Word Learning Ability in 24-Month-Olds: Interaction of Mother's Work Status and Education Level

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1. Introduction

According to a report from the U.S. Bureau of Labor Statistics (2021), up until 2019, 55.4% women who are older than 16 are employed, and 49.3% of them are mothers. Among them, 63.8% of working mothers have children under age 3. Previous surveys have shown that for families with working mothers with children under age 5, childcare arrangements are split between relying on other familial members (29.3% father, 42.1% grandparent, sibling, or other relative) and daycare settings (53%) (Laughlin, 2013). Though research does not fully support the claim that mothers entering the workforce negatively impacts children's development (Brooks-Gunn et al., 2010; Côté et al., 2007), mothers continue to report guilt and shame when returning to work postpartum (Hoffman, 1974; Segura, 2016).

The discussion regarding how maternal employment influences child development is far from settled. Some studies supported that children benefit from their mothers being employed (Gregg et al., 2003; Hsin & Felfe, 2014; Vandell & Ramanan, 1992), while a body of research suggests that maternal employment (or mothers returning to the workplace) in infants' early life is negatively associated with child outcomes, including vocabulary, reading skills, and mathematical skills (e.g., Baum II, 2003; Berger et al., 2008; Brooks-Gunn et al., 2002, 2010; Hill et al., 2005; Waldfogel et al., 2002). This negative association has been attributed to employment taking mothers' time and energy away from maternal care and leading to a decrease in the quantity and quality of mother-child interactions (Baum II, 2003; see Heinrich 2014 for review). However, much of the research that found a negative correlation between maternal employment and children's later outcomes was mainly limited to maternal employment during the first year of infants' life (e.g., Baum II, 2003; Waldfogel et al., 2002). Once children grow beyond one-year of age, maternal employment in the second and third year of the infant's life yields a positive effect on the child's cognitive and academic skills at age 7 to 8. (Waldfogel et al., 2002).

As to the possible mechanisms that underlie the positive effect of maternal employment on child development, many studies have pointed out that mothers

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who are employed tend to be more educated, and/or have higher incomes than those who do not go back to work, which in turn positively relate to child outcomes (Gregg et al., 2003; Hsin & Felfe, 2014; Vandell & Ramanan, 1992). Meanwhile, working mothers place more emphasis on the quality rather than quantity of shared activities, such as educational and structured playtime with their children (Booth et al., 2002; Hsin & Felfe, 2014). In addition, working mothers tend to send their children to high quality center-based daycares and have higher maternal sensitivities (Brooks-Gunn et al., 2010). Studies have shown that children of working mothers who use non-maternal care resources may develop better language skills because they have richer and varied language input (e.g., interactions with caregivers and peers, educational toys, books, etc; Milne et al., 1986; Yoshikawa, 1999). Recent evidence reveals that a combination of maternal and other-caregiver's care, compared to only maternal care or nonmaternal care, is correlated with better language development in 18-month-olds (Laing & Bergelson, 2019).

Other factors, such as socioeconomic status (SES), have been proposed to be the underlying mechanism that drives the above-mentioned developmental outcome variations (Baum II, 2003; Letourneau et al., 2013). Previous studies consistently demonstrated that SES is positively associated with children's language skills and lexical development across cultures (Fernald et al., 2013; Hoff, 2003; Noble et al., 2006; Letourneau et al., 2013; Pungello et al., 2009). While considering both SES and maternal employment, Baum II (2003) suggested that SES functions as a mitigating factor, such that higher SES background may counteract the negative effects of maternal work on infant's development. Highly educated mothers are more likely to balance childcare and work compared to mothers with low educational attainment (Hsin & Felfe, 2014). Sufficient economic strength may also be a prerequisite for high-quality child care and early education, and high-quality child care may supplement the reduced maternal care due to mother's work, as high-quality child care at young age is associated with infants' higher vocabulary and better cognitive and language skills (e.g., Noble et al., 2006; Belsky et al., 2007; Burchinal et al., 2000; Gialamas et al., 2014; Gormley et al., 2005; Mashburn et al., 2008; National Institute of Child Health and Human Development [NICHD] Early Child Care Research Network, 2005).

Though recent studies have begun to focus on how these factors relate to, and may even be responsible for, language outcome differences that have been observed across childcare settings, it remains unclear how maternal work status and maternal education jointly affect young children's language development. In addition, most existing studies used off-line measures, such as parentally reported vocabulary size, to assess infants' language development in relation to maternal education and work status (e.g., Magnuson et al.,2009; Brooks-Gunn et al., 2010). Compared to parental reports of vocabulary size, a real-time assessment of novel word learning ability may be more sensitive in reflecting potential learning differences. Using a Mutual Exclusivity (ME) task, Bion and colleagues (2013) demonstrated that while 2-year-olds as a group can reliably identify the correct object among two items upon hearing a label, only some of the participants performed at above-chance level in a retention task that involved novel word

learning. The large individual differences within this age group on the ME-based novel word learning task is of particular interest for two reasons. The first is that previous studies, together with Bion et al. (2013) suggested a partial dissociation between differentiating familiar objects and learning new words (e.g., Horst & Samuelson, 2008), and that MCDI-based parental reports were not designed to assess the latter. In addition, modeling work has shown that the learning process for retaining novel object-label mapping differs from that of disambiguation (McMurray et al., 2012), and that a retention task based on novel word learning is more challenging. This more challenging aspect of lexical development, however, has not been investigated within the context of maternal care and education.

The current study aims to address the gaps by examining both maternal work status and maternal education attainment to understand how they in concert affect 24-month-old infants' productive vocabulary size and word learning ability. Crucial to our interest, we have implemented the more challenging, retention, trials in an ME task to assess real-time utilization of skills related to lexical development. We examined 24-month-old infants for two reasons: 1) since previous studies reported negative effects of maternal employment on child development when infants were younger than one year old and positive effects when they enter the 2nd and 3rd year of their lives, we should expect that as infants grow and amass more linguistic knowledge, this older age group may start to benefit from maternal employment and childcare experience in all aspects of language development; 2) the more challenging ME-based retention trials from Bion et al. (2013) were not learnable to 18-month-olds, whereas some 24-month-olds were able to succeed in the task. This age group will therefore allow us to investigate the potential effects in infant language development with abundant developmental differences.

2. Methods

2.1. Participants

One hundred and eight 24-month-old infants were recruited in the study (M = 24.5 months; range = 24.02 – 27.07 months, 57 Females). All participants were typically developing children from monolingual English-speaking families. Most of the participants (89.5%) were Caucasian, 2% were Hispanic, 2% were Black, and 6.5% were from multiracial backgrounds. No participants have reported hearing or speech problems. Participating families received monetary compensation for their time.

2.2. Measures

2.2.1. Maternal Education and Maternal Work Status

Parents completed a survey, reporting basic family background information including maternal education as well as their occupations. Mothers chose the highest degree they have earned from seven options: 1 = eighth grade completion, 2 = high school diploma, 3 = two-year college degree, 4 = some college, 5 = four-

year college degree, 6 = master's degree, 7 = doctoral degree). Maternal education was coded into three groups: not having a four-year college degree = "low educational attainment", four-year college degree = "middle educational attainment", and above to college degree = "high educational attainment". For Maternal Work Status, parents provided their current occupations directly. Content including "unemployed", "caregiver", or "stay at home moms" were coded as At Home while and mothers with all other occupations were coded into the Working group.

Based on the additional information reported in the questionnaire, such as father's work status and listing the adults who were living in the household, we noticed that most of the participants in our sample who had working mothers (52 out of 59) also had working fathers; and no other adults, such as grandparents, uncles/aunts, were at home helping take care of the infants. We therefore took the Working category to indicate that those infants very likely attended daycare instead of receiving at-home care.

2.2.2. Productive Vocabulary Assessment

Caregivers completed the MacArthur-Bates Communicative Development Inventory: Words & Sentences (CDI; Fenson et al., 2006). The obtained vocabulary score was the number of words parents reported their child produced.

2.2.3. Novel Word Learning Task

Infants' novel word learning ability was measured by a mutual exclusivity (ME) task (adopted from Bion et al., 2013) and took place in the lab.

Stimuli. The visual stimuli were pictures of six familiar objects (truck, bubbles, blanket, cheese, balloon, spoon) and two novel objects (see Fig. 1), each centered on a grey background in a 640 X 480 pixel space. The speech stimuli were sentences consisting of brief carrier frames each ending in the name of one of the six familiar objects or two novel objects (e.g., modi and dofa), followed by simple questions produced by a female native speaker of American English (e.g., Where is the truck? Can you see it?). The duration of the target nouns and intensity of the sentences were normalized using Praat speech analysis software (Boersma, 2001).

Procedure. Accuracy in identifying the correct target picture was assessed using the Looking-While-Listening procedure (see Fernald et al., 2008). Participants sat on their caregiver's lap and viewed pictures of objects as they listened to speech naming one of the pictures. On each trial, a pair of pictures was presented on the screen for approximately 6s, with the speech stimuli starting after 2s, followed by 1s of silence. Each infant was presented with 28 trials, consisting of three different trial types (see Figure 1): On twelve Training trials, each novel object served as the target six times, with a single novel object presented during labeling. On eight Recognition trials, each novel object was paired with a familiar object, and the familiar objects were named during labeling. On eight Retention

trials, both novel objects were shown side by side, with one of them named during labeling.

The Recognition and Retention trials were interspersed after the Training trials. The target object was named only once per trial. Pairings of novel and familiar objects were counterbalanced across participants. The side of presentation of the target was also randomized to ensure that the target did not appear on the same side of the screen in more than two consecutive trials. Six attention-getting filler trials with colorful and visually complex scenes appeared after every four trials, accompanied by child-directed phrases such as ‘‘Hey, look at that! That’s cool!’’. Caregivers wore opaque glasses so that they could not influence infants’ looking behavior. The entire procedure lasted 5 minutes.

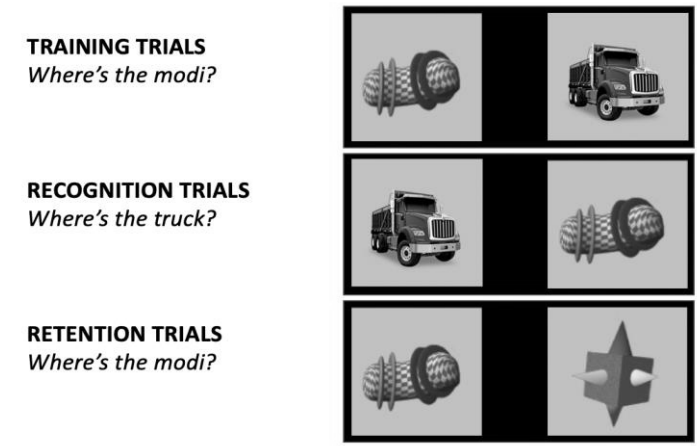

Figure 1. Three types of trials in the ME experiment

Coding and Analysis. Infants’ looking behavior during the trials was video-recorded and coded offline frame-by-frame at 33 ms intervals by observers who were blind to trial type (following the procedure described in Fernald et al., 2008). 25% of trials across participants were randomly selected and independently coded for whether an infant was looking at the picture on the left or the picture on right, transitioning between pictures, or off task. Agreement between coders within a single frame was greater than 99%.

Consistent with previous studies, trials in which infants were looking away from both pictures or shifting from one to the other were not included in these analyses (Fernald et al., 1998, 2006), nor was accuracy before 300 ms included (Haith et al., 1993). Following the rationale in Bion et al. (2013), we also adopted a longer window (3300ms, which encompasses the entire trial duration) because on the majority of trials the visual stimuli included one or two novel objects, which elicited more shifting back and forth between target and distractor than do sequences of trials on which only familiar objects are presented. Mean accuracy was then computed for each participant on each trial type as the mean proportion

of time looking to the target divided by the mean proportion of time looking to the target or to the distracter.

Though our primary interest lies in the results from the Retention trials, which are the most challenging, we also analyzed the Training trials to ensure that learning has occurred.

2.3. Data Preparation

Four participants were excluded from the analysis because they did not report either maternal education or maternal occupation. Of the remaining 104 participants, 13 parents did not report the MCDIs, and 26 participants did not contribute to more than half of each of the 3 types of trials in the ME task and therefore did not generate usable ME data. Little's MCAR test indicated that missing data occurred at random, $\chi 2$ (8, N = 76) = 3.583, p = .694. EM Imputation was used to handle the missing data. In the full data with EM, Shapiro–Wilks tests indicated that the distribution of productive vocabulary was normally distributed, W = .982, p > .05, while the ME performance was not normally distributed, W = .959, p < .01. Four outliers were then removed from the dataset, and 100 participants were included in the final analytical sample.

3. Results

All analyses were conducted in SPSS 25.0 (IBM Corp, 2017). Descriptive analysis showed that 59 mothers belonged to the Working category and 41 mothers were in the At Home group. Twenty-seven mothers did not obtain a college degree, 49 mothers had a college diploma, and 24 mothers achieved a master's degree or doctoral degree. The reported productive vocabulary size ranged from 10 to 645, and the mean of the participant' productive vocabulary size is 279.47, SD = 146.59; the average accuracy of the participants' novel word learning ability is .53, SD = .11. Productive vocabulary and word learning ability were closely connected, r = .403, p < .001. Table 1 provides descriptive statistics for the groups' productive vocabulary and word learning ability.

To examine the interactive effect of maternal education and work status on children's vocabulary, a Maternal Education x Maternal Work Status (3 x 2) factorial between-subject analysis of variance (ANOVA) was conducted for productive vocabulary (Maternal Education Levels: low, middle, high; Maternal Word Status: working, at-home). Results showed that there was no main effect of Maternal Education, F (2, 94) = 2.157, p = .121, $\eta 2$ = .04, nor a main effect of Maternal Work Status, F (1, 94) = .778, p = .38, $\eta 2$ = .01. Neither Maternal Education nor Maternal Work Status impacted 2-year-olds' productive vocabulary size as assessed by parental report using the MCDIs. Similarly, the interaction effect of Maternal Education x Work Status on infants' productive vocabulary was not significant, F (2, 94) = 2.092, p = .129, $\eta 2$ = .04. Figure 2 provides a visual representation of infants' productive vocabulary size as a function of maternal education and work status.

Table 1. Groups' Means (and *SD*s) in Productive Vocabulary and Novel Word Learning

Groups		Productive Vocabulary	Novel Word Learning
LME	Working (N = 11)	301 (165.79)	.55 (.11)
	At home (N = 16)	235 (147.86)	.45 (.08)
MME	Working (N = 28)	243 (137.20)	.53 (.11)
	At home (N = 21)	300 (127.51)	.55 (.10)
HME	Working (N = 20)	308 (159.56)	.60 (.13)
	At home (N = 4)	411 (113.84)	.55 (.12)

Note. LME: Low Maternal Education group (mothers do not have college degree); MME: Middle Maternal Education group (mothers have a college degree); HME: High Maternal Education group (mothers have a graduate degree).

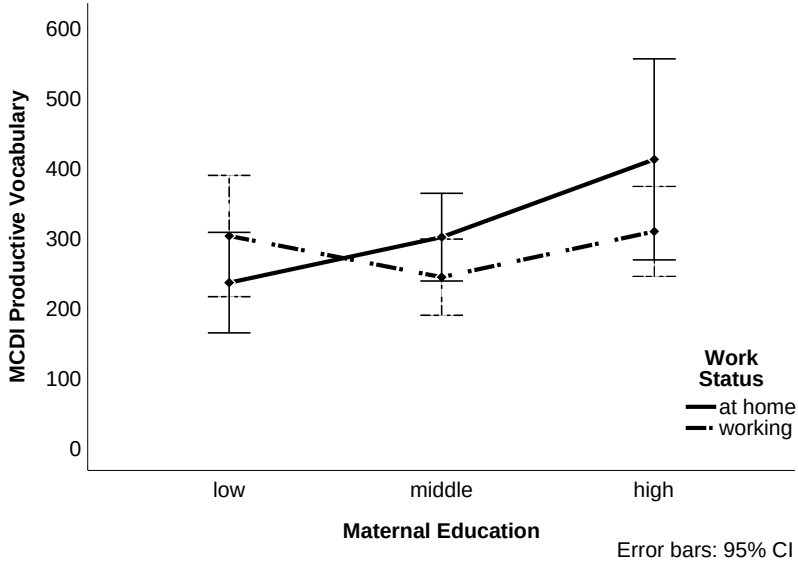

Figure 2. Productive Vocabulary as a Function of Maternal Education and Work Status

Regarding the ME task performance, we first tested infants' performance on the training trials to ensure that they were able to identify known objects in the setup. As a group, a paired-sample t-test showed that participants performed above change on the training trials, $t(99) = -3.16$, $p = .002$, $d = .364$. Infants looked more at the correct object when they heard its label in this task. Since our primary interest is infants' ability to then use ME to learn novel word-object mappings, we next ran a Maternal Education x Work Status ANOVA on infants' accuracy on the challenging retention trials. Interestingly, there was a significant main effect of Maternal Education on ME (as assessed by retention accuracy), $F(2, 94) = 2.431$, $p = .019$, $\eta 2 = .05$, indicating that infants with mothers who attained higher education were more accurate at using ME to learn novel object labels. There was also a significant Maternal Education x Work Status interaction effect, $F(2, 94) = 3.82$, $p = .025$, $\eta 2 = .08$. As a follow up, we ran a series of independent samples t-tests. There were no differences in infants' novel word learning ability across the three SES groups with working mothers. However, for the groups of mothers with a low educational attainment, infants whose mothers were in the Working group exhibited higher novel word learning ability compared to their Maternal Education-matched counterparts, $t(25) = 2.85$, $p = .008$, $d = 1.08$. Figure 3 provides a visual representation of children's novel word learning ability as a function of Maternal Education and Maternal Work Status.

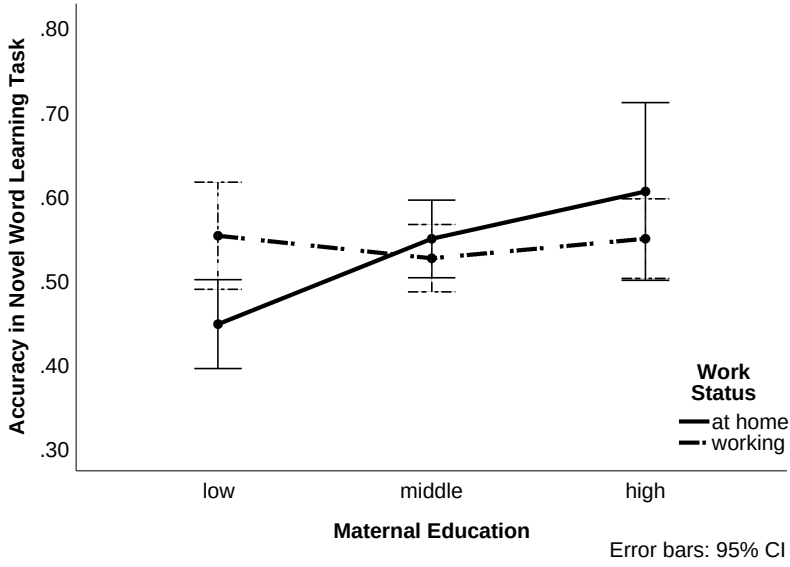

Figure 3. Novel Word Learning (in a ME Task) as a Function of Maternal Education and Work Status

4. Discussion

The current study investigated how different components of maternal background (maternal education and work status) affect two-year-olds' language development, specifically productive vocabulary size and novel word learning ability. The findings suggest that while there were no differences in infants' vocabulary size as a function of maternal education or work status, infants differed in their ability to learn new words. Specifically, while only middle- and high-SES groups patterned together on their looking behavior in the ME task for infants who have maternal care, for infants whose mothers were working, their looking behavior did not differ across the SES groups.

Perhaps surprisingly, in our sample, infants' productive vocabulary size was not affected by either maternal education level or maternal work status. This is partly inconsistent with previous studies that found a positive correlation between maternal education and children's vocabulary development. For instance, Magnuson et al. (2009) found that increases in maternal education while infants were 24 to 36 months were associated with more productive and receptive language skills at 36 months. It has also been posited that children of mothers with less educational background could face challenges in language development as these children may experience a lower degree of maternal responsiveness and less maternal language input (Hoff, 2013; Lonigan et al., 2013). However, when we considered both maternal education and maternal work status in our study, there was no significant difference in 24-month-old infants' concurrent productive vocabulary size across these groups.

The inconsistency could be attributed to that productive vocabulary size was measured by an offline measure - the MCDI of infant's vocabulary size, which may not capture these language variations related to maternal factors at this age. The validity of a parental report depends on how much time the parent spends with the infants, and how much attention they pay to the infant's language development (Laing & Bergelson, 2019). It is possible that there are variations of accuracy in vocabulary size reported by full time working mothers versus at home mothers, as well as by mothers with different levels of education or attentiveness toward infants. Instead, we found that there was a significant interaction effect of maternal education and work status on infants' novel word learning ability, which is measured by a lab-based ME task. Since we used the accuracy in the most challenging trials - Retention trials - to assess if novel word-object mappings were learned and retained, the finding may suggest that the real-time language measures, especially more challenging ones, might be more sensitive to examine the variations in infant's language development.

Extending from previous research, we showed that across three groups of varying levels of maternal education, 2-year-olds with working mothers do not differ in their ability to learn new words, while the only difference exists in the infants cared for by their mothers of different education levels. This finding goes against the "rich get richer" framework of language development, though the source of differences in infants' novel word learning ability remains to be identified. Importantly, this finding suggests that regardless of the levels of

maternal education, if the mother is working (and therefore using nonmaternal care for their infants), infants' language development is on par with those in the other groups. It should be noted that the present study did not inquire about the specific types of care utilized by each participating family, and that we should therefore be cautious not to equate children with working mothers to children attending daycare.

The results imply that childcare (including different forms of nonmaternal care) may be an equalizer for infants' language development across families with varying levels of maternal education. This is in line with previous research that related attending childcare to enhanced cognitive and language development. For instance, Belsky (2006) found that compared with care provided by mothers and other relatives, center-based childcare as well as home-based childcare better benefit children's verbal comprehension concurrently. In addition, high-quality childcare is proved to be linked with larger vocabulary size, better reading proficiency, and enhanced verbal analogical abilities in the first 3 years of life (Burchinal et al., 2000; NICHD Early Child Care Research Network, 2002). Together, these findings point to the importance of providing accessible childcare, particularly to infants and toddlers who may be lagging behind on their language development due to limited home language environments.

This study also has a few limitations. First, specific information of participants' daycare status as well as the type or quality or care were not collected in the present dataset. Future studies should incorporate measures to capture and evaluate these variables in order to pinpoint the compensatory effect that nonmaternal care may bring. Second, we used maternal education attainment as a categorical variable in an attempt to approximate levels of SES. Studies should also address the differences between mothers who work part-time versus full-time, since the two types of work status bring differences to the home beyond the number of hours a mother works.

In sum, the present study contributes to the literature on the consequences of maternal education and work status on infants' language abilities through both offline and online language measures. It suggests that compared to parental reports of vocabulary size, lab-based real-time language measures may be more sensitive to capture differences in language development in relation to maternal backgrounds. This work also highlights the potential of using a more challenging task of language development beyond the MCDIs for infants as young as 24-month-old. Additionally, this study has practical implications to mothers in the labor force and points to the importance of examining if nonmaternal care around 2-year of age can be a positive supplement to maternal care in facilitating children's lexical development.

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