectivity and language outcomes has been mixed, many studies have observed a significant relation between children's

negative affectivity and their vocabulary, whether in a positive or negative direction (e.g., Bruce et al., 2023; Canfield & Saudino, 2016; Moreno & Robinson, 2005). The current study's lack of replicating any of these relations between temperament and vocabulary may be related to shortcomings in the current sample's temperament data, likely due to low internal consistency of each of the subscales. The fact that there were no main effects of not only mind-mindedness, but also temperament dimensions, diminished the chances that there would be an interaction between the two in explaining differences in expressive vocabulary.

Also, most previous investigations with significant interactions between parenting behaviors and temperamental characteristics in predicting language outcomes have operationalized "difficult" temperament slightly differently than the current study, such as with high overall reactivity (e.g., van den Berg & Bus, 2015). The current study was justified in using the negative affectivity subscale, as negative affect by itself is commonly considered an indicator of heightened susceptibility to environmental factors (e.g., Belsky and Pluess, 2010) and is the predominant component of difficult temperament (Bates, 1980). However, this slight difference in measurement might explain differences in results to those of prior studies. Overall, this hypothesis was not supported, although due to the low internal consistency of the current study's temperament subscales, these results also do not provide substantial evidence that negative affectivity does not moderate the relation between mind-mindedness and language abilities. Therefore, future studies should explore this possibility further, particularly with a larger and older sample than that of the current study.

Demographic Predictors of Expressive Vocabulary

In addition to pre-registered and exploratory analyses examining relations between mind-mindedness, temperament, and vocabulary outcomes, demographic predictors of expressive

vocabulary were investigated. The negative relation between toddlers' time with other caregivers and expressive vocabulary scores was in line with prior studies with community samples (e.g., Miser & Hupp, 2012). Other results were unexpected when compared to those of prior findings, although they may be attributable to characteristics of the current sample. For example, the current study's failure to replicate a positive association between both maternal age and education and vocabulary scores might be attributable to the high mean age (M = 33.4) and education level of mothers, in contrast with prior studies' (e.g., McDonald et al., 2014) greater variability in maternal age and education. Overall, these findings add to limited evidence that children's time with (or conversely, apart from) their primary caregivers may play a role in their language development, although further investigation is needed for a more definitive understanding of this relation. Additionally, they suggest that caregivers' age and education may not be predictive of vocabulary outcomes in samples of caregivers with a restriction of range in age and education.

Limitations

The current study involved several limitations that should be acknowledged. First, although power analyses determined that the current study was well powered to detect a medium effect size for pre-registered analyses, this sample size was underpowered to detect smaller effect sizes for pre-registered analyses and medium effect sizes for exploratory analyses completed separately for each age group. This may have led to Type I or II errors, especially for certain analyses. For example, the association between appropriate mind-related comments and expressive vocabulary in the 24-month age group approached significance, but with a sample of 26, was not well powered to detect a medium effect size. Additionally, the current study may have been underpowered to detect effects for interaction terms in moderated regression analyses,

which often have small effect sizes. It is worth noting, however, that most prior studies testing interactions between temperament and maternal behaviors in predicting language outcomes have used similar sample sizes to the current study (Karrass & Braungart-Rieker, 2003; Laake & Bridgett, 2018; Spinelli et al., 2018).

Second, none of the temperament subscales in the current sample displayed satisfactory internal consistency. Although the current study is not the first to report low alpha values with the ECB-QR VS (Putnam & Rothbart, 2006), this low internal consistency likely explains the lack of main effects between temperament dimensions and language outcomes. Additionally, it may have contributed to the absence of interaction effects between MM and temperamental factors in predicting language outcomes.

Finally, these results are limited in generalizability due to multiple sample characteristics. First, the Dual Language Learners English-Spanish (Tamis-Lemonda et al., 2024), a vocabulary measure where scores can be compared between monolingual English and Spanish, as well as bilingual participants, was not collected for all sites in the current sample. As a result, the English-only MBCDI was used as the measure of vocabulary in the current study, so only monolingual English participants were included in the final sample. While this decision allowed for comparable vocabulary scores across all participants, it also means that the current study's results are not generalizable beyond monolingual English-speaking households. Second, collecting study visits in participants' homes may have limited generalizability. These visits involved going into participants' households, and so the study design would exclude participants who may not have been comfortable or had the availability for a study visit lasting several hours in their home environment.

Future Directions

This study's results warrant multiple future directions. First, the marginally positive association between mind-related comments and expressive vocabulary only for the 24-month age group was in line with several prior studies with toddlers at least two years of age (e.g., Laranjo & Bernier, 2013; Lundy & Fyfe, 2015); however, to understand definitively that a relation between mind-related comments and language abilities consistently appears after the second year of life, careful replication and extension of these findings is necessary. Therefore, a future investigation with a larger sample of children ($n > 200$) who are at least two years of age should aim to replicate these results, and further, examine moderating roles of children's negative affect or overall reactivity. To ensure validity of temperament and language data, temperament should be evaluated during study visits with a behavioral assessment (e.g., Laboratory Temperament Assessment Battery; Goldsmith & Rothbart, 1991), and expressive vocabulary with day-long recordings of children's utterances. This study design will allow for careful replication of previous main effects, valid measurement of all variables, and power to detect small effect sizes for interaction terms.

Conversely, an alternative explanation for this mixed body of literature that warrants exploration is that facets of mothers' language included in appropriate mind-related comments may have driven previous, significant findings. As mentioned previously, caregivers' referential language, that which involves objects and events in their environment, is a type of child-directed speech that facilitates children's language learning (e.g., Nandy et al., 2021; Tamis-Lemonda et al., 2012). Many appropriate mind-related comments are referential in nature, but no prior studies have coded for both mind-related comments and caregivers' referential speech. Therefore, it is unknown whether a high overlap in referential and mind-related comments may

have driven previous significant results in predicting children's language. To address this possibility, future studies with language outcomes should code for both referential and mind-related comments and examine the overlap. If the overlap is high and, when tested, mind-related comments are related to children's language, or conversely, the overlap is low and there is an insignificant relation, this may signify that other facets of caregivers' speech found within mind-related comments may be more robust predictors of children's language than appropriate mind-related comments themselves.

Lastly, another possible explanation for these mixed findings that warrants investigation may pertain to contextual differences in previous studies' measurement of mind-mindedness. Investigations of mind-mindedness and language have differed in the context that they measured mind-mindedness (e.g., toy play, naturalistic interaction, structured play task), and it is still largely unknown whether mind-mindedness is a contextually stable construct. Therefore, future investigations should strive to obtain a greater understanding of whether caregivers' mind-related comments are contextually stable and continuous across contexts. Data from the PLAY project, which captures dyads interacting naturalistically across several activities, is conducive to examine the contextual stability of mind-mindedness, and thus, should be used to do so. First, proportions of mind-related comments should be compared between structured play sessions and the current study's segments of natural play videos, in which dyads naturalistically engage in multiple activities (e.g., object play, feeding). This comparison will provide preliminary evidence as to whether mothers' mind-related comments in a standardized play session, the context of many prior studies' measures of mind-mindedness, are continuous and stable with those from naturalistic interactions in the home environment. Additionally, proportions of mind-related comments from segments of book reading and object play from natural play videos could be

compared to segments of the same length from the structured play session. These findings would then indicate whether mind-mindedness is contextually stable across individual contexts and would have implications for future measurement of mind-mindedness. Laranjo et al. (2010) suggested that caregivers' mind-related comments in different contexts may differentially predict developmental outcomes; however, this suggestion was made without any empirical data of whether mind-mindedness is stable across contexts. If, when measuring mind-related comments across contexts, results indicate that they may not be contextually stable or continuous, then Laranjo & colleagues' (2010) proposition may be accurate, and thus, future investigations should choose a context for measuring mind-mindedness based on the developmental outcome of interest (e.g., book reading for language outcomes).

Conclusions

Overall, this study's results add to prior investigations examining the relation between mind-mindedness and vocabulary outcomes. The current study did not indicate an association between appropriate maternal mind-related comments and receptive or expressive vocabulary, and as the first to explore toddlers' negative affect as a moderator between mind-mindedness and language outcomes, did not find an interaction effect between mind-related outcomes and negative affect in explaining toddlers' expressive vocabulary. However, exploratory analyses pointed to a positive relation between mind-related comments and expressive vocabulary for the 24-month age group and a negative association between toddlers' time with other caregivers and their expressive vocabulary scores. These findings are informative for multiple reasons. First, they add to evidence that the association between mind-mindedness and language outcomes might be predictive but not concurrent or that a concurrent relation does not appear consistently until after the second year of life. Second, the lack of an interaction between mind-related

comments and toddlers' negative affectivity, despite prior studies' interactions between similar constructs, signifies the need for re-examination in an older and larger sample of toddlers. Most importantly, these results demand a more definitive understanding of the circumstances in which a significant relation between mind-mindedness and vocabulary appears, which can be accomplished in part through greater insight of the contextual stability of mind-mindedness.

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TABLES

Table 1

Sociodemographic Characteristics of Mothers

Characteristic	*n*	%
Age[a]		
20-30	16	17.0
30-40	65	69.2
40-50	8	8.5
Race		
White	83	88.3
Black or African American	4	4.2
Asian	1	1.1
More than one	4	4.3
Other	2	2.1
Ethnicity[b]		
Hispanic or Latino	5	5.3
Not Hispanic or Latino	87	92.6
Highest level of education[b]		
Some college	2	2.1
Associate's	1	1.1
Bachelor's	29	30.9
Master's	36	38.3
Professional degree or doctorate	24	25.5
Employment		
Employed	74	78.7
Unemployed	20	21.3

[a]Five mothers did not report. [b]Two mothers did not report.

Table 2

Descriptive Statistics of Predictor and Outcome Variables

	M	*SD*	Range
Maternal total comments	96.6	28.2	15.0-180.0
Maternal tokens	481.6	215.4	50.0-1082.0
Appropriate mind-related comments[a]	12.5	6.4	0.0-29.6
Total mind-related comments[a]	12.7	6.3	0.0-29.6
Non-attuned mind-related comments[a]	0.1	0.8	0.0-6.7
Child receptive vocabulary (MBCDI)[a]	23.49	14.17	0.0-55.0
Child expressive vocabulary (MBCDI)[a]	22.9	25.7	0.0-92.0
12-months	2.5	2.1	0.0-11.0
18-months	20.7	12.3	4.0-47.0
24-months	54	23.6	9.0-92.0
Child negative affect (ECBQ)	2.5	0.6	1.1-4.7
Child effortful control (ECBQ)	4.6	0.6	3.3-6.4
Child surgency (ECBQ)	5.1	0.7	3.6-6.8

[a]Reported as percentages.

Table 3

Zero-order Correlations Between Maternal and Child Variables

	1	2	3	4	5	6	7	8
1. Appropriate mind-related comments	-							
2. Maternal age	.07	-						
3. Maternal education	.23*	.34**	-					
4. Maternal employment	.21	.15	.29**	-				
5. Child time with other caregivers	.14	.26*	.41**	.71**	-			
6. Child negative affect (ECBQ)	-.01	.04	.003	-.07	-.12	-		
7. Child surgency (ECBQ)	-.04	-.01	-.14	.15	.01	-.17	-	
8. Child effortful control (ECBQ)	.09	.03	-.07	-.17	.12	-.15	.25*	-

Note. Pearson's Correlation Coefficients are underlined; Spearman's Correlation Coefficients are not underlined. "Unemployed" was dummy coded as 0; "Employed" was dummy coded as 1.
*p < .05. **p < .01.

FIGURES

Figure 1

Scatterplot of Appropriate Mind-Related Comments and Receptive Vocabulary

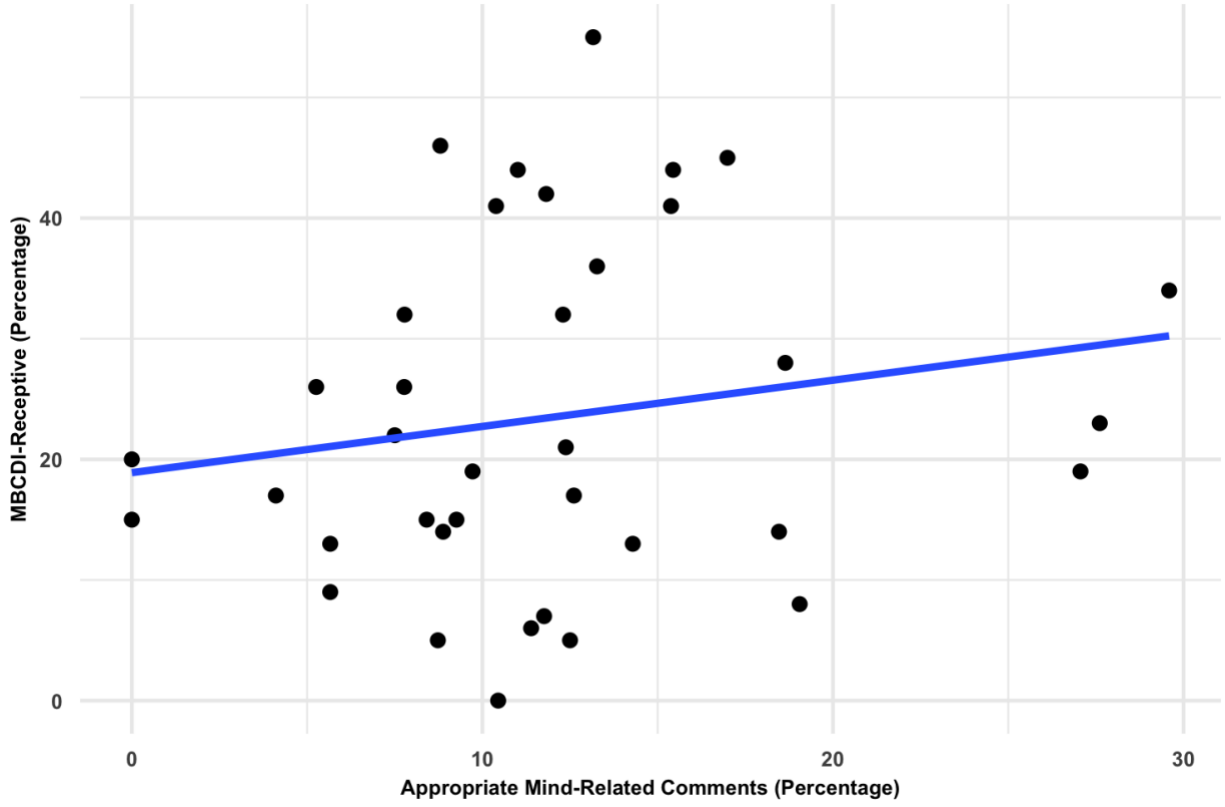


Figure 2

Scatterplot of Appropriate Mind-Related Comments and Expressive Vocabulary, Holding Child Age Constant

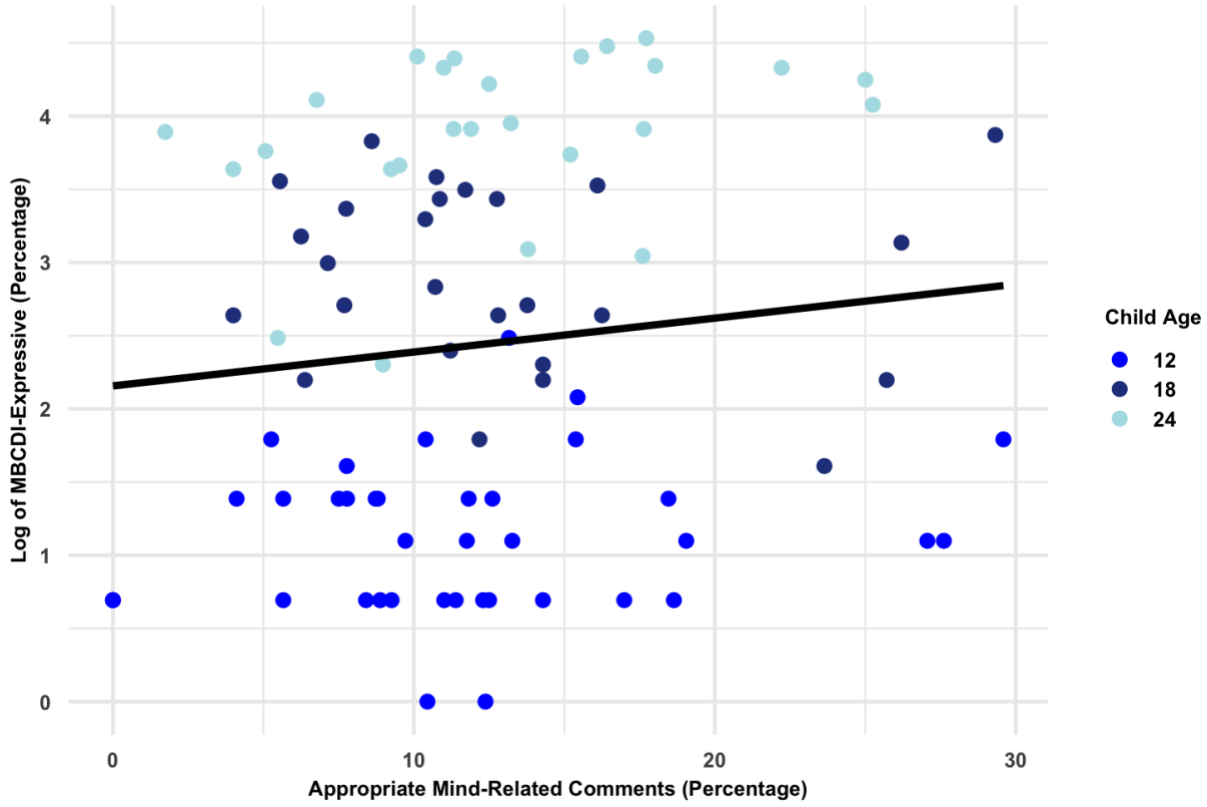
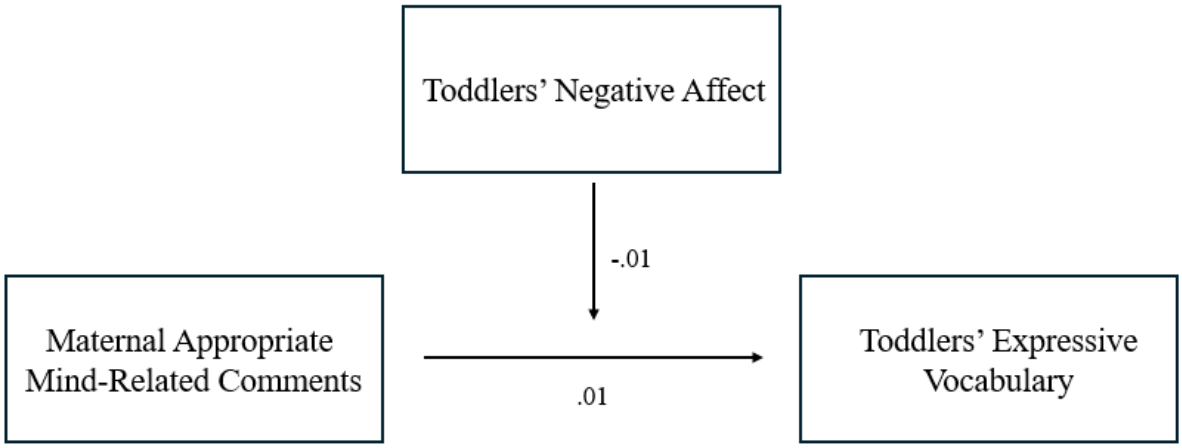


Figure 3

Moderation Model for Hypothesis 2



Note. Statistics are unstandardized regression coefficients.

Figure 4

Scatterplot of Appropriate Mind-Related Comments and Expressive Vocabulary by Child Age Group

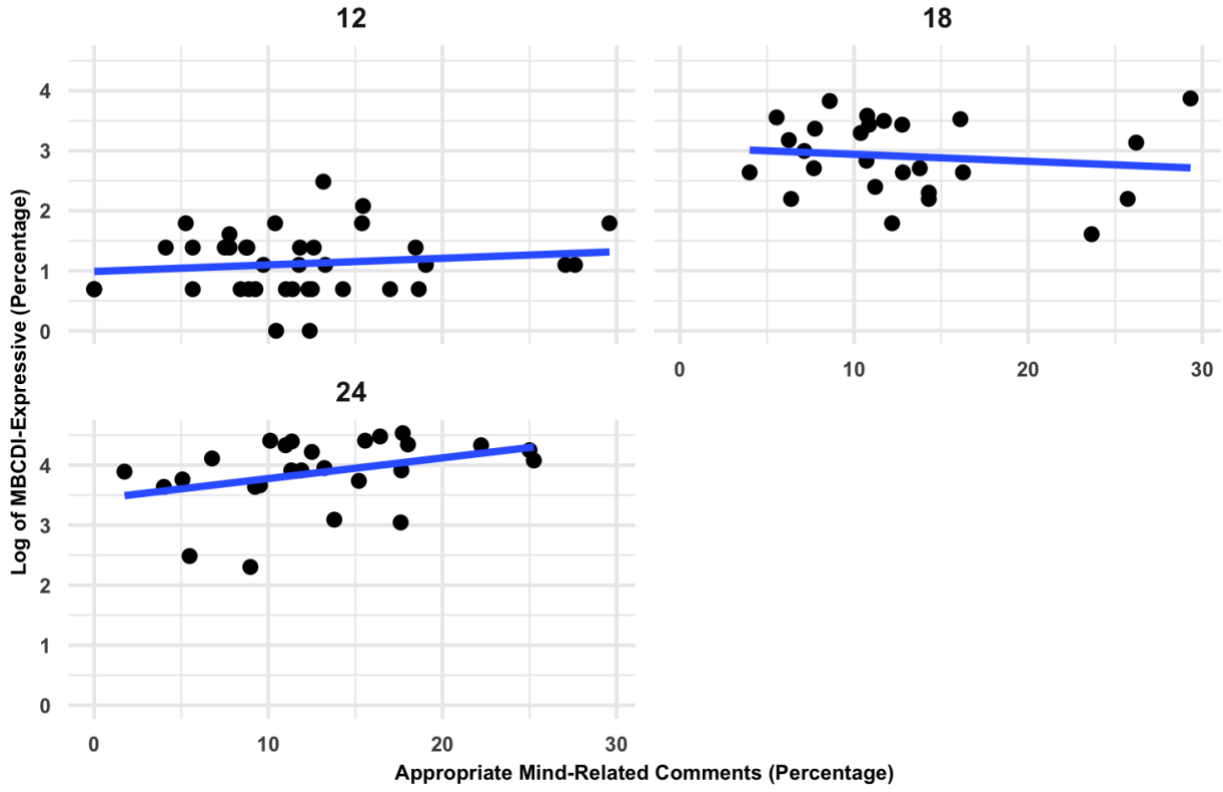


Figure 5

Scatterplot of Time with Other Caregivers and Expressive Vocabulary, Holding Child Age Constant

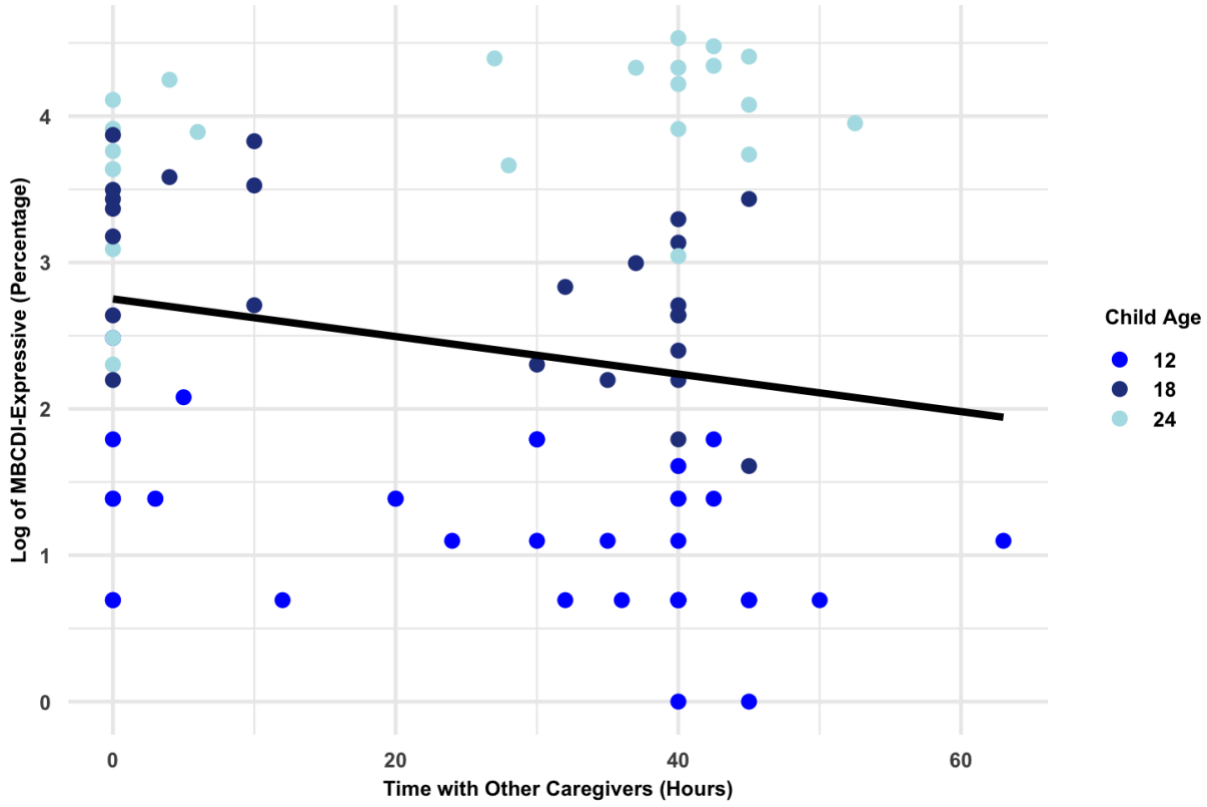
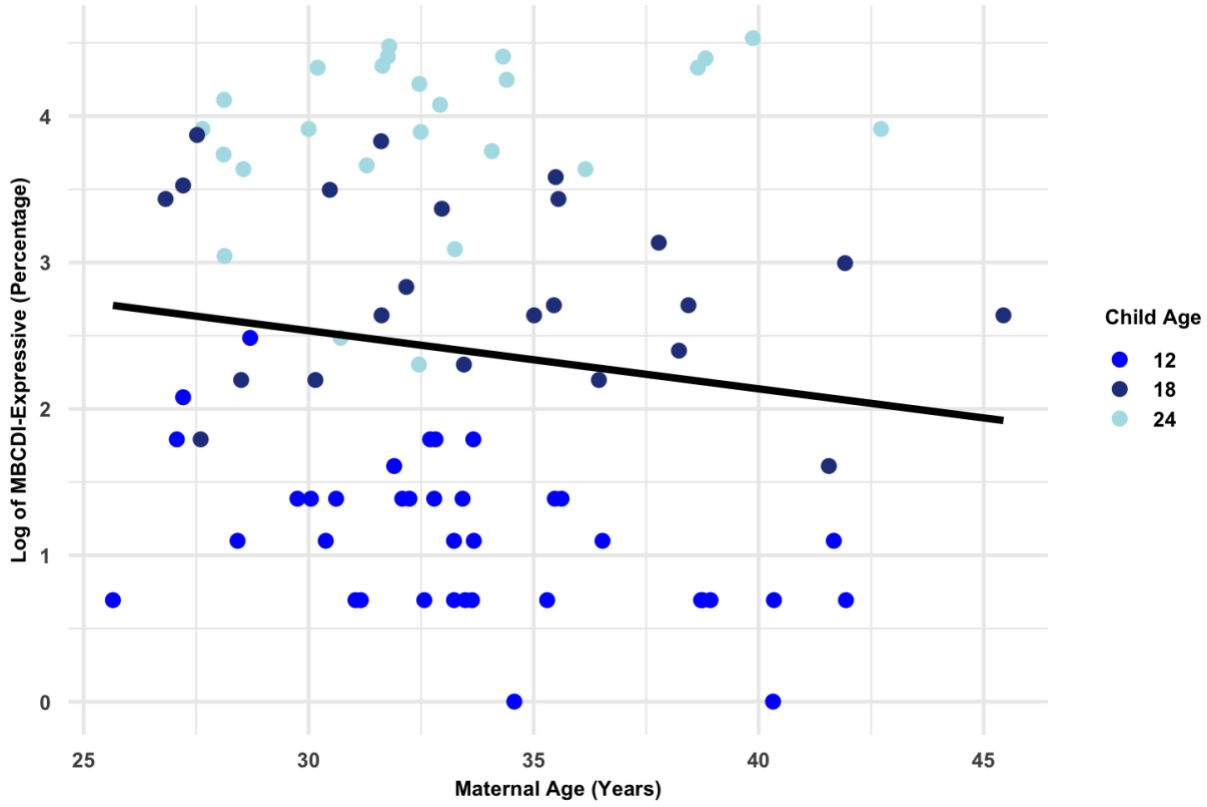


Figure 6

Scatterplot of Maternal Age and Expressive Vocabulary, Holding Child Age Constant



APPENDICES

Appendix A

Pp. 5-12 of "Mind-Mindedness Coding Manual" (Meins & Fernyhough, 2015)

Identifying Mind-Related Comments

The transcript can then be used to identify all comments which focus on the child's internal states. We have defined mind-related comments as any comment that (a) uses an explicit internal state term to comment on what the infant may be thinking, experiencing, or feeling; or (b) 'puts words into the infant's mouth' with the caregiver talking on the infant's behalf. Comments in the latter category do not necessarily have to contain an internal state term (although they often do), but should clearly be dialogue intended to be spoken by the infant (e.g., "That's a teddy bear, Mummy"). Although sometimes one feels that other types of comment produced by the caregiver may indicate treating the infant as an individual with a mind, in order to obtain the most valid and reliable coding scheme, only comments falling into categories (a) and (b) above are classified as mind-related. The comments listed below are not intended to be an exhaustive list of all possible mind-related comments, but rather reflect the comments that have been observed in our research. The comments below should, however, give sufficient guidance on how different types of comment should be coded if researchers encounter different mind-related comments in their own observations.

Desires and Preferences

Like, dislike, don't like, love, want, prefer, favourite, hate, can't stand, "are you after the ball?" (in the sense of wanting to get the ball).

Cognitions

Think (but see Non-Specific References to Infant's Internal States in Section 3.1.3 below for "what do you think?"), decide, making a decision, know, recognise, remember, recall, realise, interested, not interested, notice, focused, intent, expect, working it out, fascinated, obsessed, curious, nosy (in the sense of being interested in or curious about something).

Emotions

Had enough, fed up, shy, solemn, self-conscious, happy, sad, scared, afraid, joyful, gleeful, full of the joys of Spring, serious, grumpy, stressed, moody, in a good/bad mood, stroppy, being difficult, worried, anxious, dazed, confused, excited, cross, not feeling yourself, startled, make you jump, surprised, disgusted, bored, angry, bad tempered.

Epistemic States

Teasing, playing games with me, joking, having a joke, playing a joke.

Talking on the Infant's Behalf

Any utterance that is obviously meant to be dialogue said/thought by the infant.

Comments That May or May Not be Mind-Related

Physical States

If the caregiver comments on the infant's physical state (e.g., tired, hungry, thirsty, hot, cold, etc.) in response to a behaviour from the child indicating that such a reading of their physical state is warranted (e.g., yawning or rubbing eyes to indicate tiredness, rooting or chewing hands to indicate hunger), then these comments should not be coded as mind-related. The caregiver may also talk about being tired or hungry in the context of pretending to eat or sleep, and these should not be coded as mind related. However, if the caregiver states that the child is tired, hungry, etc. in the absence of any accompanying signs of such a state from the infant, then these comments should be coded as mind-related (and will always be coded as non-attuned).

Funny/Amusing

Fun, funny, and amusing should be coded as mind-related comments if the caregiver uses these terms in response to the infant finding something fun/funny/amusing or doing something funny/amusing (as indicated by positive affect in the infant). Comments such as "that's funny/fun/amusing" that refer to other events and which impute no positive affective response to the child should not be coded as mind-related.

Clever

If clever ("you're clever", "that's clever" "clever girl/boy") is used in response to the child performing some skilful behaviour (e.g., manipulating a toy, performing a behaviour in response to a request from the caregiver) it should be coded as a mind related comment. If clever

is used merely to give positive feedback for generally behaving well ("clever girl/boy"), where a purely non-mentalistic interpretation is possible, it should not be coded as mind-related.

Cheeky

Cheeky ("you're cheeky", "that's so cheeky", "you're a cheeky boy/girl") may be mind-related if it is used in response to the child doing something that can be construed as teasing, playful, or against the instructions of the caregiver (e.g., repeatedly putting a toy in their mouth when the caregiver has moved it away and/or asked them not to, repeatedly looking at or for something when the caregiver is trying to focus their attention elsewhere, knocking over a block tower). Note that the child's emotional tone should be positive in order for cheeky to be mind-related (e.g., the child smiling, making eye contact with the caregiver). If cheeky is used more generally (e.g., "cheeky boy/girl") and is not in response to any clear teasing or playful behaviour, it should not be coded as mind-related.

Intentions

Going to (e.g. "Are you going to play with the car?", "What are you going to do?") should not be coded as mind-related. Trying to should be classified as mind related if the caregiver also specifies the precise goal that the child is trying to achieve (e.g., "Are you trying to get the block through the hole?"), but general uses of trying to (e.g., "What are you trying to do?") should not be coded as mind-related.

Comments That Are Not Mind-Related

Perception

Comments about seeing, watching, looking, listening, touching, tasting should not be classified as mind-related.

Saying/talking

Comments about the infant saying something or talking (made in response to vocalisations from the infant) should not be classified as mind-related (e.g., "Are you talking to me?", "What are you saying?"). However, if the caregiver goes on to talk on the infant's behalf and conjecture what the child might be saying, then this is coded as mind-related (see 3.1.1 above).

Non-Specific References to Infant's Internal States

Comments which indicate that the caregiver has noted a change in the infant's internal state, but do not reflect the specific state being experienced (e.g. "What's the matter/wrong/up?", "Are you all right/OK?", "Is that better?") should not be classified as mind-related. Comments such as "Is that nice/good?" or "That's nice/good" should not be classified as mind-related. The non-specific use of think in the phrase "What do you think?" should not be coded as mind-related.

Classifying Mind-Related Comments as Appropriate/Non-Attuned

Once all mind-related comments have been identified on the verbatim transcript, they can be coded dichotomously as appropriate/non-attuned by viewing the recorded infant–caregiver

interaction. We recommend that researchers coding appropriateness watch the whole of the observation session rather than fast forwarding to each of the specific mind-related comments. It is important to have a sense of the infant's emotional state and the types of play engaged in throughout the session to aid one's judgement of the appropriateness of any specific mind-related comments produced.

Repetitions of specific internal states are counted as separate mind-related comments unless a term is repeated in rapid succession. For example, if a caregiver was observing her child playing with a toy and said, "You like that. (1s pause) Yes, you like that", this would be two mind-related comments. However, if the caregiver had said, "You love, love, love that", this would be one mind-related comment.

Criteria For Appropriate Mind-Related Comments

Mind-related comments should be coded as appropriate if any of the following criteria are met:

(a) the researcher agrees with the caregiver's reading of the infant's current internal state. For example:

a. You want the frog (said while infant is reaching towards the frog)

b. The ball is your favourite thing, isn't it? (after the infant has demonstrated a repeated preference for playing with the ball)

c. Are you thinking? (said while the infant has a pensive expression)

d. You don't like that one (after the infant has rejected a toy by pushing it away)

e. You're fascinated by those animals (after infant has been focused intently on playing with the animals for several minutes)

f. You're such a happy boy (said while infant is laughing or smiling)

g. Are you going all shy? (after infant coyly turns away)

h. Did that scare you? (after infant was startled by a noisy toy)

i. Are you playing games with me? (after infant has repeatedly disobeyed the caregiver's request not to put a toy in his mouth, smiling at her each time he raises the toy to his mouth)

(b) the comment links current activity with similar events in the past or future. For example:

a. Do you remember seeing a camel at the zoo? (while the child plays with a toy camel)

b. You liked going in the car today, didn't you? (while playing with a car)

c. Do you want to go on the train tomorrow? (while playing with a train)

d. You recognise this because you've got the same one at home

e. You like red, don't you? (Note that comments such as these where the caregiver is drawing on the child's previous preferences over an extended period of time should be coded as appropriate even if the child hasn't obviously demonstrated a liking of red in the play session. These are deemed appropriate because the caregiver is assumed to have previously observed such a preference in the infant and is therefore predicting that he or she will continue to like or dislike new items on this basis. However, if the infant's behaviour is obviously at odds with such a comment, then it should not be coded as appropriate.)

(c) the comment serves to clarify how to proceed after a lull in the interaction. For example, if the infant has been gazing around for several seconds, not focused on any particular object or event, then a comment such as Do you want to play with the farm? would be appropriate. Note that such a comment would be non-attuned if the caregiver asked this while the child was already actively engaged in attending to or playing with something else.

Criteria For Non-Attuned Mind-Related Comments

Mind-related comments should be coded as non-attuned if any of the following criteria are met:

(a) the researcher disagrees with the caregiver's reading of the infant's current internal state. For example:

a. You're bored with that one (referring to a toy with which the infant is still actively playing)

b. You really like the duck (after the infant has shown no interest in or positive affect towards the duck)

c. Are you tired? (after the infant has shown no overt signs of tiredness) d. Grumpy boy (when the infant appears to be in a good mood)

(b) the comment refers to a past or future event that is unrelated to the infant's current activity. For example:

a. Would you like Granny to come and see you tomorrow? (having not previously mentioned Granny)

b. Do you want custard for dinner? (after no previous play or discussion focused on food)

c. Do you want to go swimming when we go on holiday? (after no previous play or discussion about holidays or swimming)

(c) the caregiver asks what the infant wants to do or suggests that the infant wants to become involved in a new activity when the infant is already actively engaged in playing with or attending to something else.

(d) the caregiver seems to be attributing internal states (epistemic states, emotions or desires) that are not implied by the infant's behaviour and which appear to be projections of the adult's own internal states onto the child. For example:

a. Are you thinking about Daddy who you love so much?

(e) the referent of the caregiver's comment is not clear. For example:

a. You like that (when the infant is not playing with or attending to any particular object or event)

Appendix B

Transcript Editing and Comment Division Guidelines

1. *Never* guess whether the onset of a mother's speech is at or more than one second from the last offset of her speech. Check the seconds/milliseconds in Datavyu.
2. Guidelines for transcribing speech directed at a person, animal, or object:

- Do *not* transcribe speech directed at the experimenter
- Speech directed toward a pet or object *is* transcribed

3. General rules for noises:

- Noises should *always* go in parentheses
- If a mother intends to make a noise (e.g., kissing the baby on top of the head and saying "Mwah"), that is transcribed. If it is vegetative (sneezes, coughs, hiccups, etc.), do not transcribe. For all noises, the same rules of comment division apply. If a mother is making an intentional noise, and stops for a second or longer and resumes, start a new comment.

  Examples of noises that *are* transcribed:

  - Noises with a phonetic structure (e.g., lalala, mwah)
  - Gasps
  - Humming

  Some specifics of noises that are *not* transcribed:

  - Laughing (unless it is very exaggerated and intentional)
  - Sneezing
  - Coughing
  - Hiccuping

- Burping
- A noise that is simply a consequence of an action (e.g., Mom kisses her baby on the head and it makes a noise, but she does NOT say “Mwah”)

4. If a mother is singing and you can understand what she is singing, try your best to transcribe the words. This may take listening to this segment many times. If you cannot understand what she is singing, note (Mom singing) in parentheses, using the same one-second rule for comment division.
5. If a mother is reading a book, do your best to understand what she is saying as she reads. Use the one second rule to divide into comments.
6. If a mother is talking with a noise in the middle (e.g., she says something, loudly gasps, says something else), only divide into separate comments if there is a minimum of one second before and after the noise.
7. In an instance where you cannot understand what a mother is saying and have listened to the segment at least several times, note as “inaudible” in parentheses. Important: in the case that a mother’s inaudible speech is separated by a one second pause, the rules for dividing “inaudible” comments are the same as regular comments. However, “inaudible” must go in parentheses: if the word(s) cannot be distinguished, it will not be included in the mother’s total word count.

Appendix C

Supplementary Results of Exploratory Analyses

In assessing assumptions of regression, four residuals in the model examining mind-related comments and proportions of expressive vocabulary scores for the 24-month age group skewed the normality of residuals and thus, greatly stood out in diagnostic plots. Therefore, supplementary bivariate regressions without these values were completed.

Bivariate regressions tested the relations between appropriate and total mind-related comments and expressive vocabulary in the 24-month age group. There was a positive association between the proportions of appropriate, $b = .02$, $t(20) = 2.39$, $p = .027$, and total, $b = .02$, $t(20) = 2.39$, $p = .027$, mind-related comments and the proportion of expressive vocabulary words. In their respective models, proportions of appropriate and total mind-related comments each accounted for 22.18% of the variance in expressive vocabulary scores.