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AGE-RELATED CHANGES IN CHILDREN'S SPEECH CONTENTS DURING A FRUSTRATING TASK AND THEIR RELATIONS TO NONVERBAL ANGER EXPRESSIONS IN EARLY CHILDHOOD

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Abstract

Before the development of language, very young children express their difficulty waiting for something they desire through nonverbal anger. However, as children transition from toddlerhood to preschool age, the nonverbal anger intensity decreases and they appear better able to cope with frustration; theoretically, these developmental changes are partly due to growth in language ability (Kopp, 1989). Although relations between early language abilities and self-regulation are found in correlational research, *how* language contributes to emotion regulation remains an open question. This thesis examines age-related changes in children's spontaneous speech during a frustrating task and tests whether two different types of speech content account for a developmental decrease in nonverbal anger intensity in early childhood. Longitudinal data from 120 mother-child dyads from children (46% girls; 93.3% White) at ages 2, 3, 4, and 5 ½ years is used to test (a) how children's nonverbal anger intensity and speech content change with age and (b) how these two aspects of behavioral change relate to each other. Dyads participated in an 8-minute wait task at each age, during which mothers told children to wait to open a gift until mothers finished their work (completing questionnaires). Key variables are children's nonverbal anger intensity and spontaneous speech (either about task demands or unrelated to them) frequency at each age point. Multilevel models show 1) age-related decreases in anger intensity, 2) curvilinear change in the frequency of speech about task demands, which becomes more frequent between ages 2 and 4 years then drops by age 5 ½, and 3) linear increase in speech unrelated to task demands between ages 2 and 5 ½. Both types of speech are related to anger intensity, controlling for children's language ability, but speech unrelated to task demands better predicts this decline compared to speech about task demands. Results suggest children's strategic use of spontaneous speech unrelated to task demands may reflect self-regulation

strategies that help children cope with frustration. The findings imply one way that language supports young children's emotion regulation development. Future directions involve more nuanced classification of the two types of spontaneous speech content.

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Introduction

Self-regulation of emotion continuously develops in early childhood and around the age of 3 and 4 years, young children show increased ability to modulate and maintain emotional expressions in the face of situational challenges. Kopp (1982, 1989) postulated that this early emergence of deliberate, autonomous self-regulation of emotion is due in part to the development of children's intrinsic resources (i.e., attentional control, motor, cognitive, and language skills). The long-term positive implications of self-regulation of emotion in early childhood include school readiness, both in terms of socioemotional and academic competence (Blair et al., 2015; Harrington et al., 2020), and in adolescence, better psychological adjustment (Perry et al., 2020). To observe the early emergence of self-regulation of emotion, young children often participate in laboratory situations known to evoke prepotent negative emotions, such as anger and sadness associated with frustration (e.g., Goldsmith et al., 1995; Kim et al., 2022). In these situations, young children are observed to engage in various strategies that are thought to regulate anger, an assumption typically based on an inverse relation between use of certain strategies and expression of anger (Calkins & Johnson, 1998; Cole et al., 2011). In frustrating situations that children cannot control, they engage in an increasing number of different strategies, including calmly asserting their needs to a parent or distracting themselves, strategies that involve language and/or narrating their play which also involves attention control (Cole et al., 2010; Posner & Rothbart, 2000). That is, some of their self-regulatory strategies involve speech (Cole et al., 2017; Gilliom et al., 2002). Although language is thought to play a role in self-regulation of emotion (e.g., Kopp, 1982, 1989), how language is used in self-regulation tasks is rarely studied (Cole et al., 2010).

Evidence of associations between language ability and emotion-related behaviors provides indirect evidence of a direct link for the purported value of language development for emotion regulation (Cole et al., 2010). For example, children with language disorders have a higher probability of behavior problems, which often entail poor anger regulation, and children with behavior problems have a higher probability of language disorders (Curtis et al., 2017; Goh et al., 2021; Helland et al., 2022). On the other hand, preschoolers' higher language ability measured via standardized tests is associated with higher teacher-rated emotion regulation (Reilley & Dow, 2019). Longitudinal studies also suggest links between language and emotion regulation. Toddlers with larger expressive vocabulary size appear better regulated during psychological testing at 36 months, after controlling for talkativeness and general cognitive performance (Vallotton & Ayoub, 2011). Similarly, a composite index of language abilities at age 18 months, and the slope of language growth from 18 to 48 months, are linked to a steeper decline in anger reactivity to frustrating tasks and in part due to the emergence of certain self-regulation strategies, such as verbal bids to a parent and distraction (Roben et al., 2013). Thus, the relation between language and emotion-related self-regulation emerges in early childhood.

However, despite the prevailing views that language is advantageous to emotion regulation, there is surprisingly little direct developmental evidence to evaluate ***how*** children use language to regulate emotions. Such evidence is needed to fill a gap in knowledge and to guide practice. Socioemotional intervention and prevention programs (e.g., Bierman et al., 2008) teach children to use words to convey their thoughts and feelings rather than act on them with high intensity nonverbal emotion and potentially inappropriate behaviors, although the specific contribution of this technique has not been demonstrated. A deeper understanding of how language can support emotion regulation development is needed to better assist parents and

teachers how best to support children with self-regulation development. By examining the content of what children say we can understand whether and how language, as represented by spontaneous speech, plays a role in emotion regulation. Especially in early childhood, when children often speak aloud not only to themselves but to others, investigation of their speech content may provide insights into their thoughts and feelings (e.g., Day & Smith, 2013). Importantly, we need to understand how their use of speech relates to nonverbal emotion expressions, one way to yield more direct evidence of links between language and emotion.

Language and Anger Regulation Development in Early Childhood

Language is a symbolic representation of internal thoughts that serves the function of communicating, including communicating internal experiences such as thoughts and feelings, (Vygotsky, 1934/1962). Yet, before children use words, they communicate through nonverbal emotion expressions (Barrett & Campos, 1987). The most often studied emotion in early childhood is anger, due to its association with undesirable behaviors such as aggression and defiance. The functional theory of emotion defines anger as the appraisal that a goal is blocked and readiness to act with increased effort to overcome the obstacle (Barrett & Campos, 1987; Saarni et al., 2007). Anger peaks as toddlers become able to walk, to better manipulate objects, and act with agency, and declines as children become able to use words (Barry & Kochanska, 2010; Roben et al., 2013). There are individual differences in the rate of growth of emotion regulation when frustrated that are associated with language ability as well as with parenting behavior (Bendezú et al., 2018).

As children age and experience rapid development in language ability, it is postulated that preschool age children begin to communicate about their problems verbally, to label and understand emotions using words, and to regulate emotions in ways that involve speech (Cole et

al., 2010; Luria, 1961; Kopp, 1989). Although it is possible that a decline in anger expression over the course of early childhood is due to decreased anger reactivity, rather than regulation of anger, we cannot discern the differences without assessing the impact using language as a regulatory strategy has on developmental changes in anger. In general, as part of cognitive development, it is assumed that children learn the utility of verbal communication to express their needs, thoughts, and feelings without intense nonverbal emotion expression (Gopnik & Meltzoff, 1986; Hoff, 2013). Thus, an alternative explanation for the decline in nonverbal anger may be age-related growth in the ability to verbalize what is problematic in a frustrating situation, potentially resulting in less need to express nonverbal anger as much. Moreover, age-related growth in the ability to verbalize may enhance a putative regulatory strategy such as distraction, which is identified as an optimal strategy for young children in delayed reward, frustrating situations (Cole et al., 2017; Sethi et al., 2000; Supplee et al., 2011). If verbalizing during play is associated with more absorbed play, then it should enhance the value of distraction from a frustrating stimulus for regulating anger.

Meanwhile, while very young children's reliance on nonverbal expressions of anger to convey their needs appears to diminish as they reach their first words and vocabulary spurt, language does not replace nonverbal emotion expressions in young toddlers (Bloom & Capatides, 1987; Bloom & Beckwith, 1989). Whereas earlier children cannot express both verbal and nonverbal communications simultaneously, they become able to use both at the same time, suggesting that language functions as an additional means of expressing needs, thoughts, and feelings (Bloom, 1998). Language may not emerge as a dominant means to communicate, let alone regulate emotions, until after toddlerhood. Across a typical day in a childcare setting, toddlers, even older and verbal toddlers, mostly rely on gestures (e.g., pointing) when they are

distressed (Konishi et al., 2018). Thus, as Kopp (1982, 1989) posits, a transition from nonverbal expression to the use of language to *regulate* anger may appear later in the preschool years.

The Content of Speech and their Relations to Nonverbal Anger Expression

Most studies that examined the role of language on young children's emotion regulation development focus on children's language or verbal ability, such as vocabulary size (Morgan et al., 2015) or expressive and receptive language skills (e.g., MLU, pointing to pictures that match a word) via standardized measures (e.g., Reilly & Downer, 2019; Roben et al., 2013; Rojas et al., 2021; Vallotton & Ayoub, 2011). Although the relation between various indices of language ability and emotion-related behaviors is established, the evidence does not address how young children's language relates to their emotion expression during emotionally challenging situations. If following typical language developmental trajectory, children improve in forming longer sentences with more words and ask descriptive questions by age 3 years (Zubler et al., 2022), which then language should better reflect one's thoughts and strategies to serve the putative regulatory functions. However, there is very little evidence of how the sematic content of young children's speech during emotionally challenging situations and its variations are associated with the emotion expression.

A few studies examine what children say during laboratory-based frustration tasks; they vary in how they categorize children's speech but generally focus on task- or goal-related and task-irrelevant statements (e.g., Day & Smith, 2013; Manfra et al., 2014; Winsler et al., 2003). Task-related speech may or may not refer to the problematic nature of the task situation. Goal-related speech reflects Luria's (1961) framework in which language guides behavior first through overt and later covert self-directed speech, which theoretically is a form of self-regulation (Cole et al., 2010). For example, during a task in which the child's aim of retrieving a preferred toy

from a locked box task but without the correct key, 4.5- to 6-year-olds engage in overt (audible) facilitative task-relevant speech (i.e., appraisal and planning). That task-relevant speech is inversely related to nonverbal anger whereas negative self-statements (e.g., "I can't do it") is associated with more nonverbal anger (Day & Smith, 2013). Thus, speaking may add to expressing frustration and not replace anger.

There remains a need to understand whether the developmental decline in anger reactions (Barry & Kochanska, 2010) is related to developmental changes in the types of spontaneous speech children utter during laboratory frustration tasks. In this way, we can address the extent to which the content of speech (a) changes with age and (b) whether age-related changes in the content of speech are associated with the developmental changes in nonverbal anger expression. The latter question includes addressing whether certain forms of speech, e.g., verbalizing about the frustrating situation, co-occurs with anger or replaces it over the course of early childhood. These questions are best addressed in a longitudinal design, but no longitudinal studies are available to address them. A longitudinal study from our lab finds that bids for maternal attention during toddlerhood (at 18 and at 24 months) co-occur mainly with nonverbal anger expressions, but by 36 months those bids shift to occurring more often with calm (happy or non-emotional) expressions, an effect which increases further by age 48 months (Cole et al., 2011). However, that study does not distinguish between verbal and nonverbal bids or consider the content of children's verbal bids. Therefore, whether the decline in nonverbal anger expression is related to developmental changes in the content of speech remains to be determined.

As children get older and are better able to use words to describe their thoughts and feelings, they show an increase in behaviors that resembles thinking out loud. Most of the related evidence comes from studies of young children's private speech which increases during the

preschool years but overt private speech becomes less common as children enter school (Winsler et al., 2000; Winsler & Naglieri, 2003). Less is known of other types of speech, such as social speech that is directed to others and not to themselves. Among young children, it is commonly observed where children use language to describe their own and others' behaviors and inquire information from their environment. When children are made to wait for a reward, verbalizing about the problems of situations that make them frustrated is commonly observed (i.e., "When can I open the gift? Is it time yet?") and possibly more so when their language ability is going through rapid development period between the ages of 2 and 3 years. It is possible that children may display less anger as they may be better expressive and understood through their words (Kwon et al., 2013) than with nonverbal anger expression; parents are less likely to respond verbally to toddlers who express nonverbal negative emotion and more likely to respond to toddlers' verbal communications, including babbling (Fields-Olivieri & Cole, 2019). Thus, socialization practices may communicate a preference for speech than nonverbal emotion as a way of communicating.

However, anecdotally we observe that children do not only verbalize about task demands during frustration tasks. They also refer to events and objects that are not part of the task demands. In our procedure, a parent is in the room but busy and rarely interacts verbally with the young child, even when children ask a question (e.g., "After this can we go to McDonald's?"). Often, their speech unrelated to task demands appears self-directed; for example, we frequently see them narrate their play activity. Potentially, talking about matters unrelated to the task demands represents a way that language supports distraction, i.e., shifting of attention away from task demands (e.g., the delayed reward) and to some other activity. Children as young as 3 years engage in distraction in delayed reward tasks designed to evoke frustration (Kochanska et al.,

2001; Lougheed et al., 2019; Supplee et al., 2011). As children become able to distract themselves away from objects they desire but must wait for, they can use their language skills in ways that support their attention control, i.e., distractions. A longitudinal study in our lab found that 18-month-olds' level of language skills and steeper rate of language growth between ages 18 to 48 months are associated with a steeper decline in anger reactivity during this period (Roben et al., 2013). Moreover, this longitudinal association appears partially attributable to children's use of bids to the mother at 36 months and use of distraction at age 48 months, two putative emotion regulatory strategies. As children learn to wait for the delayed reward, they engage in activities like singing, reading posters on the wall, imaginative play, or try to talk to their mothers about topics irrelevant to the situation they are in, which all involve use of language. However, how children use speech while they distract themselves in a frustrating situation is not well known. When task-irrelevant speech is studied, it is typically assessed in relation to completing a task and is inversely related with goal-directed activity (Winsler et al., 1999; Thibodeaux et al., 2019) and occurs infrequently among school age children (Al-Namlah et al., 2006). It is unclear how children may speak about topics unrelated to the demands of the task as they transition from toddler to preschool age—e.g., they may talk to their mother about planning a future event or they may talk to themselves as they engage in imaginative play. The question then is whether either or both of these are associated with an age-related decline in nonverbal anger.

Thus, where earlier in childhood, children come to be able to integrate verbal and nonverbal expressions of emotions or needs, in the preschool years, children may begin to use language as a substitute for, or a strategy to modify, anger. For example, they may state their needs without expressing anger and/or they may use language to speak about other matters.

Thus, it may be that over the course of early childhood, the use of language during a frustrating situation may state the problem and replace nonverbal expression of anger or may support distracting the attention away from the problem and contribute to the decrease in anger expression. If so, age-related increases in verbalizations that are unrelated to the task demands of waiting should be associated with age-related decline in nonverbal anger expression. Specifically, if children verbalize aloud about their play activity or talk about topics other than the demands of waiting, such as recalling or anticipating future events, this could be linked to less nonverbal anger. Attempting to converse with their mothers (as in our version of the wait task) about subjects unrelated to waiting may also help them to distract from the waiting demands, and thus support anger regulation.

Covariates

Various environmental factors and child characteristics influence children's language development, which potentially influences relations between spontaneous speech and anger expression. Namely, birth order, socioeconomic status (SES), and gender are associated with language development.

Early work on the effects of birth order suggests that first-borns have an advantage in language development relative to later-born children, such as a larger vocabulary and more developed lexical and grammatical knowledge (Hoff-Ginsberg, 1998). First-borns tend to understand and produce more words than later-borns and reach verbal developmental milestones faster than their siblings (Berglund et al., 2005; Bornstein et al., 2004). Similarly, children from families with higher SES demonstrate linguistic advantage compared to their less resourced peers (Hoff-Ginsberg, 1998), represented by gaps in vocabulary size, grammatical understanding, the amount and frequency of syntactic complexity, and oral comprehension (Hoff, 2006). Although,

SES may influence children's language growth in different ways (i.e., mediated through caregiver speech, greater amount of word and variability in types of word; Hart & Risley, 1995; Huttenlocher et al., 2010), the association between SES and language development is well established (Hoff, 2013). In the present study, the children and mothers were from economically strained households, a not well-understood group of families. Economic strain is defined by household income (all sources) being above the federal poverty threshold level but below the national median income. That is, economically strained families lack the range of resources and advantages that are associated with middle and higher income. These factors can impact children's language development which may influence the extent to which children engage in spontaneous speech, using language as a tool to express needs and ideas and as a way to support shifting attention away from a blocked goal. Finally, gender continues to be identified as a child characteristic associated with variations in language growth. Girls tend to show earlier emergence and faster growth of language (Fenson et al., 1994), greater vocabulary size (Vallotton & Ayoub, 2011), and syntactic complexity (Bouchard et al., 2009). An epidemiological study also suggests male gender as a significant predictor of late language emergence at 24 months of age (Zubrick et al., 2007). Some studies report gender differences in talkativeness; during toddlerhood, girls tend to be more talkative than boys, which may be due to their higher average language skills (Leaper & Smith, 2004). The difference tends to become smaller and negligible as children age and boys catch up by age 9 years (Rice & Hoffman, 2015). Results from a meta-analysis (Leaper, 2014) suggests that when mothers are present, the gender difference effects become stronger, such that girls become more talkative with their mothers than boys are and are generally more disclosing of their feelings and thoughts. Therefore, girls may be more likely to use overt speech as they regulate frustration than do boys.

While not one factor drives the differences in language development, the language learning environment elicited by such environmental factors or gender socialization can reduce the opportunity for language growth for some, which can influence how language may support emotion regulation development as purported by Kopp (1982). To account for the effect of the early language acquisition environment and individual variation in language skills, birth order, SES, and child gender, and language skills were included in the analyses as covariates.

Current Study

In sum, this study investigates the age-related changes in children's spontaneous verbalizations during a frustrating wait task while replicating the age-related decreases in anger expression. Moreover, this study aims to uncover the extent to which age-related changes in young children's use of language during a frustrating wait is associated with their nonverbal expressions of anger. To this end, we use data from a longitudinal study in which children and their mothers participated in a task, at four ages—2, 3, 4, and 5½ years—during which the mother was busy working and told the child that the child had to wait to open a gift until mother finished working. Children had one boring toy in addition to the wrapped gift.

Based on the theory and empirical evidence, we test several hypotheses. Specifically, we hypothesize that:

Hypothesis 1 (H1): As found in previous studies (Barry & Kochanska, 2010; Cole et al., 2011), there is a steady decrease in the intensity of anger expression between ages 2 and 5½ years.

Hypothesis 2 (H2): The content of children's speech changes between ages 2 and 5½ years, specifically:

a) There is a quadratic pattern of changes in speech about the demands of the task (i.e., "When are you done?) between ages 2 and 5 ½ years; specifically, there is an increase in the

frequency of speech about the demands of the task between ages 2 and 3 years as children's use of language increases, but a decline between ages 3 and 5 ½ years as children focus less on the task demands.

b) There is a positive linear relation in other task-unrelated speech that reflects both children's use of speech to narrate their play (i.e., "This is a tennis racket!) and their use of speech to address their mothers while mothers are busy (i.e., "I love you") between ages 2 and 5 ½ years because children's speech shifts from a focus on task demands and to other activities that are regarded as regulating in the presence of a delayed reward.

Hypothesis 3 (H3): Age-related changes in task-related and task-unrelated speech are associated with age-related changes in nonverbal expression of anger, specifically:

a) The decrease in nonverbal anger expression between the ages 2 and 5 ½ years is steepened by age-related quadratic changes in speech about the task demands as speech replaces anger expression to communicate feelings and thoughts.

b) The decrease in nonverbal anger expression between ages 2 and 5 ½ years is associated with the age-related increase in speech unrelated to the task demands because engaging in other activities than the task demands help children shift their focus away from the frustrating demand of waiting.

Methods

Participants

This study uses data collected from a larger longitudinal study examining the emotional and language development of young children from economically strained households (Cole et al., 2011). Families were recruited from rural and semi-rural households using U. S. Census data to target tracts with both a high number of families with young children and a high number of

families with incomes above poverty threshold but below median income. Families who were identified through birth announcements received invitation letters through postal service and others expressed their interest based on posters and flyers distributed to community leaders (e.g., clergy, educators) and at community events. The families had to meet income eligibility criteria, i.e., household income (all sources) below the national median income but above the national poverty threshold for the first year in which they participated. The study protocol was approved by The Pennsylvania State Office of Research Compliance (IRB #: 990642).

As a result, 128 families were enrolled when the child was 18 months of age. The first four families served as pilot cases as procedures were finalized, leaving a sample of 124 families. Children were seen twice at 18 months of age, first during a home visit and then within a week or two in the lab. They were then seen again every 6 months either at home and/or in the lab. Demographic data were collected at child ages 18 months, 30 months, 42 months, and at age 5½ years. The present study uses lab data from ages 2, 3, 4, and 5½ years.

Of the 124 families, four withdrew early in the study phase, leaving a total of 120 children who participated in at least three visits between age 2 to 4 years. The age 5 ½ year visit was not originally planned. For that visit, 99 of the 120 families contributed another visit. The non-returning families either explained that their lives had become too busy or could not be located. Demographic differences between those who continued and those who did not were tested; χ^2 analyses indicate no differences in terms of child racial identity, gender, or birth order, and in terms of parental racial identity, age, education attainment, or family income, ps > .05. Thus, it seems the data are most likely missing at random.

The families were given annual feedback, newsletters, and a graduated compensation amounting to $450 for participating in all visits. The 65 boys and 55 girls, seen within two weeks

of their half or full birthday between 2 and 4 years of age, had mean ages at each time point of 24.39 (SD = 1.3), 36.44 (SD = .80) and 48.33 (SD = .67) months. Families were invited to return when children were between 5 and 6 years of age, because there were funds remaining. The mean age of the 99 children who participated in the final visit (54 boys, 45 girls) was 69.66 (SD = 2.73) months.

Most (93.3%) children were identified as White by their mothers; 6.7% were biracial. Most mothers completed high school (19.2%) or attended (21.7%) or completed college (36.7%). Fathers either completed high school (30.8%) or attended (23.3%) or completed college (26.7%). The family demographics were like earlier visits; most (93.9%) children were identified as White by their mothers; 6.1% were biracial. Most mothers completed high school (18.2%) or attended (22.2%) or completed college (41.4%). Fathers either completed high school (31.3%) or attended (20.2%) or completed college (29.3%).

Procedures

From a set of standard laboratory anger-eliciting tasks administered at each lab visit, this project focused on an adaptation of a waiting task (Vaughn et al., 1984). It was administered at all four age points in this study with little procedural variation. In this procedure, a child's goal to open a gift is blocked by the child's mother who instructs the child to wait to open the gift until she is finished working. Mothers were told about the procedure in advance and that its purpose was to observe how children handled waiting to open the gift. Mothers are asked to keep busy with the work because we are interested in their views about children's waiting behavior. Mothers' work involves a) describing how their child usually handles waiting and whether today's wait is different or similar, and b) rating their own and their children's emotions. Finally,

they are told to do what they usually do when they are busy and their child needs to wait to do something the child wants.

Only procedure materials and wall posters were present in the room. At each age, in the wait task, a research assistant (RA) gave the mother the questionnaires and the child two items—a boring toy: one side of a silent cloth cymbal (age 2), a toy car missing wheels (age 3), a toy horse with missing legs (age 4), and a toy puzzle with missing pieces (age 5½) and a shiny wrapped gift, tied tightly with a ribbon so a young child could not open it, placed on the child's table, saying, "This is a surprise for you." As the RA left, the mother told the child to wait until her work was finished to open the gift. After eight minutes, the RA returned, and the mother let the child open the gift. The wait task was video recorded for later coding.

Measures

Nonverbal Anger Expression

Teams of trained undergraduate coders were trained to accuracy in identifying four basic emotions and rating each emotion's intensity. Child anger expressions during the wait task were coded second-by-second with a coding system based on facial movements (e.g., furrowed brow, square mouth), vocal quality (e.g., plosive, harsh quality), and posture/gesture (e.g., arms akimbo, finger jabbing) to infer anger (Cole et al., 1994). Anger intensity was rated on a 4-point scale (0 = *No sign of any cue for this emotion*, 1 = *Slight intensity*, 2 = *Moderate intensity*, 3 = *Strong intensity*). Anger expression at each age represents the average intensity of anger expressed across the task out of times anger was observed across the children. Inter-rater reliability was based on 20% of cases at each age, assigned to two coders throughout the coding period for each age. Across ages, the average κ for anger expressions ranged from .81 to .93.

Spontaneous Speech Content

Children's verbalizations were transcribed by trained RAs experienced in working with young children. The transcriptions were then coded second-by-second using a binary coding system (0 = *absence* and 1 = *presence*) to categorize speech content as either speech about the demands of the task (e.g., "The toy is boring", "I wanna open it [:gift]", "When are you done?") or speech unrelated to the demands of the task, such as narrating or enacting aloud play activity or speaking to the mother (e.g., "Mom, what is this on my lip?", "I love you", "Is Allison at Nana's house?"). By coding only transcribed speech, the influence of nonverbal emotion on the coding was minimized. If an utterance was longer than a second, only the first second where the verbalization began were coded as 1 and the rest of the duration was coded as 0 to calculate the frequency of speech. Coders also were given other mutually exclusive categories to use to capture vocalizations (e.g., "choo choo") and unintelligible speech that were not analyzed in the study. To establish inter-rater reliability, 20% of the transcripts for all ages were coded by two independent coders. Across ages, the average κ for speech content ranged from .78 to .93. Interrater discrepancies were resolved through discussions after reliability data were calculated. In those discussions, raters examined where the disagreements occurred and reached the consensus which was used in the final analyses.

Covariates

Child Birth Order. The birth order of the target child was coded using a 5-point scale (1 = first born, 5 = fifth or more born).

Child Gender. A binary coding system was used to code for child gender (boys = 0, girls = 1).

Child Language Ability. Different measures reflecting different components of language ability that are developmentally appropriate were used at each age. At child age 2 and 3 years, linguistic complexity was assessed from spontaneous speech produced between parent and child during natural interactions in free play, reading, and clean-up tasks during the laboratory visits. The mean length of utterances (MLU) derived from transcriptions during these tasks were measured as an index of linguistic complexity (Brown, 1973). A language analysis software package, CLAN, was used to calculate MLU for each child (MacWhinney, 2000). By age 4, MLU starts to become a less developmentally sensitive approach to capture children's language ability. Thus, at child ages 4 and 5, a standardized test was administered during the laboratory visits. Children completed the Sentence Imitation and Grammatical Understanding subtests from the Test of Language Development–Primary Third Edition (TOLD–P:3; Newcomer & Hammill, 1997). The scaled scores were summed across and standardized to reflect the level of the language ability at ages 4 and 5.

Income-to-needs ratio (INR). The INR is an index of household income relative to national norms. The total income per household was obtained at child ages 18, 30, 42 months and age 5 ½ years. INR was calculated based on poverty threshold of the year data was collected reflecting the number of family members and children. An INR of 1.0 indicates that the household income (all sources) meets the U.S. government definition of poverty for that year, and an INR of 3.0 indicates that the household income is representative of the middle class. The annual mean INR at each age was 2.32 (SD = 0.87) at 18 months, 2.49 (SD = 1.02) at 30 months, 2.58 (SD = 1.15) at 42 months, and 2.42 (SD = 1.14) at 5 ½ years, indicating economic strain.

Data Analytic Plan

Age-related changes in nonverbal anger expression intensity (anger for brevity; H1) and two speech content types (references to task demands and unrelated to task demands; H2) were examined using multi-level modeling. This method can accommodate dependencies of repeated measurements of individuals. Income-to-needs ratio (INR) at 18 months, gender, and birth order were coded as between-person time-invariant covariates, and language skills at each age as between-person time-varying covariates. Anger intensity (varying from low to high), child gender, and birth order were coded as discrete variables. All analyses were examined using Linear Mixed-Effects Models using Eigen and SE package (lme4; Bates et al., 2015) in R (Version 4.0.3; R Core Team, 2020).

Data preparation. Across four laboratory visits, data from 78% of children (N = 94) is complete and across all variables 93% of data is complete. The following percentages of main study variables were missing during one of the four age points: 5.2% for INR; 6.5% each for child concurrent language ability, speech about task demands, and speech unrelated to task demands; and 13.5% for anger intensity. Reasons that data was missing included technical issues that interfered with video recording (e.g., poor lighting, experimenter error) or unplanned discontinuation of the task (e.g., child noncompliance or notable distress). Little (1988)'s MCAR test was conducted to assess the pattern of missing data, $\chi^2(18) = 20.90$, $p = .29$. This result is consistent with data missing completely at random. Therefore, the analyses used Full Information Maximum-Likelihood estimation (FIML; Arbuckle, 1996) to handle missing data. FIML uses all available information available to estimate parameters to provide unbiased estimates; it is superior to listwise deletion in handling missing data (Enders & Bandalos, 2001).

Descriptive statistics were analyzed and means, standard deviations, and ranges for all variables across ages are reported in Table 1. First, null models were fit across all ages to

calculate the intraclass correlation (ICC) to determine the proportion of variation between individuals in the outcome variables. Next, linear effects over time were analyzed in two models: age-related changes in anger expression and verbalizations unrelated to task demands and quadratic effects over time was analyzed in a model to test age-related changes in verbalizations about task demands. Subsequent analyses examined age-related changes in outcome variables over four 4 years by including *age* as a level-1 predictor. The between-person time-invariant and time-varying covariates were included into each model as level-2 variables. An example model is presented below:

Level 1:

$$Anger_{ij} = \beta_{0j} + \beta_{1j}(Age_{ij}) + e_{ij}$$

Level 2:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Birth\ Order_j) + \gamma_{02}(Gender_j) + \gamma_{03}(Language\ Skills_j) + \gamma_{04}\ (INR_j) + \sigma_{0j}$$

$$\beta_{1j} = \gamma_{10} + \sigma_{1j}$$

In this equation, child *j*'s anger is a function of the change in age, the child's time-invariant birth-order and gender, and time-varying language skills and INR at each age. Similar model was analyzed for verbalization unrelated to task demands as an outcome variable with the within-person change in age as the level-1 predictor, and the between-person differences in INR, gender, birth order, and language skills as the level-2 covariates. A model to test for quadratic effects over time in verbalizations about task demands was examined by including a function of quadratic change in age in level-1 predictor additionally. Power polynomial was used to account

for quadratic trend instead of raising the age variable to various powers (squaring the age variable) as power polynomials hold the advantage of the linear and quadratic effects being orthogonal. This allows to identify both the linear and quadratic effects through one model. After series of model fit tests, it was determined to include random effects for the intercept and linear slopes for age in two linear models and both linear and quadratic slopes for age in the model testing age-related changes in verbalizations about task demands.

The relationship between changes in anger and changes in verbalizations about task demands or changes in verbalizations unrelated to task demands are qualified by an interaction between the child's age and each speech content type. This interaction addresses the question of whether the hypothesized decrease in anger with age is a function of change in verbalizations about or unrelated to task demands with age (H3). An example model is presented below:

Level 1:

$$Anger_{ij} = \beta_{0j} + \beta_{1j}(Age_{ij}) + e_{ij}$$

Level 2:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Birth\ Order_j) + \gamma_{02}(Gender_j) + \gamma_{03}(Language\ Skills_j) + \gamma_{04}(INR_j) + \gamma_{05}(Verbalizations\ about\ task\ demands_j) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(Verbalizations\ about\ task\ demands_j) + \mu_{1j}$$

Similarly, child *j*'s anger is a function of the change in age, the changes in content of speech with age, the child's time-invariant birth order, gender, and time-varying child's language skills and INR at each age. Similar model was analyzed for verbalization unrelated to task

demands replacing the verbalizations about task demands variable but all others remaining constant. Both models included random effects for the intercept and linear slope of age.

Results

Overview of Analyses and Descriptive Statistics

The results section is organized around the following hypotheses: H1) age-related changes in anger expression, H2) age-related changes in speech about task demands and speech unrelated to the task demands, and H3) associations between the age-related changes in anger expression and two types of speech content.

The untransformed means and standard deviations for the study variables and their correlations are presented in Table 1. Children's nonverbal anger intensity (*M*s range: 1.03-1.34) is the averaged rating across task time, excluding seconds when no anger was observed, and averaged across individuals. The grey lines on Figure 1 demonstrate individual trajectories of age-related changes in nonverbal anger expression, showing some children express more intense anger across the task than the others, but the majority express slight to moderate anger at age 2 years. Age 3 years and up, except for a handful of children, most children express slight or minimal nonverbal anger.

Children's speech about task demands (*M*s range: 9.80-16.79) is the total frequency of spontaneous child produced speech about task demands during the task time averaged across individuals. The grey lines on Figure 2 reveals that most children spoke 25 times or less about the task demands at age 2, while more children spoke frequently about task demands by age 3 and 4, which then mostly declines at age 5 ½ years. Notably, spearman's rank-order correlation analyses indicate that speech about task demands starts to be significantly associated with nonverbal anger intensity starting around age 3 ($r = .24$, $p < .0001$) and continues to be positively

associated until age 5 ½ years old (r = .33, p < .0001; r = .23, p < .0001, respectively for age 4 and 5 ½ years).

Children's speech unrelated to task demands (*M*s range: 22.33-37.89) is the total frequency of spontaneous child produced speech unrelated to task demands during the task time averaged across individuals. The grey lines on Figure 3 suggest greater variability in this type of speech than speech about task demands across individuals. Moreover, throughout ages 2 to 5 ½ years, the frequency of speech unrelated to task demands continuously increase, year after year, overall, at the group level. Interestingly, this type of speech becomes less coupled with nonverbal anger intensity with increase in child age between ages 2 and 4 years (r = 0.29, p < .0001; r = .23, p < .0001; r = -.13, p = .01, respectively for ages 2, 3, and 4 years) and no longer is associated with nonverbal anger by age 5 ½ years (r = .01, p = .86).

Intraclass correlations (ICC) of outcome variables indicate that 4% of variance in anger expression intensity, 20% of variance in speech about task demands, and 8% of variance in speech unrelated to task demands are a function of between-person differences. In addition, the evidence indicates sufficient within-person variability to test age-related differences in the outcome variables. The results of omnibus test of age-related changes in anger expression, speech about task demands, and speech unrelated to task demands is shown in Table 2.

Results from multilevel model analyses are outlined below. As expected, they indicate developmental changes in nonverbal anger expression, speech about task demands, and speech unrelated to the task demands as children aged by one year. Furthermore, subsequent analyses from multilevel models suggest the associations between developmental changes in nonverbal anger expression and the two speech content categories.

Developmental Changes in Anger and Speech Content

The results of analyses testing hypotheses regarding age-related changes in nonverbal anger expression and speech both about task demands and unrelated to them are presented in Table 3. All models controlled for children's birth order and gender, and for language ability and INR at each age. Also, all models presented here allowed intercepts, linear slopes, and the quadratic slope, where applicable, to vary for the best model fit.

The model testing Hypothesis 1 shows age-related linear change in anger. As hypothesized, and consistent with previous studies, there is a linear decrease in nonverbal anger expression intensity as a function of age (γ_{10} = -.01, $p < .001$; Figure 1) between ages 2 and 5 ½ years. That is, at the group-level, children express less intense anger during the wait task as they age during early childhood. Moreover, children's time-variant language ability is inversely related with anger intensity across age, such that children with higher language ability show less intense anger during the task (γ_{03} = -.04, p = .001). Children's birth-order, gender, and time-variant INR are not associated with age-related changes in nonverbal anger.

Second, the model testing Hypothesis 2a tested both age-related linear and quadratic changes in speech content that involved verbalizations about task demands, incorporating power polynomial for the age variable to model for non-linearity. The hypothesized quadratic effect on speech about task demands is significant, (γ_{20} = -56.36, $p < .001$; Figure 2) while the linear trend is nonsignificant (γ_{10} = -16.73, p = .22). Specifically, at the group-level, there is marginal growth in speech about the demands of waiting between ages 2 and 3, b = 3.45, p = .06, negligible change between ages 3 and 4, b = 0.58, p = .69, but a significant growth between ages 2 and 4, b = 4.03, p = .01; then, a significant decline between ages 4 and 5 ½ years, b = -6.71, $p < .001$. That is, at the group-level, children refer more frequently to the task demands between ages 2 and 4 years and less frequently between ages 4 and 5 ½ years. Children's birth order, gender, and

time-variant language ability and INR are not associated with age-related changes in speech about task demands.

Lastly, the model testing Hypothesis 2b tested hypothesized age-related linear changes in speech unrelated to task demands. As hypothesized, there is a positive linear effect of age on speech unrelated to task demands ($\gamma_{10} = 0.38$, $p < .001$; Figure 3). That is, at the group-level, children refer more frequently to topics unrelated to the demands of the waiting as they age during early childhood. Children's birth order, gender, and time-variant INR are not associated with age-related changes in speech unrelated to task demands. Meanwhile, children's time-variant language ability marginally approaches significance in accounting for change in speech unrelated to task demands; that is, the trend suggests that children with higher language ability may speak more frequently about unrelated topics ($\gamma_{03} = 1.76$, $p = .06$).

Interactions between Age-Related Changes in Children's Anger and Speech Content

The results testing hypothesized (H3a, H3a) interactions between age-related changes in anger and speech content are presented in Table 4. All models controlled for children's birth order and gender as well as their language ability and INR at each age. Also, all models allowed intercepts and linear slopes to vary for the best model fit.

The model testing H3a tests whether age-related changes in anger are associated with age-related changes in speech about task demands. The average frequency of speech about task demands is associated with anger intensity at all ages ($\gamma_{05} = .003$, $p = .003$). As expected, the age-related quadratic changes in frequency of speech about task demands is associated with an age-related decline in anger intensity ($\gamma_{12} = -.05$, $p = .04$). That is, the increase in frequency in speech about task demands between ages 2 and 4 years and the decrease between ages 4 and 5 ½ years accelerates the decline in the nonverbal anger intensity with age.

While accounting for the effect of age-related changes in speech about task demands, children's birth order, gender, and time-variant INR are not significant predictors, but children's time-variant language ability is inversely related to age-related change in anger intensity, such that children with higher language ability tend to show less intense anger across time (γ_{03} = -.03, p = .01).

The model testing H3b tests whether age-related changes in nonverbal anger expression are associated with age-related changes in speech unrelated to task demands. The average level of unrelated speech is inversely associated with anger intensity at all ages (γ_{10} = -.01, p < .001). Moreover, as hypothesized, age-related linear changes in speech unrelated to the task demands account for the age-related decrease in anger intensity (γ_{11} = .0002, p < .001). This suggests that the developmental increase in speech unrelated to the demands of waiting between the ages of 2 and 5½ contributes to age-related decreases in anger intensity. Additionally, controlling for all other effects, children's time-variant language ability is inversely related to the decline in anger intensity (γ_{03} = -.04, p = .003), while children's birth order, gender, and time-variant INR are not significant predictors.

Discussion

The present study examined age-related changes between toddlerhood to pre-kindergarten period in anger expression and two ways that children engage in spontaneous speech during a laboratory frustration task. Longitudinal multilevel modeling replicated age-related decrease in anger across the early years of life (Barry & Kochanska, 2010) and an association between better language ability and the decrease in nonverbal anger intensity (Roben et al., 2013). The new findings involve associations between age-related changes in nonverbal anger intensity and the content of children's spontaneous utterances.

First, although not as specifically hypothesized in terms of developmental timing, there is the hypothesized age-related quadratic change in children's references to the demands of waiting to open a gift. This type of spontaneous speech increases between toddlerhood and early preschool age before declining between later preschool and kindergarten ages. Although not directly tested, this may signal growth in emotion regulation skill and/or internalization of private speech (Winsler et al., 2000). Although it is speculated that growth in language ability may contribute to children's developmental changes in use of speech, the curvilinear pattern in age-related changes in speech about task demands is not associated with growth in language ability. That is, while referring to the task demands (e.g., "Are you done yet, mama?") increases from age 2 to 4 years, a period of rapid language ability growth, these utterances are not accounted for by basic language ability.

Further, despite modest associations between the frequency of references about the problem of waiting and expressing anger between ages 3 and 5 ½ years, these utterances also account to some extent for the age-related decrease in anger intensity. Perhaps, as their expressive language ability develops, young children may have less need to convey intense anger because they can use their words to convey the problem of waiting. As Bloom (1998) discusses, language continues to assist emotional communication during the preschool years. This finding adds new evidence that despite an age-related decrease in nonverbal anger, the developmental trajectory of children's spontaneous references to the waiting task demands (the broken toy, the busy mother, the restriction about opening the gift), at least until age 4 years, the waiting task is challenging for children throughout early childhood. By age 4 years, anger intensity declines but the frequency of speaking about the demands of waiting increases. This may indicate that words may often replace nonverbal anger by age 4 years. Between ages 4 and 5 ½ years, however, we

see a decrease in both references to the task demands and nonverbal anger intensity. While this study did not differentiate between private versus social speech, children may be speaking less about the task demand overtly as they internalize thoughts by age 5 ½ years (Vygotsky, 1934/1962; Winsler et al., 2000). Although this study did not assess the regulatory effect of speech on anger, it is possible that speech, both private and overt, may be an effective coping strategy by age 5 ½ years.

In contrast, and as hypothesized, speaking about topics unrelated to the demands of waiting is not only more frequent than speaking about task demands at each consecutive age period, but also increases with age. Moreover, there is a significant trend toward where growth in language ability is associated with increase in this type of spontaneous speech; as children's language develops between the age 2 and 5 ½ years of age, children are likely to speak more of topics unrelated to the task demands. This may be that increased language ability allows for more flexibility in regard to how children use their verbal skills and/or their ability to think about the situation in ways that require higher cognitive resources (i.e., planning, recalling, or imaginative play) that require thinking beyond immediate situation and short-term (minutes) to medium to long terms (Nigg, 2017). Children may also learn that getting frustrated and communicating frustration does not achieve the blocked goal and can deploy strategies that involve engaging language by diverting their focus from the blocked goal.

Moreover, as hypothesized, the age-related increase in speech unrelated to the task demands is associated with an age-related decline in nonverbal anger intensity, above and beyond concurrent language ability. In this regard, this form of speech appears to be a better predictor of decline in nonverbal expression of anger than references to task demands. Thus, it is not merely greater language skill, but the ability to use language in strategic ways that appears to

account for decreasing anger intensity during a frustrating situation in early childhood. Some children sing, some read the posters on the wall, and some become absorbed in play that they narrate—each of these suggests the children are using the strategy of distraction, i.e., turning attention away from the blocked goal (Ravindran et al., 2021). Children also talk to their busy mothers about topics unrelated to the task (e.g., whereabouts of family members, lunch menu, an activity they are looking forward to). This type of verbalization can be considered another form of distraction, even as it is focused on the parent and not on children's own activity. Distraction is a self-regulatory strategy that increases with age and is more commonly observed in older children (Ravindran et al., 2021). Often, distinctions are not made regarding children's bids for parental attention and bids are seen as a less self-regulatory strategy than, for example, getting absorbed in, i.e., distracted by, play. However, spontaneous speech about events outside the task demands may entail the engagement of cognitive resources, e.g., controlling attention, planning, and recalling past events (Nigg, 2017) that are theorized to be important for self-regulation (Blair 2002; Cole et al., 2019; Kopp, 1982, 1989). Language development does support being able to distance psychologically, which helps with regulation of emotion and action (Grenell et al., 2019; Nook et al., 2017; Orvell et al., 2021). Thus, emerging language may serve the role above and beyond of expressing thoughts and feelings, and transition to a purported strategy to help manage frustration about waiting for the delayed reward. A next step is to understand the relation between this type of spontaneous speech and children's strategies, especially in terms of bidding to the parent and distraction, the best form of self-regulation for young children in delayed reward paradigm (Cole et al., 2011; Sethi et al., 2000) and examine whether dampening of anger expression occurs in real-time.

Developmental change in anger reactivity likely depends on situational context—whether an adult is present and the child's relationship to that adult, the circumstances that are frustrating the child, and the child's prior experience with frustration and the child's resources at the time of the frustration, e.g., whether the child is hungry or tired. Evidence indicates that low intensity anger can be functional in situations in which children should persevere to overcome a blocked goal (Chaplin et al., 2017). In the present task context, the age-related decrease in anger reactivity when mothers are present but busy may reflect children's learning about social expectations and their experience with waiting for things that they desire but cannot have immediately. The ability to wait is suggested to increase with children's growth in self-regulation (Cole et al., 2011) which coincides with language development. When children are in social context, what children are managing is not just the behavior (acting on desire) and emotions but also language. With repeated negative feedback in response to speaking about the problems of wait, children may have learned that using language differently than to talk about the challenging demand can spare them from negative feedback from mothers. Rather, describing their play behaviors or discussing past or future events may have been reinforced through positive or lack of negative feedbacks such that children are socialized to engage in distraction-related verbalizations when reward is delayed. Thus, examining parental response to the type of children's speech will help us better understand how potential socialization process might influence what children learn to say more during frustrating waiting.

Although it is not surprising to say that the content of speech is more important than just the language ability itself, no studies directly test this association in the early childhood by differentiating among the content of children's speech during a self-regulation challenge task. Transcribing verbalizations is inherently exhaustive work both in terms of time and effort but

such work with young children can be even more difficult as their speech may not be as clear (i.e., grammatical errors, inaudible speech, inaccurate word pronunciation) compared to adult's speech. However, by directly examining how the speech content is related to the developmental changes in anger expression suggests a detailed information that can help clinical interventions, parenting, and education on what to teach children when we want then to "use your words" when we want language to support emotion regulation.

The affective science literature suggests that language helps shape emotional perception as well as experiences above and beyond the communication purposes (Lindquist et al., 2015). This framework is well embedded in emotion talk literature that promotes children to use emotion words to describe their feelings and thoughts. However, while emotion talk may help consolidate the emotional experiences and increase emotional understanding (Grazzani & Ornaghi, 2011), which is associated with more prosocial behaviors in young children (Ensor & Hughes, 2010), it may not have a direct effect on reducing anger reactivity. One pathway that suggests how emotion talk and enhanced emotion understanding can help with regulating emotion is through the input of extrinsic regulation by caregivers (Brinton & Fujiki, 2011). Caregivers may process with their children what they are feeling and what is making them feel frustrated, who can also offer them coping skills through structuring responses that was found to predict increased children's engagement with distraction strategy during the wait task (Ravindran et al., 2021). Children expressing what is making them frustrated, such as talking about the demands at hand, can help them understand their emotions better which can further be scaffolded into the type of verbalizations reflecting distraction to modulate emotional experiences and expressions. Yet, such contingent relationships remain to be explored through a deeper

understanding of how language and different words contribute to emotion regulation development in early childhood.

Limitations and Future Directions

Although the current study suggests how language development can support anger regulation in early childhood, using longitudinal analyses, there are limitations to its conclusions. First, the results are limited by the use of a variable-centered approach in which person-level effects—e.g., some children may use language and not nonverbal emotion to communicate while others may use language in conjunction with emotions—are not known and blur distinctions among different developmental pathways. Future research should consider the advantages of a dual trajectory model (Nagin, 2005) that examines change among different pathways.

Second, a direct regulatory effect of language use on anger expression cannot be determined. Microanalytic studies that investigate the moment-by-moment dynamics of how speech and nonverbal emotion unfold during a task may shed light on the immediate regulatory effects of certain forms of speech on emotions. Speech content may forestall or dampen, or accelerate or amplify, nonverbal emotion. Moreover, a dynamic approach can address other temporal perspectives such as latency to speech about demands of waiting, which may change with age, or duration of utterances unrelated to the task demands, to determine if they serve a regulatory function, delaying frustration. Moreover, we only examine the frequency of two types of speech content. We do not know how other temporal variables relate to nonverbal negative emotion or speech content and how they relate to each other during the task. Does the longer the child speaks about unrelated topics predict a longer latency to speaking about the problem and longer latency to or reduced intensity of expressing anger in subsequent moments? A further and more elaborated examination of mechanisms in which emotion changes as a function of language

use is warranted for a better understanding of the role of language in emotion regulation development.

Third, this study formulated hypotheses but in the absence of a corpus of studies to guide predictions. As a result, the approach is limited to two large categories of speech—related and unrelated to the demands of the wait task. However, among utterances that are unrelated, some self-directed speech may reflect the strategy of distraction while others involve bids for parental attention. Bids for maternal attention are generally regarded as less autonomous than self-directed strategies like distraction (Ratcliff et al., 2021). In one study, the authors found that 3- to 5-year-olds' private speech during a challenging Lego-building task is associated with children's lower language skills and teacher-report self-control in classroom settings (Bono & Bizri, 2014), suggesting that overt speech is indicative of disruptiveness in a classroom rather than an effort to regulate emotions. Clearly, speech content matters and there is a need for more nuanced analysis of what children say in different situations if this line of research is to inform clinicians, parents, and teachers of how to promote language use in young children to regulate emotions.

Lastly, as directions for future studies, we need more studies that look beyond just the private speech of children when examining their spontaneous speech samples. Private speech decreases by around the age of 5 ½ years as it may increasingly take forms of covert (i.e., inaudible muttering) and internal speech evident in several studies across different contexts (e.g., Winsler et al., 2000; Winsler et al., 2003). What these studies also report is that task-irrelevant private speech tends to occur at an extremely low frequency that they are usually excluded from the final analyses (Day & Smith, 2013) or overlooked of its importance (Manfra et al., 2014). The present study examines both self-directed and other-directed overt speech; the contribution of private, covert speech that can occur in 4- and 5-year-olds is unknown. Given the presence of

covert speech at older ages, findings may provide inaccurate description of how young children use language as a tool for regulating emotions.

Conclusion

The current study tests hypotheses about age-related changes in nonverbal anger and two types of spontaneous speech content during a frustrating wait task while mothers are present. It examines whether and how those two types of speech are associated with the age-related decrease in nonverbal anger expression between the ages of 2 and 5½ years old. Findings indicate that when children are told to wait for the delayed reward, they speak more frequently about the demands of waiting at each age up until age 4 years, but this type of speech rapidly drops by age 5 ½ years. Meanwhile, they also speak more frequently about topics unrelated to the situational demand of waiting as they age during this period, including an increase from age 4 to 5 ½ years. Notably, the increase between the last two age points occurs only for speech unrelated to the demands of waiting, and not for speech about the task demands. Both types of speech are associated with the age-related decrease in the intensity of nonverbal anger expression; however, the processes in which they support emotion regulation may look different. While speech about task demands may be replacing the strong anger and thus children are "using their words" rather than acting on anger, speech unrelated to the demand of waiting may play a more significant role in reducing the intensity of nonverbal anger as children get older through purported strategy use, i.e., distraction. The findings suggest that when children are challenged to wait for desired gift, language not only replaces strong emotion, but children strategically use language that resembles distraction strategy use to support keeping anger expression low.

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APPENDIX A

TABLES

Table 1. Descriptive Statistics and Correlations between Study Variables

Variables	n	*M*	*SD*	1	2	3	4	5	6	7
24-month										
1. Anger Expression	117	1.34	0.41	--						
2. Speech about Task Demands	118	12.31	15.91	-0.02	--					
3. Unrelated Speech	118	22.33	20.44	-0.29****	0.18****	--				
4. MLU	120	1.53	0.44	-0.25****	0.23****	0.29****	--			
5. INR at 18-mo	120	2.32	0.87	-0.29****	0.11*	0.26****	0.12*	--		
6. Child Gender	120	1.46	0.50	0.12*	0.01	0.07	0.09*	-0.07	--	
7. Child Birth-Order	120	1.80	0.87	0.05	0.15***	-0.05	-0.15**	-0.20****	0.06	--
36-month				1	2	3	4	5	6	7
1. Anger Expression	98	1.22	0.40	--						
2. Speech about Task Demands	117	15.87	14.55	0.24****	--					
3. Unrelated Speech	117	31.48	21.62	-0.23****	0.25****	--				
4. MLU	115	2.48	0.55	0.01	0.04	-0.11*	--			
5. INR at 30-mo	120	2.49	1.02	-0.08	-0.17***	-0.08	0.09	--		
6. Child Gender	120	1.46	0.50	-0.01	-0.15***	-0.12**	0.18***	0.00	--	
7. Child Birth-Order	120	1.80	0.87	-0.10	-0.03	0.06	-0.01	-0.15***	0.06	--

Table 1 continues

Table 1 (continued). Descriptive Statistics and Correlations between Study Variables

48-month				1	2	3	4	5	6	7	8
1. Anger Expression	106	1.05	0.11	--							
2. Speech about Task Demands	117	16.79	11.34	0.33****	--						
3. Unrelated Speech	117	31.59	18.47	-0.13**	0.13**	--					
4. TOLD Grammatical Understanding	117	9.64	2.43	-0.09	-0.25****	0.06	--				
5. TOLD Sentence Imitation	113	9.05	3.07	-0.01	-0.16***	0.15**	0.30****	--			
6. INR at 42-mo	120	2.58	1.15	0.12*	0.00	0.03	0.26****	0.17***	--		
7. Child Gender	120	1.46	0.50	-0.11*	-0.04	0.01	0.05	0.20****	-0.05	--	
8. Child Birth-Order	120	1.80	0.87	-0.13**	-0.03	0.00	0.08	0.11*	-0.20****	0.06	--
Age 5				1	2	3	4	5	6	7	8
1. Anger Expression	94	1.03	0.11	--							
2. Speech about Task Demands	95	9.80	9.21	0.23****	--						
3. Unrelated Speech	95	37.89	22.35	0.01	0.20****	--					
4. TOLD Grammatical Understanding	96	10.57	2.72	-0.19***	-0.05	-0.06	--				
5. TOLD Sentence Imitation	96	10.24	3.38	-0.39****	-0.22****	-0.17***	0.36****	--			
6. INR at 60-mo	95	2.42	1.14	-0.15**	-0.04	0.14**	0.23****	0.17**	--		
7. Child Gender	120	1.46	0.50	-0.08	-0.20***	-0.13*	0.14**	0.14**	0.05	--	
8. Child Birth-Order	120	1.80	0.87	-0.14**	-0.24****	-0.09	0.00	0.02	-0.13*	0.06	--

Note. *p < .05; **p < .01, ***p < .001, ****p < .0001. MLU = Mean Length Utterances. INR = Income-to-Needs Ratio

Table 2. Omnibus Effects of Age-Related Changes in Anger Expression and Two Speech Content Types

	B	SE	df	*F*	*p-value*
Anger Expression	-0.01	0.001	1, 413	69.75	< .0001
Speech about Task Demands	-0.04	0.05	1, 445	0.64	0.42
Unrelated Speech	0.39	0.07	1, 445	27.36	< .0001

Note. B = unstandardized coefficient. SE = standard error.

Table 3. Fixed and Random Effects for Age-Related Changes in Anger Expression and Two Speech Content Types

	Estimate (SE)	*t*(df)	*p-value*
Anger Expression			
Fixed Effects			
Intercept γ_{00}	1.56 (.09)	18.05(300)	< .0001
Linear age-related changes γ_{10}	-.01 (.001)	-7.59(138)	< .0001
Covariates			
Birth-order at 18 months γ_{01}	-.02 (.02)	-1.06(195)	.29
Child gender γ_{02}	.01 (.03)	.42(192)	.67
Child language ability γ_{03}	-.04 (.01)	-3.43(362)	.001
Income-to-Needs Ratio γ_{04}	-.001 (.01)	-.06(273)	.95
Random Effects			
SD of Intercept σ_{0j}	.50		
SD of Linear age-related changes σ_{1j}	.01		
Residual e_{ij}	.24		
Verbalizations about task demands			
Fixed Effects			
Intercept γ_{00}	18.53 (3.24)	5.72(147)	< .0001
Linear age-related changes γ_{10}	-16.73 (13.54)	-1.24(127)	.22
Quadratic age-related changes γ_{20}	-56.36 (12.26)	-4.60(145)	< .0001
Covariates			
Birth-order at 18 months	-0.73 (.87)	-.85(121)	.40
Child gender γ_{02}	-1.93 (1.49)	-1.29(121)	.20
Child language ability γ_{03}	0.11 (.54)	.20(371)	.84
Income-to-Needs Ratio γ_{04}	-0.35 (.65)	-.53(205)	.60
Random Effects			
SD of Intercept σ_{0j}	6.60		
SD of Linear age-related changes σ_{1j}	93.19		
SD of Quadratic age-related changes σ_{2j}	71.19		
Residual e_{ij}	9.79		
Verbalizations unrelated to task demands			
Fixed Effects			
Intercept γ_{00}	10.19 (5.83)	1.75(222)	.08
Linear age-related changes γ_{10}	0.38 (0.08)	4.75(114)	< .0001
Covariates			
Birth-order at 18 months γ_{01}	.14 (1.30)	0.10(121)	.92
Child gender γ_{02}	.05 (2.23)	0.02(122)	.98
Child language ability γ_{03}	1.76 (.92)	1.91(427)	.06
Income-to-Needs Ratio γ_{04}	1.67 (1.05)	1.59(197)	.11
Random Effects			
SD of Intercept σ_{0j}	19.52		
SD of Linear age-related changes σ_{1j}	.49		
Residual e_{ij}	18.14		

Note. SE = standard error. σ = standard deviation of random effects.

Table 4. Fixed and Random Effects for Cross-Level Interactions between Age-Related Changes in Anger Expression and Two Types of Speech Content

	Estimate (SE)	*t*(df)	*p-value*
Anger X Verbalizations about Task Demands			
Fixed Effects			
Intercept γ_{00}	1.13 (.06)	17.74(277)	< .0001
Linear age-related changes γ_{10}	-2.48 (.44)	-5.62(277)	< .0001
Quadratic age-related changesγ_{20}	1.46 (0.42)	3.47(277)	.001
Mean Verbalizations about Task Demands γ_{05}	0.003 (.001)	2.99(277)	.003
Age Slope X Verbalization Linear Slope γ_{11}	-.01 (.02)	-.43(325)	.67
Age Slope X Verbalization Quadratic Slope γ_{11}	-.05 (.02)	-2.10(362)	.04
Covariates			
Birth-order at 18 months γ_{01}	-.01 (.02)	-0.91(117)	.36
Child gender γ_{02}	.01 (.03)	.23(117)	.82
Child language ability γ_{03}	-.03 (.01)	-2.86(277)	.005
Income-to-Needs Ratio γ_{04}	-.0001 (.01)	-0.01(277)	.99
Random Effects			
SD of Intercept σ_{0j}	.14		
SD of Linear age-related changes σ_{1j}	2.89		
SD of Linear age-related changes σ_{2j}	2.01		
Residual e_{ij}	.20		
Anger X Verbalizations Unrelated to Task Demands			
Fixed Effects			
Intercept γ_{00}	1.86 (.11)	17.48(226)	< .0001
Linear age-related changes γ_{10}	-0.01 (.002)	-7.53(185)	<. 0001
Mean Verbalizations Unrelated to Task Demands γ_{05}	-0.01 (.002)	-5.76(400)	< .0001
Age Slope X Verbalization Slope γ_{11}	0.0002 (0)	4.83(389)	<.0001
Covariates			
Birth-order at 18 months γ_{01}	-.02 (.02)	-1.07(198)	.29
Child gender γ_{02}	-.002 (.03)	-.06(195)	.95
Child language ability γ_{03}	-.04 (.01)	-3.02(365)	.003
Income-to-Needs Ratio γ_{04}	.004 (.01)	.36(284)	.72
Random Effects			
SD of Intercept σ_{0j}	.68		
SD of Linear age-related changes σ_{1j}	.01		
Residual e_{ij}	.21		

Note. SE = standard error. σ = standard deviation of random effects.

Table 5. Examples of Speech about the Task Demands and Unrelated to Task Demands at Each Age during the Wait Task

	Speech about Task Demands	Speech Unrelated to Task Demands
Age 2	I want that.	I get stuck.
	Prize. Prize. Prize. No, Prize!	Monkey-ey-ey-ey
	Mommy, done!	What's that?
	My! [Mine!]	This is hat!
Age 3	I don't have wheels.	Now where's my, my, my bathroom mirror?
	I want to open it.	When I drive it. Back it up. Back it up.
	Oh it's broken.	Jump! Jump!
	Are you done?	(Reading posters…) Hi Baby Buggy. Nest! One, two, three, four…
Age 4	This one broke off his leg.	I'm gonna bring my comb home.
	This horse is dumb.	Can I have something to draw on?
	I don't wanna wait.	I'll take you to the hospital (to toy)
	What is this? What's in there? (pointing to the gift)	Mom, I love you.
Age 5 ½	I don't want to do this.	I got a plane and it flies.
	How long are you going to be?	I'm going to knock this chair.
	I want it now.	Two plus three equals four, five, six…
	Is this the last thing? I'm bored!	Watch my face in the mirror.

APPENDIX B

FIGURES

Figure 1. Age-Related Changes in Anger Expression

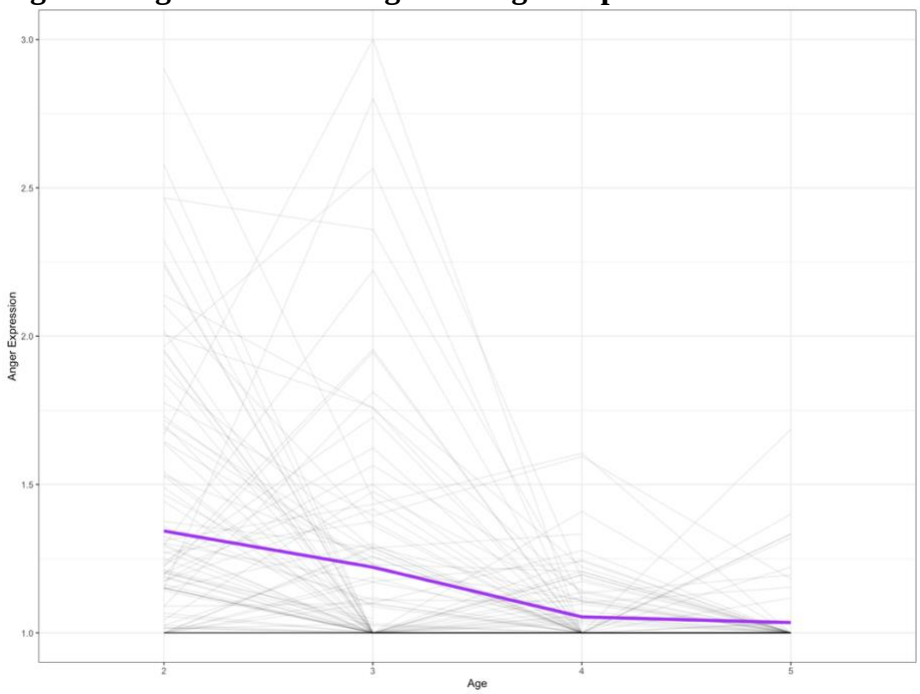

Figure 2. Age-Related Changes in Verbalizations about Task Demands

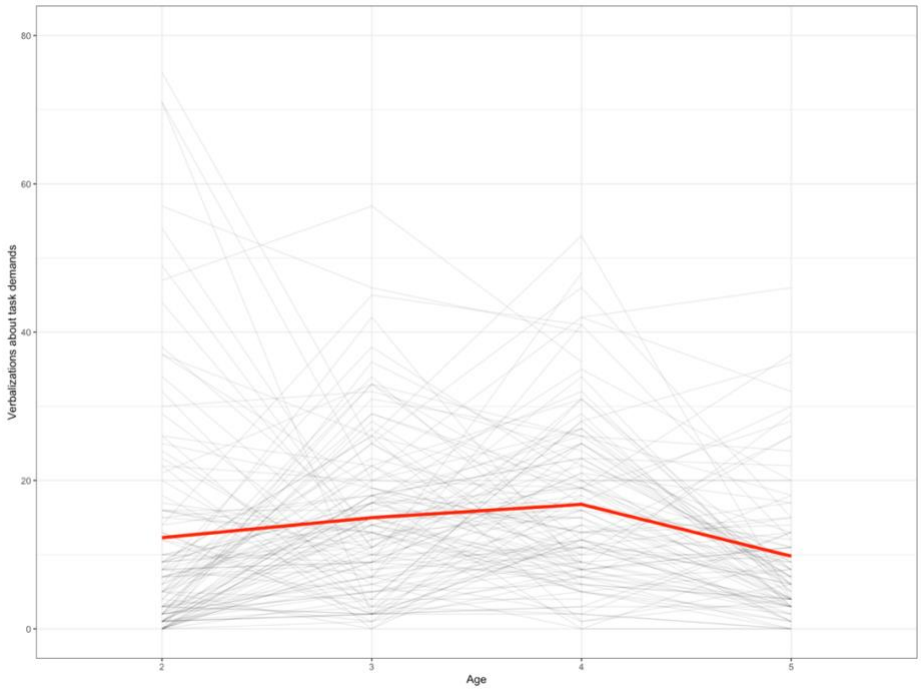

Figure 3. Age-Related Changes in Verbalizations Unrelated to Task Demands