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Enriching home language environment among families from low-SES backgrounds: A randomized controlled trial of a home visiting curriculum

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ABSTRACT

This study evaluated the efficacy of the six-month 3Ts Home Visiting (3Ts-HV) curriculum, designed to empower socioeconomically disadvantaged caregivers with evidence-based knowledge and strategies in order to enrich the home language environment for their young children's cognitive and language development. Using a matched pairs randomized controlled trial design, caregiver–child dyads were randomized into the 3Ts-HV intervention (n = 79) or Healthy Lifestyle control (n = 78) condition. Analyses of covariance revealed that compared with their control counterparts, the 3Ts-HV caregivers were more knowledgeable about early childhood cognitive and language development, and provided more language exposure for and engaged in more conversational turn-takings with their child. The 3Ts-HV caregivers also utilized more praise, explanations, and open-ended questions but less criticism, physical control, and intrusiveness than their control counterparts when interacting with their child. Findings provided empirical evidence supporting the immediate efficacy of the 3Ts-HV intervention in enhancing caregiver knowledge, the quantity of linguistic inputs, and the quality of caregiver interactions in the context of low-SES households, controlling for caregiver education level, language skills, and marital status.

1. Introduction

A landmark study by Hart and Risley (1995) showed that, compared with their affluent peers, children in poverty heard approximately 30 million fewer words in the first four years of life; they were also more likely to hear words of discouragement and experience harsh parenting, such that a substantially large proportion of a small total number of child-directed words was negative in the low socioeconomic status (SES) households (Conger, Conger, & Martin, 2010; Hart & Risley, 1995). The 30 Million Word Gap, representing socioeconomic disparities in both quantity and quality of early language environments, has invoked widespread attention to early language inputs in relation to children's language development and academic outcomes. Early language input disparities have been implicated in creating cumulative disadvantages over time, putting children from low-SES backgrounds at greater risk for academic failure and lifelong adverse outcomes (Tamis-LeMonda, Luo, McFadden, Bandel, & Vallotton, 2017). Despite substantial evidence that disparities in language inputs and child learning emerge well before the age of two years, early childhood education in the United States traditionally focuses on preschool-age children. Such disconnection between science and policy underscores the importance of focusing on prevention rather than remediation (Greenwood et al., 2017).

Linguistic and social experiences in early childhood are critical in fostering children's foundational brain development, cognitive functioning, language acquisition, and later academic skills (Romeo et al., 2018; Tamis-LeMonda et al., 2017). Children in early toddlerhood (around the age of 13–16 months) show steady, significant progress on their cognitive and language development. Language inputs from and social interactions with caregivers allow children at this developmental stage to practice their emerging language skills, significantly promoting their language development (Zimmerman et al., 2009). Indeed, SES differences in child language skills are evident as early as the age of 18 months (Fernald, Marchman, & Weisleder, 2013).

Home environment is the first and most important social learning context for young children (Schull & Anderson, 2008). Enriching the home language environment of children from low-SES back-

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grounds in early toddlerhood is a critical step to reduce disparities in early language input and improve young children's language and pre-academic skills (Tamis-LeMonda et al., 2017). Educating caregivers with knowledge of early childhood cognitive and language development provides a strong foundation for fostering caregiver enrichment of the early home language environment. Importantly, promoting the quantity of language inputs and the quality of social interactions caregivers provide for their young children is essential for behavioral interventions addressing disparities in early home language environment. Moreover, delivering interventions via home visiting allows a more tailored approach to the home environments of the target population (Peacock, Konrad, Watson, Nickel, & Muhajarine, 2013).

The 3Ts Home Visiting (3Ts-HV) curriculum, a six-month intervention for caregivers with 13- to 16-month-old children from low-SES backgrounds, is designed to address the SES-related disparities in early language exposure. Through caregiver enrichment of the home environments in early toddlerhood, the goal of the 3Ts-HV intervention is to promote socioeconomically disadvantaged young children's cognitive and language development. Using a randomized controlled trial (RCT), this study evaluated the efficacy of the 3Ts-HV intervention by testing whether it significantly enhanced: (1) caregiver knowledge of early childhood cognitive and language development, and (2) home language environment in the context of low-SES households. A mixed-methods approach was utilized to assess the quantity and quality of the home language environment: (2a) the quantity of linguistic inputs for the child was estimated using Language ENvironment Analysis (LENA) technology, and (2b) the quality of caregiver interactions with the child was captured through observations.

1.1. Caregiver knowledge of early childhood cognitive and language development

Disparities in early language environments are linked to socioeconomic differences in parental knowledge (e.g., Rowe, Denmark, Harden, & Stapleton, 2016; Suskind et al., 2017). More educated and economically advantaged parents tend to possess more knowledge about child development (Bornstein, Cote, Haynes, Hahn, & Park, 2010; Rowe et al., 2016). Caregivers who better understand early childhood development are more likely to foster a home environment with cognitive stimulations and linguistic inputs for their young children (Vernon-Feagans et al., 2008). Longitudinal research with socioeconomically disadvantaged families has further revealed the impact of parental knowledge on young children's early language skills. Mothers who were more knowledgeable of child development provided more support for their toddlers, which in turn fostered their toddlers' cognitive competence (Wacharasin, Barnard, & Spieker, 2003). Compared with their counterparts from low-SES backgrounds, more affluent and educated parents had more knowledge of child development and might therefore utilize more child-directed speech with their toddlers, which in turn predicted higher child vocabulary skills one year later (Rowe, 2008). Parental knowledge also partially mediated the association between parent education and child language and pre-literacy skills (Rowe et al., 2016).

Caregiver knowledge plays an important role in shaping the home environments critical to young children's development. Yet, the literature on parental knowledge in relation to early language input disparities predominantly focuses on knowledge of overall infant development, even though early childhood cognitive and language development is the primary outcome of interest (Suskind et al., 2017). Increasing caregiver knowledge of early childhood cognitive and language development is an essential first step for a home-based intervention in addressing early language disparities. Thus, the first aim of this study was to examine the 3Ts-HV intervention impact on caregiver knowledge of early childhood cognitive and language development.

1.2. Quantity of linguistic inputs for the child

There have been consistent and robust findings that children who receive a larger amount of language inputs in early childhood have higher vocabularies, language, and literacy skills later on (e.g., Hoff, 2003; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Rowe, 2012; Tamis-LeMonda, Bornstein, & Baumwell, 2001). The impact of SES on young children's early vocabulary skills has been accounted for by the amount of caregiver speech during everyday activities (Hoff, 2003). Yet, the number of adult words a child hears is only one of the indicators capturing the amount of language inputs available to the child in the home environment (Cartmill, 2016; Hirsh-Pasek et al., 2015). Simply overhearing words from adults (i.e., overheard speech) does not necessarily facilitate young children's language learning (Weisleder & Fernald, 2013). Instead, young children learn language most effectively from the speech directed to them (i.e., child-directed speech; Weisleder & Fernald, 2013; Shneidman & Goldin-Meadow, 2012) and the linguistic responses contingent to their communicative signals (i.e., conversational turns with adults; Hamer, 2012). Empirical studies have revealed that children, especially at a very young age, learn new words more successfully from interacting with live speakers than from watching videos (Krcmar, Grela, & Lin, 2007; Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009). The reciprocal nature of conversation turn-taking is key to young children's cognitive development and language learning (Mermelshtine & Barnes, 2016; Rowe, 2008).

Conversational turn-taking refers to continuous and non-simultaneous verbal exchanges in which caregivers and children provide prompt and contingent linguistic responses to one another's preceding utterances (Bornstein, Putnick, Cote, Haynes, & Suwalsky, 2015). Taking conversational turns allows young children to practice and consolidate their newly acquired language skills; it also allows caregivers to hone their own speech to the optimal complexity to best support young children's language development (Mendelsohn et al., 2010; Romeo et al., 2018). Frequent conversational turns with caregivers have been shown to foster receptive language skills in toddlers (VanDam, Ambrose, & Moeller, 2012) and promote school readiness (Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Zimmerman et al., 2009). Notably, the amount of adult word exposure (including both overheard speech and child-directed speech) and language exchanges are two important components capturing the quantity of linguistic inputs for the child. The ability to increase linguistic inputs for the child in the home environment is essential to the success of a home-based intervention in narrowing early language disparities. Hence, the second aim of this study was to examine the 3Ts-HV intervention impact on the quantity of linguistic inputs for the child at home.

1.3. Quality of caregiver interactions with the child

A metric-based approach to assess home language environment focuses on the linguistic stimulation and language exchange available for the child, but overlooks the complexity and diversity of language learning environments (Cartmill, 2016; Hirsh-Pasek et al., 2015). Caregiver language input does not occur in isolation. Language is embedded in social interactions, from daily routines to play activities. Through caregiver scaffolding of physical, social, and visual contexts, young children learn the meaning of new words, building upon shared knowledge and experience (Hirsh-Pasek et al., 2015). Thus, the quality of caregiver interactions with children, one of the key components of the home learning environ-

ment, is foundational to young children's cognitive and language development (Tamis-LeMonda et al., 2017).

Stimulating and responsive caregiver interactions in early childhood play a critical role in promoting children's cognitive and language development (Hirsh-Pasek & Burchinal, 2006; Tamis-LeMonda et al., 2001; Tamis-LeMonda, Kuchirko, & Song, 2014). Caregiver use of descriptions, explanations, and cognitive stimulations (i.e., intentional teaching efforts appropriate to the child's developmental level) provides young children with the necessary scaffolding to facilitate their cognitive growth and language learning (Hirsh-Pasek & Burchinal, 2006; Vallotton, Mastergeorge, Foster, Decker, & Ayoub, 2017). Moreover, caregivers' positive emotions, displays of affection, encouragement, and expression of acceptance provide young children with a secure base promoting young children's exploration of the surroundings and active engagement in learning (Nievar, Moske, Johnson, & Chen, 2014; Tamis-LeMonda & Bornstein, 2002). These positive behavioral and positive emotional dimensions of caregiver interactions have been shown to promote early cognitive competence, communicative ability, and vocabulary development (Hirsh-Pasek & Burchinal, 2006; Nievar et al., 2014; Tamis-LeMonda & Bornstein, 2002; Vallotton et al., 2017), significantly accelerating young children's achievement of milestones in language development (Tamis-LeMonda et al., 2001). In contrast, caregiver criticism, physical restraint, restrictiveness, negative discipline, intrusiveness, expression of negative emotions, and harshness in tone of voice are adversely associated with children's cognitive and language functioning (Hubbs-Tait, Culp, Culp, & Miller, 2002; Landry, Smith, & Swank, 2006; Nievar et al., 2014; Tamis-LeMonda & Bornstein, 2002).

The relations between quality of caregiver interactions and children's cognitive and language outcomes are also evident among disadvantaged populations. Parental cognitive and/or linguistic stimulations have been shown to enhance young children's cognitive and language skills concurrently and longitudinally in Early Head Start samples (Chang, Park, Singh, & Sung, 2009; Harden, Sandstrom, & Chazan-Cohen, 2012). Moreover, research with at-risk mothers revealed that lower levels of negative parenting (physical intrusiveness and negativity) at age 24 months and higher levels of positive parenting (warmth and affections, contingent responsiveness, language stimulation, support for children's communication skills, and scaffolding) at age 30 months promoted young children's complexity of play, social engagement, and expressive language skills at age 30 months (Guttentag et al., 2014). Furthermore, a recent study with families of low-SES found that maternal contingency and responsiveness, effortful cognitive stimulations, and encouragement at age 14 months fostered young children's vocabulary ability and emergent literacy and numeracy skills upon kindergarten entry, which in turn promoted their academic skills in 5th grade (Tamis-LeMonda et al., 2017).

Taken together, the ability to improve the quality of caregiver interactions is essential for a home-based intervention in addressing early language disparities (Cartmill, 2016; Guttentag et al., 2014; Hirsh-Pasek et al., 2015). Thus, the third aim of this study was to examine the 3Ts-HV intervention impact on the quality of caregiver interactions with the child during a play session at home. Specifically, the behavioral dimension of caregiver interactions focuses on caregiver behaviors that have been shown to facilitate versus minimize young children's engagement and/or learning during shared activities. In contrast, the emotional dimension of caregiver interactions focuses on caregiver facial expressions, affect, and tone of voice. These caregiver emotions have been shown to foster, rather than discourage, young children's attunement to their social interactions and linguistic exchanges with caregivers, especially at the age when communications with caregivers are still predominantly nonverbal. Both positive and negative aspects of caregiver behaviors and emotions were assessed qualitatively through observations.

1.4. 3Ts home visiting curriculum

Building upon the language development and behavior change literature (Michie, Jochelson, Markham, & Bridle, 2009), 3Ts-HV is a caregiver-directed intervention designed to empower socioeconomically disadvantaged caregivers with evidence-based knowledge and strategies to foster an optimal home environment for their young children's cognitive and language development. Caregiver knowledge and behaviors are the building blocks supporting the theory of change for the intervention. Importantly, the 3Ts-HV intervention respects differences in parenting across cultures. The intervention seeks to encourage the parent–child interactions that have been shown to foster children's cognitive and language outcomes and promote school readiness and academic achievement, sharing common goals endorsed by caregivers of all SES (Driessen, Smit, & Sleegers, 2005). The emphasis of the intervention is to establish a partnership between caregivers and home visitors throughout the program such that caregivers are considered the primary agents of change for their children, whereas home visitors support caregivers in learning and implementing behavior changes.

Using an RCT, the preliminary version of the 3Ts-HV intervention has been pilot tested in a small sample of socioeconomically disadvantaged mother-child dyads (12 Experimental and 11 Control; Suskind et al., 2015). Results showed that the preliminary 3Ts-HV intervention was efficacious in prompting knowledge gain beyond the intervention period, but fostering behavior changes at home only during the intervention period. Knowledge gain might not have transferred to sustained behavior changes because the intervention did not consistently incorporate behavior change techniques (concrete feedback, goal setting, etc.; Suskind et al., 2015). Thus, there was a need to improve the intervention's efficacy in promoting sustained behavior changes in caregivers beyond the intervention period in order to impact the home language environments of socioeconomically disadvantaged families in the long term.

Upon completion of the pilot study, a subsample of the experimental mothers was interviewed to obtain feedback on the preliminary 3Ts-HV intervention. In response to the needs articulated by the mothers and results from the pilot study, the 3Ts-HV curriculum was expanded from eight to twelve modules (Table 1). Mothers from the preliminary 3Ts-HV specifically expressed the need for help and support with using talk to shape their young children's behaviors. Thus, three modules of the 3Ts-HV curriculum incorporated scientific concepts on the development of executive function and self-regulation skills, linguistically driven strategies for using prompts and encouragement, and behavioral strategies for minimizing direct commands without reasoning. One separate module focused on caregiver responsiveness to child communication initiatives. Content on book sharing, story-telling, and number and spatial talk was also elaborated, along with more concrete examples of implementing these activities during daily routines to foster young children's cognitive and language development.

The twelve modules in the 3Ts-HV curriculum were implemented in sequence, with each new module building upon the content of the preceding modules. The three key behavior change strategies designed for parents to enrich their child's home language environment, referred to as the "3Ts" — *Tune In*, *Talk More*, and *Take Turns* with the child, were interwoven throughout the twelve modules. Scaffolding of caregivers was the key emphasis throughout the 3Ts-HV intervention to better support caregivers in learning how to apply scientific knowledge and/or implement behavioral strategies in their everyday lives. True-to-life video

Table 1
Overview of the 3Ts-HV intervention curriculum.

Module 1: introduction Caregivers were introduced to the overarching themes and concepts throughout the 3Ts-HV curriculum. Foundational science regarding incremental theory of intelligence, brain plasticity in early childhood, critical period for language learning, and lasting impact of language input on children's brain, cognitive and language development was discussed.
Module 2: talk more *Talk more* strategies, designed to increase language input for young children in everyday life, were presented to caregivers. Strategies included using descriptive language, labeling, singing songs, and talking about here/now, past/future, and thoughts/feelings.
Module 3: tune in *Tune in* strategies, designed to promote responsiveness to young children's communication initiatives, were presented to caregivers. Strategies included reading young children's cues, talking about objects/actions in the child's current focus of attention, using child-directed speech, and adjusting to the child's level to make eye contact and/or share facial expressions.
Module 4: take turns *Take turns* strategies, designed to promote back-and-forth conversations with young children, were presented to caregivers. Strategies included reading and responding to young children's cues, limiting technology use to increase the quality of parent-child interactions, and singing songs together with the child.
Module 5: spread the words To further enrich young children's language environments and harness social capital, this module was designed to empower caregivers to maximize language inputs from other adults in their children's lives. Caregivers were presented with strategies for sharing what they learned from the curriculum with other caregivers and family members surrounding their children.
Module 6: executive function To foster young children's development of executive function and self-regulation skills, caregivers were presented with behavioral strategies for using talk to regulate child misbehaviors and/or tantrums. Behavior management strategies (such as recognizing own emotions and tone of voice, teaching children to describe feelings, think, and make choices, and reasoning and modeling self-regulation skills) were discussed and demonstrated.
Module 7: directives Caregivers were presented with behavioral strategies for reducing the use of directives (e.g., "No football in the house!"). The negative impact of directives on young children's language abilities and self-regulation skills was discussed. Caregivers were encouraged to use explanations to correct misbehaviors, foster cognitive thinking skills, and promote positive behaviors in young children (e.g., "Do not throw the football in the house because you might break something.").
Module 8: encouragements Caregivers were presented with behavioral strategies for using more encouragement or praise to promote positive behaviors, foster perseverance, and develop self-concept in young children. Differences between person-based and process-based encouragements were examined, explained, and exemplified, with an emphasis on praising children for their efforts rather than their results or abilities.
Module 9: literacy Book sharing as opposed to book reading with young children was introduced to engage children with books, encourage children's autonomy during book sharing, and foster positive experiences associated with books. Using the *3 Ts* strategies during book sharing with children was explained and exemplified. Book sharing was presented as a way to foster young children's language and socioemotional skills, and short- and long-term interest in books.
Module 10: oral narratives Oral narrative was introduced with an emphasis on caregivers telling stories to their young children and engaging their young children to tell stories. Using the *3Ts* strategies during storytelling with children was explained and exemplified. Storytelling was presented as a way to foster young children's vocabulary learning, narrative skills, reading readiness, and understanding and self-regulation of emotion.
Module 11: numbers Young children's early mathematical abilities such as understanding measurement, sorting, and patterns were first discussed. Using the *3 Ts* strategies to incorporate math and spatial language into everyday routines, playtime, and conversations with young children were then explained and exemplified. Incorporating math talk was presented with an emphasis on fostering young children's foundational understanding of mathematics and promoting their readiness for math learning upon school entry.
Module 12: media diet In the final module, technology use was identified as a common obstacle of using the *3Ts* strategies, and a technology diet was recommended to caregivers. Caregivers learned about the negative impact of technology use on their ability to tune in to their children, the quality of caregiver-child interactions, and their children's cognitive and language development. Suggestions on how and when to limit technology use were presented, along with an emphasis on having one-on-one interactions with young children.

examples were added to illustrate how caregivers can implement specific strategies and/or techniques with young children ranging from the age of one to three years. Two *theory-driven techniques* were implemented systematically with further improvement to support caregiver behavior change in the 3Ts-HV intervention: (1) guided practice, and (2) quantitative linguistic feedback and goal setting (Suskind et al., 2013; see description in Section 2).

Taking the first empirical step to evaluate the efficacy of the 3Ts-HV intervention, the present study examined the immediate impact of the intervention on: (1) caregiver knowledge of early childhood cognitive and language development, (2) the quantity of linguistic inputs for the child, and (3) the quality of caregiver interactions with the child. Three hypotheses regarding the expected post-intervention changes were developed based on the theory of change for the 3Ts-HV intervention. First, we hypothesized that the 3Ts-HV caregivers would be more knowledgeable about early childhood cognitive and language development than their Control counterparts. Second, we hypothesized that the 3Ts-HV caregivers would provide higher quantity of linguistic inputs for the child, i.e., higher adult word count (AWC) and higher conversational turn count (CTC), than their Control counterparts. Third, we hypothesized that the 3Ts-HV caregivers would engage in higher quality interactions with the child (i.e., more positive behaviors and less negative behaviors) than their Control counterparts. Given the emphasis on behavior change, we explored the intervention effect on the emotional dimension of caregiver interactions with the child (i.e., positive and negative emotions) in the present study.

2. Method

2.1. Participants

Caregiver–child dyads were recruited to participate in a study regarding young children's development through postings at child care centers, libraries, health clinics, local stores, public transportation, and community organizations serving low-income

populations in the Chicagoland areas between December 2014 and December 2017. Inclusion criteria were that caregivers[1] had a 13- to 16-month-old child born without significant cognitive or physical impairments, had legal custody of the child, spoke English as their primary language, and had a household income at or below 200% of the federal poverty line. Exclusion criteria were that caregivers were under 18 years old, received education beyond the baccalaureate level, did not live with the child, or did not spend at least two full days per week with the child.

Among the 1006 caregivers who expressed interest in the study, 532 did not meet the eligibility criteria and 83 did not proceed because they were no longer interested or unreachable after multiple contact attempts. Of the 391 caregivers who gave consent to participate in the preliminary assessment, 160 did not complete and 25 declined to proceed due to time constraints. Written consent was obtained from the remaining 206 caregivers for their participation in the study. These caregiver–child dyads were randomly assigned to either the 3Ts-HV intervention ($n = 106$) or Healthy Lifestyle control ($n = 100$) condition, using matched pairs randomization to control for child age and CTC (see detailed description below). Eleven 3Ts-HV and six Control dyads discontinued before the baseline assessment or the beginning of the curriculum. Of the 189 dyads (95 3Ts-HV; 94 Control) who received at least one curriculum module, 38 dyads (16 3Ts-HV; 16 Control) discontinued prior to post-intervention assessment. Together, 157 dyads (79 3Ts-HV and 78 Control), completed all study activities (76.21% of the original sample; 23.79% overall attrition rate). Each stage of the matched pairs RCT is illustrated in the CONSORT flow diagram (see Fig. 1). Primary reasons for attrition, from most to least frequent, were loss to follow-up after multiple attempts to contact, inability to continue participation due to time constraints and/or other commitments, or loss of child custody.

2.2. Design and procedure

The present study was a matched pairs parallel group RCT. All study activities were approved by the Biological Sciences Division Institutional Review Board at the University of Chicago Medicine (IRB#14-0895). To eliminate potential bias, all assessments and curricula were completed by two different research teams during separate visits at participant homes. Research assessors collected data for preliminary, baseline, and post-intervention assessments, whereas curriculum home visitors delivered the twelve curriculum modules. To minimize potential experimenter effect, assessors were blind to participant condition and performance throughout the course of the curriculum, whereas home visitors were blind to all observation and questionnaire data. All six research assessors and five home visitors were paraprofessionals who had at most a bachelor's degree; they were highly trained to follow the research protocol to collect data from or deliver the curriculum to the participants.

Specifically, a professional trainer who had five-years experiences in adult/teacher education and professional development conducted the training of all home visitors (three 3Ts-HV and two Control). In the initial two-week training, home visitors learned about the science supporting the intervention and the importance of implementation fidelity. They also learned to facilitate each element of the intervention, personalize the content for participating families, and develop partnerships with caregivers. Such training involved direct coaching, reviewing videos of previous home visits, observing actual home visits, and delivering the curriculum to a practice family, with feedback provided by the trainer at each stage. To ensure fidelity of implementation, the trainer reviewed ten percent of the total number of home visits and provided home visitors with feedback/coaching throughout the study.

Furthermore, to minimize subject expectancy effect, participants learned about the content specific to the curriculum they received only after randomization; they were never informed about the alternate curriculum. To control for the potential attentional effect experienced by participants in the intervention condition, those in the control condition received an analogous curriculum about healthy lifestyle for young children (a parallel group study design). To minimize extraneous variability across conditions, participants in both conditions filled out the same measures, completed the same number of LENA recordings, and received $200 compensation in total for participating in all study activities.

2.2.1. Preliminary assessment

In the preliminary assessment, caregivers completed the demographic questionnaire and received training on how to complete audio recordings with their child using the LENA digital device. Caregivers were given a LENA device to complete one full-day recording with their child during everyday activities at home. Each device allows up to 16 consecutive hours of recording. The device must be worn by the child in the front pocket of a t-shirt specifically designed for use with the LENA system during the recording. Caregivers were asked to record on a day typical to the child's routines, start recording at the beginning of the child's day, and continue to record without pause/stop. To minimize the Hawthorne effect, caregivers completed three LENA recordings within four weeks for the preliminary assessment; each recording must be at least 8 h long. Data from the three recordings were analyzed to generate an estimate of average adult-child vocal exchanges (i.e., CTC; Suskind et al., 2013), providing a baseline measure of the home language environment.

2.2.2. Matched pairs randomization

To increase the power and accuracy to detect significant intervention effects, following the completion of three LENA baseline recordings, a matched pairs randomization procedure (King, Nielsen, Coberley, Pope, & Wells, 2011) was applied to ensure baseline equivalence on child age and CTC across conditions. Similar caregiver-child dyads were paired according to child age in month and CTC tertile[2] at baseline. The closest match available was used for pairing when an exact match was unavailable. In each pair, the first caregiver–child dyad was randomly assigned to either the intervention or control condition by flipping a coin; the second dyad was automatically assigned to the alternate condition.

2.2.3. Baseline assessment, curriculum, and post-intervention assessment

Baseline assessment was completed upon randomization. Next, a six-month curriculum (either 3Ts-HV intervention or Healthy Lifestyle control) was implemented every other week. Post-intervention assessment was conducted upon the completion of all modules. In both baseline and post-intervention assessments, caregivers and their child participated in a 20-min videotaped, unstructured free play during which they were asked to play as they normally would with a given set of age-appropriate toys (includ-

[1] In this sample, 95% of primary caregivers were mothers, 2% were fathers, and 3% were grandmothers or other female relatives; thus, the entire sample was referred to as "caregivers".

[2] In this study, each participant's baseline CTC was converted to a LENA Natural Language Study corpus percentile; the percentile was then ranked according to the tertile ranges. CTC tertile ranges were based on data from the pilot RCT of the preliminary 3Ts-HV intervention (Suskind et al., 2015), with tertile breakdown consisting of 1st tertile (0–11 percentile), 2nd tertile (12–40 percentile), and 3rd tertile (41+ percentile).

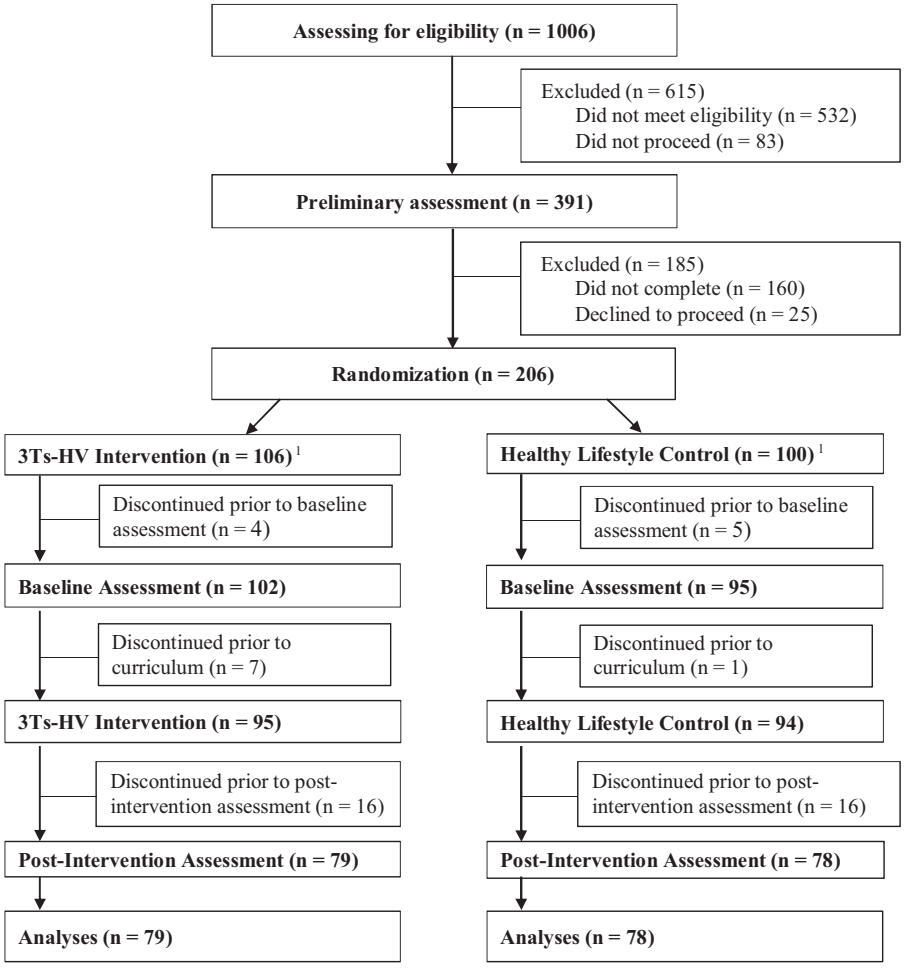

Fig. 1. CONSORT flow diagram illustrating each stage of the matched-paired RCT.

ing a baby doll, food toys, blocks, cars, plastic animal toys, puzzles, and picture books) in a designated area of their home. Then, caregivers completed measures on knowledge and/or language skills. To obtain a post-intervention measure of the home language environment, caregivers completed two full-day LENA recordings four weeks after the last modules; data from both recordings were analyzed to generate estimates on average.

2.3. Intervention and control conditions

Both of the intervention and control curricula were implemented in a sequence of 12 modules. A trained curriculum home visitor facilitated each module in a one-on-one session with the caregiver during a home visit.

2.4. 3Ts home visiting intervention condition

Caregivers in the intervention condition received the 3Ts-HV intervention, consisting of four core components. Each home visit began with a module viewing (25 min), followed by a practice session (10 min) and a feedback review (10 min), and finally ended with collaborative goal setting (10 min). Caregivers received an age appropriate children's book at the end of each visit.

2.4.1. Learning developmental science

Educating caregivers about developmental science was a fundamental component of the intervention. Standardized online modules were presented by home visitors to caregivers on a laptop computer. In each video module, scientific concepts were introduced to caregivers in plain language. Key concepts were illustrated using animation (e.g., early brain plasticity and development in Module 1). Home visitors were trained to ask questions to ensure caregiver understanding of the content as well as to help caregivers think about applying the content to their daily routines. The module viewing was interactive such that scientific concepts were translated into actionable knowledge and/or applicable behavioral strategies for caregivers through active discussions with the home visitor.

2.4.2. Social learning and guided practice

Transforming knowledge into actions through social learning and guided practice was a primary aim of the intervention. After introducing the scientific concepts, a specific behavioral strategy or parenting skill was demonstrated through animation (e.g., using process praise rather than person praise in Module 8). True-to-life video examples[3] were then presented to illustrate how parents implement the target strategy/skill with infants and toddlers (e.g., a mother praised her daughter for putting toys away in Module 8). Upon completion of each module viewing, caregivers learned how

[3] As part of the 3Ts-HV curriculum development, true-to-life video examples were created to demonstrate how parents successfully implement a specific behavioral strategy or parenting skill with their infants or toddlers. Parents were recruited and trained to master the specific strategy/skill with their child prior to the video recording. The sample was diverse in terms of their ethnicity and SES. None of them participated in the present RCT study.

to apply the target strategy/skill with their child through guided practice. To prepare for the practice, the home visitor first asked caregivers to talk about a suitable approach utilizing the target strategy/skill with their child. Caregivers then applied the target strategy/skill with their child during an activity (e.g., a mother engaged her child with a book through storytelling during the practice for Module 9). The practice exercise was videotaped and then reviewed with the home visitor. Caregivers received concrete, qualitative feedback on their strategy application or skill development, reinforcing the emphasis on enriching the child's early language environments.

2.4.3. Quantitative linguistic feedback

Besides social learning and guided practice, quantitative linguistic feedback was also a theory-driven technique utilized in the intervention to support caregiver language behavior changes (Suskind et al., 2013). Caregivers completed one LENA recording in the week between modules. Results of the LENA analysis of the home language environment were presented as quantitative linguistic feedback to caregivers in the form of easy-to-understand weekly reports. In these individualized reports, informative data about the amount of adult talk available to the child (i.e., AWC) and the frequency of adult-child conversational turn-takings (i.e., CTC) were presented, illustrating progress throughout the intervention program (see Suskind et al., 2015 for a detailed description). Reports also included the language environment norms drawn from the LENA Natural Language Study corpus (representative samples of the U.S. population with regard to parent education levels; Gilkerson & Richards, 2008). Specifically, the AWC and CTC population averages were presented to caregivers as prompts for more frequent language input and communicative interactions for the child at home (Suskind et al., 2013). Home visitors reviewed the reports of quantitative linguistic feedback with caregivers to stimulate discussions about progress and goals. During these discussions, the home visitor highlighted the caregiver's strengths, provided encouragement, and offered individualized problem-solving suggestions to foster a sense of self-efficacy in the caregiver. These discussions also informed the subsequent goal-setting activity.

2.4.4. Goal setting

Goal setting was another theory-driven technique utilized in the intervention to support language behavior change among caregivers. Upon reviewing the quantitative linguistic feedback reports, caregivers and home visitors set goals for the AWC and CTC as well as the target behavioral strategies for the following week. These goals were aligned with the emphasis of the intervention on increasing adult language input for the child and adult–child communicative interactions. In case the goals from the last session were not met, the caregiver and home visitor would review all previous quantitative linguistic feedback reports to identify the typical amount of language input and communicative interactions available in the household in order to develop realistic LENA goals for the caregiver. The goal-setting process happened collaboratively between caregivers and home visitors. The process was driven by caregivers to achieve self-identified goals (e.g. to maintain an 'above average' turn count and to implement language behavior changes) and directed by the home visitor to reinforce specific module content and to encourage modest, incremental goal ranges during each session.

Moreover, caregivers and the home visitor indicated where, when, and how the newly learned behavioral strategies along with the *3Ts* could be employed in everyday contexts to accomplish the target LENA recording goals. Caregivers identified potential barriers that might impede them from incorporating the new behavioral strategies into daily routine. Together with the home visitor, they discussed possible solutions to overcome the anticipated barriers. Caregivers then completed a goal-setting worksheet with the target AWC and CTC along with the identified behavioral strategies, which would be reviewed at the next home visit. Collaborative goal setting provided caregivers with an action plan along with achievable goals for applying the module knowledge and behavioral strategies into their daily routines to enrich the home language environments for their young children. This activity helped caregivers monitor progress, stay motivated, and develop awareness of language behaviors.

2.4.5. Healthy lifestyle control condition

Caregivers in the control condition received an analogous Healthy Lifestyle curriculum designed to promote caregiver knowledge and practices to develop a healthy lifestyle for their young children. Content of the curriculum was built upon the American Academy of Pediatrics, Bright Futures guidelines (Hagan, Shaw, & Duncan, 2008) on pediatric nutritional needs, healthy eating behaviors, and physical activities for obesity prevention in early childhood. Practices that could be implemented in everyday life to maintain a healthy lifestyle for young children were introduced to caregivers. Each home visit with caregivers in the control condition began with module viewing (15 min), followed by a discussion about their goals to develop a healthy lifestyle for the child (5 min). Caregivers received one recipe for a healthy family meal on a budget, along with information about nutrition or dental hygiene at the end of every other home visit. Notably, the emphasis of the control curriculum was always about the role of caregivers in developing a healthy lifestyle for their young children. All twelve modules were designed to solely focus on meeting nutritional needs, fostering healthy eating behaviors, and/or maintaining physical health of young children, without overlapping with the content of the 3Ts-HV modules.

2.5. Assessment

2.5.1. Caregiver knowledge of early childhood cognitive and language development

A shortened version of the Survey of Parent/Provider Expectations and Knowledge (SPEAK; Suskind et al., 2017) was used to assess caregiver expectations and knowledge about cognitive development and language learning from birth to 5 years old. It captures caregiver expectations about the malleability of intelligence (e.g., "How well a young child will do in school depends mostly on the natural intelligence he or she is born with"), understanding of the importance of early language experiences (e.g., "Infants learn little about language in the first six months of their life"), and perceptions about media use in child learning (e.g., "Children 0–2 years old can learn just as many words from educational TV as they can from their parents"). The SPEAK has been validated in diverse samples of adults. Three items are rated on a 6-point scale, ranging from 0 (*in elementary school 6 years and up*) to 5 (*as an infant 0–6 months*), and seven items on a 5-point scale, ranging from 0 (*strongly agree*) to 4 (*strongly disagree*). An overall score was calculated by summing the 10 items. Higher scores represented higher levels of knowledge. Cronbach's alpha coefficient for the current sample was .76.

2.5.2. Quantity of linguistic inputs for the child

The quantity of linguistic inputs for the child at home was estimated using the LENA technology (Suskind et al., 2015). Utilizing digital audio-recording devices and a specialized processing software, the LENA system automates the gathering and analysis of audio data on child vocalizations, adult vocalizations, and adult-child vocal exchanges in the home environments (Gilkerson & Richards, 2008; Gilkerson et al., 2017). To provide estimates of language environments, the LENA software analyzes audio data using speech recognition technology. Two estimates from the LENA anal-

ysis were examined in the present study to assess the quantity of linguistic inputs available for the child at home: adult word count (AWC) and conversational turn count (CTC). AWC is the number of words spoken by an adult surrounding the target child; it is a measure of adult word exposure, including overheard speech and child-directed speech. CTC is the number of vocal exchanges between an adult and the target child, capturing adult-child linguistic interactions. Child nap and/or sleep time was excluded from the LENA analysis.

2.5.3. Quality of caregiver interactions with the child

The quality of caregiver interactions with the child at home was assessed through coding caregiver behaviors and emotions towards the child during a free-play session at home, using four subscales of the Parent–Child Interaction System (PARCHISY; Deater-Deckard, Pylas, & Petrill, 1997). The PARCHISY is a global rating system designed to assess various aspects of observed parent–child interactions. It has been applied to capture socioeconomically disadvantaged parent behaviors and emotions towards their toddlers during play at home (e.g., Cabrera, Karberg, Malin, & Aldoney, 2017). In this study, Positive Behaviors (i.e., use of praise, explanations, and open-ended questions); Negative Behaviors (i.e., criticism, physical control, and intrusiveness); Positive Emotions (i.e., warmth, smiling, and laughing); and Negative Emotions (i.e., rejection, frowning, and cold or harsh tone) of the caregiver were rated on a 7-point scale, ranging from 1 (*none shown*) to 7 (*consistently shown/exclusive use*). Coding was completed by two independent coders who were trained to achieve reliability, with overall weighted Kappa = .81 and intraclass correlation coefficient (ICC) = .95. Both coders were blind to participant condition and research questions.

2.5.4. Covariates

Differences in caregiver knowledge, linguistic input quantity, and interaction quality might relate to other factors such as caregiver education level, language skills, marital status, and number of children living in the household (e.g., Rowe, 2008; Son & Peterson, 2017). To account for the potential confounding effects, these four variables measured at baseline were considered as potential covariates. Education level was ranked from 1 (*some high school*) to 5 (*four-year bachelor's degree*). Receptive language skills at baseline was assessed using the Peabody Picture Vocabulary Test-Parent (Dunn & Dunn, 2015), marital status was examined as a dichotomous variable, and the number of children was examined as a continuous variable.

2.6. Statistical analyses

2.6.1. Sample size and power analysis

Findings of the pilot RCT of the preliminary 3Ts-HV intervention showed that the average Cohen's *d* effect size was .66 (ranging from .49 to .88). Such effect size produced an average minimum required sample size of 87 (ranging from 44 to 134) in each condition for a test with 80% power, two-tailed alpha of .05. Thus, the current sample size of at least 90 in each condition met the average minimum sample size requirement.

2.6.2. Characteristics across conditions

All statistical analyses were conducted in SPSS 24. Chi-square tests and/or independent sample t-tests were conducted to compare the (a) attrition rate across conditions (3Ts-HV versus Control) and (b) baseline demographic characteristics between caregivers who completed and those who discontinued from the study. To examine whether or not the two conditions were balanced, baseline demographic characteristics were compared across conditions using chi-square tests and independent sample t-tests; all study variables at baseline were also compared in a multivariate analysis of variance (MANOVA).

2.6.3. Efficacy of the 3Ts-HV intervention

To identify relevant covariate(s), correlations between the seven dependent variables at baseline (knowledge, AWC, CTC, positive behaviors, negative behaviors, positive emotions, and negative emotions) and the four potential covariate variables (caregiver education, language skills, marital status, and number of other children living in the household) were analyzed. Variables that were significantly related to the dependent variable(s) would be examined as covariates. A mixed multivariate analysis of covariance (MANCOVA) was then applied to test the 3Ts-HV intervention impact on the dependent variables, controlling for the identified covariate(s). Condition (3Ts-HV vs. Control) was examined as the between-subject factor and time (baseline vs. post-intervention) was examined as the within-subject factor. Post hoc mixed analyses of covariance (ANCOVAs) were applied to examine the 3Ts-HV intervention impact on each of the seven dependent variables, above and beyond the identified covariate(s). Partial eta-square (η^2_p), a measure of effect size in ANOVA indicating the proportion of variance in the dependent variable attributed to a specific independent variable, was reported. Based on the Cohen's guidelines (1988), $\eta^2_p = 0.01$ is considered small, 0.06 is medium, and 0.13 is large.

3. Results

3.1. Attrition analyses

Results showed the attrition rate was not significantly different between the 3Ts-HV (25%) and Control (22%) conditions, $\chi^2(1) = 0.34$, $p = .56$. Caregivers who completed the study did not differ from those who discontinued in terms of age, relationship to the child, race/ethnicity, education, marital status, employment status, and LINK/WIC[4] recipient.

3.2. Characteristics across conditions

There were no significant differences between the two conditions in terms of demographic characteristics at baseline (see descriptive statistics in Table 2). Overall, a vast majority of the sample was mothers (95%), most of them identified as non-Hispanic African American (87%), and more than half of the sample was single (69%). Close to half of the sample had some college or postsecondary non-degree education (49%), less than half of the sample was employed (47%), and most of them received LINK and/or WIC (86%). Results of a MANOVA showed that the 3Ts-HV and Control caregivers did not significantly differ on their knowledge, linguistic input quantity (AWC and CTC), interaction quality (positive behaviors, negative behaviors, positive emotions, and negative emotions), and language skills at baseline, Pillai's Trace $F(8147) = 0.67$, $p = .71$ (see descriptive statistics in Table 3).

3.3. Efficacy of the 3Ts-HV intervention

Caregiver education levels, receptive language skills, and marital status were positively associated with knowledge, linguistic input quantity, and/or interaction quality at baseline (see Table 4). Thus, all three variables were examined as covariates in the following analyses. Mixed MANCOVA revealed a significant Time*Condition interaction, indicating a significant 3Ts-HV intervention impact

[4] LINK, Illinois Link program; WIC, Women, Infants and Children program.

Table 2
Baseline characteristics of the 3Ts-HV and Control caregiver–child dyads.[a]

	3Ts-HV	Control
Sample size	79	78
Caregiver characteristics		
Age in year (*M*, *SD*)	29.13 (6.24)	29.11 (7.40)
Relationship to the child		
Mother	77 (.98)	72 (.94)
Grandmother or other female relative	1 (.01)	3 (.04)
Race/Ethnicity		
European American, non-Hispanic	3 (.05)	5 (.07)
African American, non-Hispanic	61 (.91)	60 (.83)
Education level		
Some high school	7 (.09)	5 (.06)
High school graduate or equivalent	18 (.23)	20 (.26)
Some college credit or postsecondary non-degree program	35 (.44)	31 (.40)
Two-year associate degree	8 (.10)	10 (.13)
Four-year bachelor's degree	11 (.14)	12 (.15)
Marital status		
Single	54 (.68)	55 (.71)
Married or civil union	14 (.18)	14 (.18)
Employed	37 (.47)	37 (.47)
LINK/WIC recipient	65 (.82)	70 (.90)
Child characteristics		
Age in year (*M*, *SD*)	1.18 (0.10)	1.19 (0.10)
Female	37 (.47)	38 (.49)

Note. Abbreviations: 3Ts-HV, 3Ts Home Visiting Curriculum intervention; LINK, Illinois Link program; WIC, Women, Infants and Children program.

[a] Frequency and proportion are reported in Table 2 except as otherwise noted. Chi-squared tests and independent-sample *t*-tests revealed no significant differences between the 3Ts-HV and Control participants in terms of their demographics characteristics at baseline.

on the dependent variables, Pillai's Trace $F(7129) = 8.82$, $p < .001$, $\eta^2_p = .32$. Post hoc mixed ANCOVAs showed that the 3Ts-HV caregivers had significantly higher knowledge, AWC, and CTC relative to their Control counterparts after the intervention, $F(1,152) = 31.21$, $p < .001$, $\eta^2_p = .17$, $F(1,135) = 4.93$, $p = .03$, $\eta^2_p = .04$, and $F(1,135) = 5.30$, $p = .02$, $\eta^2_p = .04$, respectively. On average, the 3Ts-HV caregivers had an 18.24% increase in knowledge, 11.58% increase in AWC, and 44.47% increase in CTC, whereas Control caregivers had a 2.35% increase in knowledge, 10.65% decrease in AWC, and 13.82% increase in CTC.

Moreover, the 3Ts-HV caregivers significantly increased their positive behaviors (i.e., more frequent use of praise, explanations, and open-ended questions) and decreased negative behaviors (i.e., less criticism, physical control, and intrusiveness) relative to their Control counterparts after the intervention, $F(1151) = 15.96$, $p < .001$, $\eta^2_p = .10$ and $F(1151) = 5.95$, $p = .02$, $\eta^2_p = .04$, respectively. However, there were no significant differences between the 3Ts-HV and Control caregivers in terms of their positive emotions, and negative emotions after the intervention, $F(1151) = 1.43$, $p = .23$ and $F(1151) = 0.72$, $p = .40$, respectively.[5]

4. Discussion

The present findings provided empirical evidence supporting the immediate efficacy of the 3Ts-HV intervention in enhancing caregiver knowledge and promoting the linguistic input quantity and interaction quality in the context of low-SES households, controlling for caregiver education level, receptive language skills, and marital status. Utilizing quantitative and qualitative mixed-methods to assess the home language environments (i.e., LEAN measure of linguistic input quantity and observations of caregiver interaction quality) was the strength of the present study. Findings were discussed in light of implications and future research directions.

In support of the first hypothesis, the 3Ts-HV caregivers were significantly more knowledgeable than their Control counterparts after the intervention. Socioeconomic disparities in parental knowledge of child development have been linked to differences in parental education level and/or language proficiency (Bornstein, Cote, Haynes, Hahn, & Park, 2010; Rowe et al., 2016). Consistent with the literature, caregivers in the current sample who had lower levels of education and/or language skills were less knowledgeable at baseline. Through the twelve curriculum modules, the 3Ts-HV caregivers learned about the foundational science regarding brain plasticity in early childhood, the critical period for language learning, and lasting impact of language input on children's brain, cognitive and language development. Despite their education level, language skills, and marital status, these 3Ts-HV caregivers significantly gained knowledge about early childhood cognitive and language development after the intervention.

Parental knowledge of child development has been implicated in shaping the early home language environment, above and beyond parental education and language proficiency (Vernon-Feagans et al., 2008). Previous studies with socioeconomically disadvantaged families show that parents who are more knowledgeable provided more frequent language stimulations for their toddlers at home (Suskind et al., 2017; Zajicek-Farber, 2010). More frequent literacy-oriented stimulation activities in turn promoted emerging language competency in their toddlers (Zajicek-Farber, 2010). Findings of the present study indicated a substantially large effect size such that the 3Ts-HV intervention was highly efficacious in promoting knowledge of early childhood cognitive and language development among caregivers from low-SES backgrounds, despite their education level, language skills, and marital status. Enhancing caregiver knowledge is the first step to fostering their enrichment of the home language environment for their young children.

Moreover, findings of the present study confirmed the second hypothesis regarding the linguistic input quantity. Compared with their Control counterparts, the 3Ts-HV caregivers provided more adult word exposure for and engaged in more conversational turn-takings with their child after the intervention. During the six-month intervention, the 3Ts-HV caregivers received quantitative linguistic feedback and developed LENA goals in enriching the home language environment. Through identifying where, when, and how they could have implemented the target behavioral strategies along with the *3Ts* in everyday contexts, these caregivers have learned to maximize the amount of language inputs for their child.

More importantly, the 3Ts-HV intervention is built upon the premise that child-directed speech is key to facilitating very young children's cognitive skills and language learning (Weisleder & Fernald, 2013). In particular, the temporal connectedness, contextual relevancy, and stimulating nature of conversational turn-taking are critical to the development of cognitive and language abilities during infancy through toddlerhood (Tamis-LeMonda et al., 2014). Recent findings revealed that conversational turn counts promoted neural language processing, which in turn enhanced verbal abilities among preschool children, over and above SES and/or adult word exposure (Romeo et al., 2018). Thus, the main emphasis of the 3Ts-HV intervention is to foster the reciprocal nature of language exchanges/interactions with young children. In addition to increasing the amount of language exposure available for their young child, the present findings were significant such that despite caregiver education level, language skills, and marital status, the 3Ts-HV intervention was efficacious in promoting

[5] Prior to randomization, 19 participants (14 Intervention; 5 Control) reported knowing someone participating in the present study. To eliminate potential contamination bias across conditions, each of these 19 participants was automatically assigned to the same condition as the participant they knew. All other participants confirmed that they did not have prior knowledge about any of our curricula. Preliminary analyses revealed non-significant differences in the variables of interest at baseline between these 19 participants and all other participants.

Table 3
Means and standard deviations of all study variables among 3Ts-HV and Control caregivers.

	Baseline				Post intervention			
	3Ts-HV		Control		3Ts-HV		Control	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Caregiver knowledge	27.90	6.27	27.71	7.53	32.99	6.72	28.36	7.93
Adult word count	11237.94	5606.67	10819.02	5645.32	12539.17	6997.22	9666.84	5355.40
Conversational turn count	235.85	116.61	241.93	118.73	340.74	176.99	275.36	196.15
Positive behaviors	4.46	1.23	4.52	1.36	5.53	1.28	4.64	1.48
Negative behaviors	2.42	1.08	2.22	1.28	1.71	0.95	2.04	1.17
Positive emotions	4.43	1.47	4.21	1.34	4.76	1.54	4.21	1.60
Negative emotions	1.48	0.73	1.48	0.82	1.38	0.70	1.50	0.77
Receptive language skills	84.00	13.39	83.77	15.03				

Table 4
Pearson correlations between the seven dependent variables and the four potential covariates at baseline.

	Education level	Receptive language skills	Marital status	Number of children in household
Caregiver knowledge	.40**	.60**	.24**	−.07
Adult word count	.08	.10	.07	.12
Conversational turn count	.08	.17*	.12	.05
Positive behaviors	.21*	.42**	.11	−.06
Negative behaviors	−.05	−.30**	−.14	.09
Positive emotions	.11	.20*	.25**	.07
Negative emotions	−.03	−.08	−.05	.14

* $p < .05$.
** $p < .01$.

caregiver-child conversational turn-takings among low-SES families as early as toddlerhood.

Furthermore, findings of the present study supported the third hypothesis regarding the behavioral dimension of caregiver interaction quality. Compared with their Control counterparts, the 3Ts-HV caregivers engaged in more positive behaviors and less negative behaviors when interacting with their child after the intervention. Caregiver language inputs and cognitive stimulations that are contingent to the focus of children's attentional and/or communicative intents have been shown to promote young children's language learning, cognitive processing skills, and understanding of cognitive and social interactions (Hirsh-Pasek & Burchinal, 2006; Nievar et al., 2014; Tamis-LeMonda et al., 2001). On the other hand, caregiver intrusiveness such as the use of directives (i.e., short verbal commands that offer no reasoning nor opportunity for child inputs), prohibition and restriction, interference, and/or physical guidance and restraint have been shown to minimize young children's emerging exploration desire, cognitive functioning, and language abilities (e.g., Hubbs-Tait et al., 2002; Nievar et al., 2014). Building upon the scientific evidence, the 3Ts-HV intervention focuses on supporting caregivers to implement linguistic/cognitive-stimulating behavioral strategies in their everyday lives.

With continuous guidance, practice, and feedback during the six-month intervention, the 3Ts-HV caregivers learned to better implement the target behavioral strategies. Compared with baseline, they were more likely to praise and encourage their child's efforts and/or desirable behaviors, use explanations and scaffolding, provide cognitive stimulations through open-ended questions, and minimize the use of directives, criticism, and intrusive control towards their child. Results of the present study revealed a moderate effect size such that the 3Ts-HV intervention was efficacious in fostering positive behavior changes among socioeconomically disadvantaged caregivers within six months, despite their education level, language skills, and marital status. In contrast, the 3Ts-HV intervention did not appear to have an immediate impact on the emotional dimension of caregiver interaction quality. Findings of the present study revealed non-significant differences in the positive emotions and negative emotions between the 3Ts-HV and the Control caregivers after the intervention. Given the emphasis on behavior changes in the 3Ts-HV intervention, expressions of caregiver emotions were perhaps only implied throughout the twelve modules without being explicitly addressed. Nonetheless, the effectiveness of the intervention in fostering caregiver behavior changes that promote their young child's development is critical in addressing early language disparities in the context of low-SES households.

4.1. Limitations and future directions

There are several limitations in the present study. To evaluate the efficacy of the 3Ts-HV intervention, the present study examined post-intervention changes in caregiver knowledge, linguistic input quantity, and caregiver interaction quality. However, the present study did not consider the diversity and complexity of linguistic inputs. Disparities in the diversity and complexity of linguistic inputs significantly contribute to smaller vocabularies and lower language skills among children with low-SES backgrounds (e.g., Hart & Risley, 1995; Hoff, 2003; Rowe, 2012). Future studies will examine the impact of the 3Ts-HV intervention on caregiver vocabulary diversity and sentence structure complexity.

To examine the immediate efficacy of the 3Ts-HV intervention, the present study analyzed baseline and post-intervention assessment data. Our larger longitudinal research study is currently following the caregiver-child dyads over 5 years through the children's kindergarten entry. Utilizing longitudinal data from multiple assessment points, future studies will examine the sustainability of caregiver knowledge gain and behavior changes as well as the potential long-term intervention impact on their children's cognitive functioning and language skills.

Moreover, attrition in the present study might have limited a full evaluation of the efficacy of the 3Ts-HV intervention. An overall 23.79% attrition rate, though comparable with the attrition rates in other home visiting programs (see Peacock et al., 2013 for a review),

reflected the difficulties with retaining participants in the present study. Such an issue might be especially salient when working with socioeconomically disadvantaged caregivers of young children due to unstable lifestyles, time constraints, and/or multiple life stressors, etc. The present findings revealed no differences in demographic characteristics between caregivers who discontinued and those who remained. Yet, the ability to retain participants over time is essential for a home-visiting intervention to impact socioeconomically disadvantaged caregivers and their young children on a population level in order to address the SES-related disparities in early language exposure. Currently, we are exploring partnerships such as communities or healthcare centers in terms of implementing/scaling the intervention with a more sustainable approach.

Furthermore, the sample of the present study exclusively involved caregivers of young children within the age of 13–16 months. Even though the content materials of the 3Ts-HV intervention do apply to children ranging from infants to toddlers, this longitudinal study is designed to focus on early toddlerhood in order to investigate the intervention impact on the early language environments of young children in this developmental stage. Considering the relatively wide child age range typical for home visiting programs (e.g., birth to three years old; Peacock et al., 2013), the narrow age range might have limited the generalizability of the present study to early toddlerhood. Nevertheless, findings of the present study were significant by showing the efficacy of the 3Ts-HV intervention in promoting linguistic input quantity and caregiver interaction quality as early as 13–16 months old. Future research will examine the possibility to implement this intervention with a wide age range within the setting of communities or healthcare centers.

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