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Assessing speech exposure in the NICU: Implications for speech enrichment for preterm infants

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Abstract

Objective: Quantify NICU speech exposure over multiple days in relation to NICU care practices.

Methods: Continuous measures of speech exposure were obtained for preterm infants (*n* = 21;12 M) born <34 weeks gestational age in incubators (*n*=12) or open cribs (*n*=9) for 5–14 days. Periods of care (routine, developmental) and delivery source (family, medical staff, cuddler) were determined through chart review.

Results: Infants spent 13% of their time in Care, with >75% of care time reflecting Developmental Care. Speech counts were higher during care than no care, for mature vs. immature infants, and for infants in open cribs vs. incubators. Family participation in care ranged widely, with highest speech counts occurring during periods of intentional voice exposure.

Conclusions: Care activities represent a small portion of NICU experiences. Speech exposure during Developmental Care, especially with intentional voice exposure, may be an important source of stimulation. Implications for care practices are discussed.

Introduction:

Medical advances over the last 50 years have led to dramatic improvements in survival rates for children born preterm (1). Despite these many advances, over half of children born very preterm (i.e., <32 weeks gestation) continue to face increased risks of neurodevelopmental impairments (2–8), including language and learning disorders (9–15). Poor language skills can lead to poor social relationships (16), academic and occupational underachievement (17), and high utilization of special education (18). Optimization of current clinical

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approaches are needed to ensure positive neurodevelopmental outcomes for children born preterm.

Recent observational studies of preterm infants have shown that the amount of speech experienced by infants in the neonatal intensive care unit (NICU) is related to changes in brain structure and in language outcomes at 2 years of age (19–21). Consistent with these findings, recent experimental studies have also shown that increasing the amount of speech that preterm infants hear in the NICU can lead to improvements in cardiorespiratory stability (22,23), growth and feeding outcomes (24–26). Factors associated with increased speech exposure in the NICU include family presence at bedside, family participation in care activities, and NICU room design (single patient versus open bay) (27). However, studies have yet to directly compare amounts of speech exposure provided by different NICU care practices and caregivers to preterm infants. Such data are needed to identify which care practices and caregivers offer greater amounts of speech exposure and to identify care practices that may offer opportunities for speech enrichment to preterm infants.

In the current study, we aimed to measure and compare amounts of speech exposure provided during various NICU care activities and by caregivers of preterm infants. We obtained extensive, round-the-clock samples of the NICU speech environment over multiple days of an infant's hospital stay using Starling (Versame, Inc, Menlo Park, CA), a small (~ 5 × 5 cm), humidity resistant device that generates speech counts continuously over a period of approximately 4 days. To determine the relative amounts of speech exposure that occurred during various care times, we aligned continuous estimates of speech exposure to information from chart review of each individual infant's care activities and interactions with care providers. Taking this approach, we found differences in the amounts of speech exposure from different NICU care practices and caregivers. We discuss these findings in the context of identifying potential opportunities for speech enrichment in the NICU.

Methods

Subjects

In this prospective, observational study, participants were $n = 21$ infants born preterm representing a range of postmenstrual ages (PMA), cared for in one or more neonatal care units at a major children's hospital. Inclusion criteria included preterm birth < 34 weeks gestational age (GA). All infants were deemed stable enough for intentional sound exposure by evidence-based institutional developmental care protocols. Infants on high frequency oscillatory ventilation (HFOV) were excluded due to increased background noise that might interfere with estimates of speech exposure. Participants were enrolled between July - December 2018. A University Institutional Review Board approved the study and informed consent was obtained from all parents/guardians.

Protocol

Starling devices were used for measurement of speech counts. Starling does not incorporate recording technology, removing concerns about privacy and biases which may alter speech behavior. Importantly, the speech recognition algorithms in Starling were designed to be particularly robust in the presence of environmental noise, an advantage in the often noisy NICU environment. We validated speech counts from Starling by comparing to speech measures obtained from a Language Environment Analysis (LENA) digital language processor (LENA Research Foundation, Boulder, CO), a device used previously in studies assessing NICU sound environments (20,27) (see Supplemental materials).

After informed consent was obtained, 2 Starling devices were placed at the head of the infant's bed. Approximately every 5 days, a research assistant (RA) collected the devices and downloaded the output containing the automatic speech counts per 5 minutes. The devices were then charged and returned to the bed in the same location as soon as possible, until data collection reached approximately 14 days. A RA checked the outputs for quality, identifying and removing segments in which counts were deemed unreliable either due to insufficient battery or incomplete Bluetooth syncing. If an infant moved from an incubator to an open crib during data collection, the longest period in a single bed type was selected for analyses. Clinical data were obtained by review of electronic medical records (EMR).

Measurements

Care Activities and Sources.—A RA blinded to speech counts examined EMRs to identify when care activities occurred and aligned these activities to each 5 minute segment of data output. Each segment identified as Care was further sub-categorized by type as *Routine Care* (e.g., changing diaper, feeding, checking blood pressure or temperature, position changes) or *Developmental Care* (e.g., positive touch, kangaroo care, massage, swaddled holding outside of oral feeding attempts). For all care activities, Care Sources were identified depending on who participated in the care: *Medical Only, Family,* or *Cuddler*. We were particularly interested in Developmental Care activities that intentionally encouraged caregivers or other family members to talk, read, or sing to their infants (*Talk/Read/Sing*).

For each care type and source, the number of 5 minute segments were summed to derive a total duration per infant per activity type and care source. Proportions were computed to reflect time in: (1) Care vs. No Care (out of total duration), (2) Routine vs. Developmental Care (out of total duration), (3) Routine vs. Developmental Care (out of Care duration), (4) Medical vs. Family (out of Routine Care duration), and (5) Medical vs. Family vs. Cuddler (out of Developmental Care duration), and (6) Talk/Read/Sing vs. all other Developmental Care activities (out of Developmental Care duration).

Speech counts.—Each Starling device provided an automated speech count for each 5 minute segment of the data collection period. Mean speech counts were averaged across both devices over the full duration and then for sub-periods charted as involving pre-specified care activities or care sources. Average speech/5 minutes reflects the number of speech units identified by Starling as produced near to the infant, corrected for overall data collection length. Mean speech counts/5 minutes were computed for all care types and sources.

Data Analysis

Group differences in demographic and participant characteristics were analyzed across bed type using a student's T test. For proportion time measures, between group differences across bed type were analyzed using non-parametric Mann-Whitney U and within-subject comparisons were analyzed using Wilcoxon Signed Rank Test. For speech count measures, a series of mixed 2 × 2 ANOVAs examined the distributions of speech counts across care types (Care vs. No Care, Developmental Care vs. Routine Care) or care source (Medical, Family, Cuddler) as the within-subjects factors and Bed Type (Incubator vs. Open Crib) as the between-subjects factor. We also compared the proportion time spent and word counts in Developmental Care which specifically encouraged parents to talk, read, or sing (Talk/Read/Sing) to their infants to all other types of Developmmental Care activities (Other). Associations between PMA and word counts were explored using Pearson correlation. All significant effects were indicated as $p < .05$ (two sided); exact p-values are provided for all significant and non-significant effects, except when $p < .001$.

Results

Characterization of Study Subjects

As shown in Table 1, the current analyses involved $n = 9$ infants in incubators and $n = 12$ infants in open cribs. Infants were about 28 weeks GA at birth with no differences as a function of bed type. All infants were < 2000 grams at birth. Infants in incubators were about 100 g smaller than those residing in open cribs, however, this difference did not achieve statistical significance. There were more males than females overall in the sample with more males in incubators, however, this difference did not achieve statistical significance. Infants in incubators were significantly younger than those in open cribs. Day of life at start of data collection was younger for infants in incubators than open cribs, but did not achieve statistical significance.

A total of 5 (of 21, 23.8%) infants were part of a multiple births (1 set of twins, 1 set of triplets). Twelve families (57%) reported their ethnicity as Hispanic, 6 as Non-Hispanic Asian (29%), 2 as Non-Hispanic White (9%), and 1 as Non-Hispanic African American (5%). Most families preferred to use English (81%), 2 preferred Mandarin (9.5%), and 2 preferred Spanish (9.5%); one of the Spanish-speaking families required an interpreter. About one-third of the families used public insurance ($n = 8$, 38.1%) and two-thirds used private insurance ($n = 13$, 61.9%). Total data collection ranged from 5.3 to 17.6 days ($M = 12.8$) overall. Table 1 shows that analyzed periods were longer for infants in Incubators compared to those in Open Cribs, likely due to the fact that infants weaned to open cribs were closer to discharge and had a more limited sampling window.

Duration of Care Periods

Table 2 presents descriptives for proportion of time spent in care activities as a function of bed type. Across bed type, an average of about 13% of infants' round-the-clock life involved care activities, although there was variation across infants. Time in care was not different as a function of bed type. Overall, Routine Care represented less than 5% of infants' daily lives, on average, while Developmental Care represented nearly twice that proportion, $Z =$

3.9, $p < .001$. There was some suggestion that time spent in Routine care was higher for infants in Incubators vs. Open Cribs, however, this difference did not achieve statistical significance. The proportion of time spent in Developmental Care was similar for infants in Incubators and Open Cribs.

Table 3 shows how times were distributed across the different care types and delivery sources. For all infants, less than one-third of all care times involved Routine Care compared to about two-thirds that involved Developmental Care, $Z = 3.9$, $p < .001$. The proportion of time spent in both Routine and Developmental Care did not differ as a function of bed type. Across all infants, Routine Care was more frequently delivered by medical staff compared to family, $Z = 4.1$, $p < .001$. No bed type differences were found in proportion of time with Family involvement in Routine Care.

An opposite pattern was observed for Developmental Care, with more family involvement than medical staff alone overall, $Z = 2.4$, $p = .02$. Family participation occurred in almost three-quarters of Developmental Care times for infants in Incubators, whereas the distribution was more balanced for infants in Open Cribs. There was significantly more Medical Staff involvement in Developmental Care for infants in Open Cribs than in Incubators. The opposite was true for Family involvement, such that more family involvement was likely for infants in Incubators. Care provided by a Cuddler represented only a small portion of Developmental Care time compared to that provided by Medical Staff and Family. Cuddler participation was significantly higher for those infants in Incubators vs. Open Cribs. Finally, activities identified as Talk/Read/Sing represented about 12% of all Developmental Care activities, with no significant differences as a function of bed type.

Speech Counts

Over the entire data collection period, all infants were exposed to about 26.5 speech units per 5 minutes. Table 4 shows that infants in Open Cribs were exposed to about twice as much speech than infants in Incubators, $t(19) = 2.6$, $p = .02$. Figure 1 shows that speech counts were significantly associated with PMA ($p = .004$), such that older infants, who were more likely to be in open cribs, were exposed to more speech than younger infants and infants residing in incubators. Moreover, as illustrated in Table 4 and Figure 2, all infants heard more speech when receiving some type of care compared to when care activities were not charted, $F(1,19) = 132.4$, $p = .001$, regardless of Bed Type, $F(1,19) = 2.8$, $p = .11$. Speech counts were similar during Routine and Developmental Care, $F(1,19) = 1.8$, $p = .20$, again, not moderated by Bed Type, $F(1,19) = 2.2$, $p = .15$.

Looking next at Care Source, for Routine Care, overall speech counts were higher from Medical Staff than during care times involving Family, $F(1, 19) = 6.9$, $p = .02$. This effect was not moderated by Bed Type, $p = .37$, even though there were increased speech counts during family involvement for infants in Open Cribs. During Developmental Care, speech counts were significantly higher for care delivered by Medical Staff than by Family, $F(1, 19) = 5.5$, $p < .03$, an effect again not moderated by Bed Type, $p = .68$. Speech counts during Family care times were significantly higher during Developmental compared to Routine Care, $F(1, 19) = 5.8$, $p = .03$, with a marginally significant interaction with Bed Type $F(1,$

19) = 4.3, $p = .052$. During Developmental Care, Cuddlers were observed to have low speech counts, especially for infants in Incubators, and to have speech counts that were significantly lower compared to either Medical, $F(1,20) = 11.3$, $p = .003$, or Family, $F(1,20) = 6.8$, $p = .02$, care periods.

Table 4 and Figure 3 show that mean speech counts during periods of Developmental Care activities that specifically targeted voice exposure through talking, reading and/or singing at the bedside were significantly higher compared to all other types of Developmental Care, $F(1,19) = 7.4$, $p = .01$. There was a marginally significant interaction with Bed Type, reflecting the fact that this effect may be more evident for infants in Open Cribs vs Incubators, $F(1,19) = 4.0$, $p = .06$.

Discussion:

Our study quantified the continuous speech environment of the preterm infant in the NICU over multiple days. This approach allowed us to capture the variability of speech exposure during normal NICU experiences including care compared to rest periods, bed types, range of caregivers, various developmental care experiences, and over a range of PMA/degrees of infant maturity. Several findings regarding how speech exposure compares over a range of NICU experiences emerged from our study.

First, infant care experiences represent a small fraction of the overall NICU experience with the largest fraction of the day in rest periods. When fractions of the day in family interaction were examined, only ~5–6% of the day involved contact with family for preterm infants. NICUs with more family integrated care may have larger times of family interaction (28) although some limits on parent involvement may be a function of gestational age and desire for sleep protection. Our unit is likely fairly typical of patterns in NICUs in the United States, particularly those with an open bay design (27). The amount of family interaction was highly variable, reflecting variation in our sample in degree of parent visitation and involvement in care activities. If family interaction is indeed important to infant speech exposure, significant differences in family presence and engagement may translate into variations in clinical and neurodevelopmental outcomes for infants.

Second, there were differences in speech exposure experienced by infants residing in incubators compared to open cribs. Although medical device manufacturers continue to work on improving sound levels in incubators, they often remain significantly above American Academy of Pediatric noise guidelines, potentially masking speech exposure (29,30). Considering that the most immature infants require thermal support in an incubator, the sounds of the incubator may have a negative impact on healthy speech exposure needed for brain development. The less mature infants in our study experienced speech counts at one fifth that of the more mature infants. Future research will need to determine if supplementing language exposure for preterm infants, particularly those cared for in incubators, is beneficial for brain development and neurodevelopmental outcomes. Our research demonstrates a gap in exposure created by these differing care environments.

Third, infants heard more speech during care times than during non-care or rest periods. Interestingly, there was no difference in amount of speech exposure when family members were participating in care, compared to care times in which only medical staff participated. During routine care, medical providers were found to provide more speech than families. At the same time, speech from family members increased once infants were cared for in open cribs, likely a reflection of more family comfort, medical stability in older babies, or overheard speech. We speculate that medical providers are likely to be fairly consistent sources of speech, no matter the care activity, routine or developmental, and have less variation than parents as a result of bed type. Medical providers spoke more during developmental care periods than did families. The exception to this were the cuddlers, who provided generally low levels of speech compared to other caregivers. Training cuddlers to provide intentional voice exposure may offer an avenue to enrich the language environment of NICU babies. Examination of medical provider messaging regarding family language interaction with their infants, particularly at younger postmenstrual ages, should also be examined as a modifier of bedside speech by family members.

Fourth, even during rest periods, some speech was captured reflecting speech exposure from the general NICU environment in an open bay NICU. The impact of this exposure on sleep quality and brain development is unknown, although at older postmenstrual ages, some alteration of sleep patterns has been shown to be associated with variation in maternal voice exposure (31). Evaluation of the sound environment in single family rooms would be valuable to see if rest periods in these care environments contain lower levels of speech exposure than in open bay rooms. Other groups have reported greater periods of silence in single family rooms than open bay rooms (27), yet more research is warranted that explores the impact of care environment on estimates of speech exposure.

Fifth, the amount of speech during developmental care was similar to that during routine care. Nevertheless, developmental care frequency may be a modifiable factor that results in enriching the language environment of infants. Assuming that the percent of an infant’s day required for routine care is somewhat fixed, developmental care experiences may represent a mechanism to increase the time in which caregivers engage with infants, thereby, increasing infant language exposure. Developmental care periods were three times longer than routine care periods, albeit still a small proportion of infants’ overall experience, representing the most significant contributor of language exposure in our infants. In particular, periods of intentional voice exposure via talking, reading, and singing were relatively higher in speech, making this the most powerful developmental care activity for contributing to overall language exposure. Considering that only 13% of Developmental Care involved intentional voice exposure, even small increases in this activity type may have sizable impacts on the preterm language environment. Guiding parents to engage in intentional voice exposure at times judged best for brain development is likely to have a substantial impact on the amount of language infants hear during their NICU stay.

Finally, concerns have been raised about disparities in NICU care (32) and home language environments in underprivileged populations leading to differences in speech and language outcomes (33). Our sample size precluded full analysis of this variable as postmenstrual ages were not balanced between public and private insurance. Nevertheless, no statistically significant differences were seen in amount of time in family delivered care or in speech during developmental care between families on public compared to private insurance. This finding is in contrast with other studies (21) that showed higher rates of developmental care among families with higher rates of privilege (Caucasian, father employed). Future investigations involving a large sample than the current study are needed to further explore the impact of these important factors in NICU infant care and outcomes.

Potential Limitations.

Our sample size was generally small with relatively few infants represented at each postmenstrual age. We were able to capture preterm infants across a range of PMA, providing a general overview of the speech exposure heard over the course of the NICU stay. We were also able to capture much longer periods of the infant’s NICU stay than have been previously described in earlier studies.

Our use of Starling may have limited our understanding of the NICU speech environment. Our validation experiment (see Supplementary Materials Figure S1, S2) demonstrated strong associations between Starling word counts and another automatic measures of speech exposure, from LENA (34). Nevertheless, Starling output is best viewed to reflect relative levels of speech exposure, rather than a measure of absolute number of speech units or words heard. It will be important for future studies to quantify the speech environment in the NICU using alternative tools in order to evaluate the robustness of our findings.

Because the Starling devices were placed at the head of the infant, inside the incubator or crib, we may have undercounted speech exposure during some developmental care periods. At times, nurses may close incubator doors and tops, limiting the ability for Starling to detect language outside the incubator. Although Starling detects speech within a 6 foot radius, quiet speech at the limits of this range may have gone undetected. Undercounting speech during developmental care means that we may have underestimated the power of developmental care in its contribution to infant language exposure rather than overestimated it in our findings.

The impact of single family rooms on language exposure was not measured because that care environment was not offered at our institution during the study period. Parents at bedside may feel inhibited in speaking in front of and to their infants, as evidenced by the lower levels of speech during developmental care provided by families, and the lack of increase in speech during care times when families are present. Single family rooms may provide a more comfortable environment for families to speak with privacy and have been shown to encourage more family visitation (35). These features may lend themselves to increased opportunities for developmental care, thereby, increasing infant language exposure. Our ongoing research aim to use Starling technology to measure speech environments in this care environment, an important next step now that those room types become available at our center.

Conclusion

Understanding the soundscape in the NICU, particularly with respect to language exposure, is a first step in optimizing the care environments of preterm infants. It is estimated that adult women speak ~16,000 words per day (36). Thus, it is the norm for the growing fetus to experience thousands of words per day from their mother, in addition to the many more that the mother experiences in her everyday surroundings. Without research on global features of preterm infant language exposure, a deeper understanding of how a more normalized sound environment might positively impact infant health and neurodevelopment is impossible (37). Greater detailed understanding of NICU speech exposure allows further exploration of its association with infant neurodevelopmental outcomes. If specific sound exposure, including speech "dose," is found to be optimal for preterm infant development, medicinal sound may be added to infant medical care plans. Currently, research involving infant exposure to recorded parental voices has represented clinician best guesses at timing and length of exposure. A prophylactic approach to mitigating neurodevelopmental problems has been used with early intervention in which support of toddlers improves reading and language issues at later ages (38). Future exploration of the clinical applications of this innovative device in supporting optimum infant language development is warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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- Continuous measures of speech exposure in the NICU were catalogued by type of care activity (Routine vs. Developmental Care) and care source (Medical, Family, Cuddler).
- Periods of Developmental Care, particularly those involving intentional voice exposure, were identified as rich sources of speech exposure and may be a powerful tool to enrich infants' NICU experience.
- This research reports the longest period of continuous measurement of the NICU speech exposure for preterm infants available to date and may be useful to guide targeted interventions to enrich infant speech exposure in the NICU.

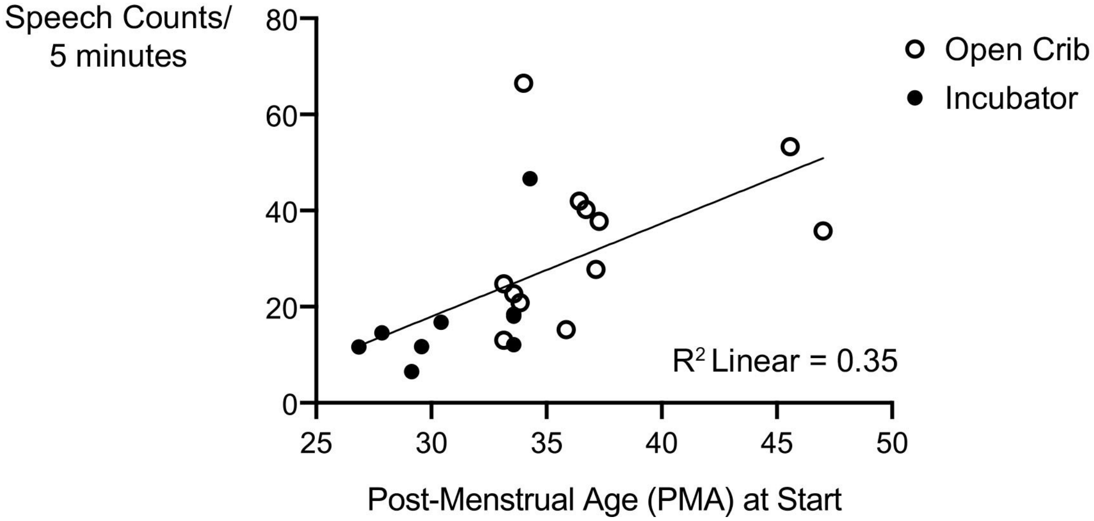

Figure 1.

Relation between mean overall speech counts and post-menstrual age (PMA) at start of recording and bed type (*n* = 21)

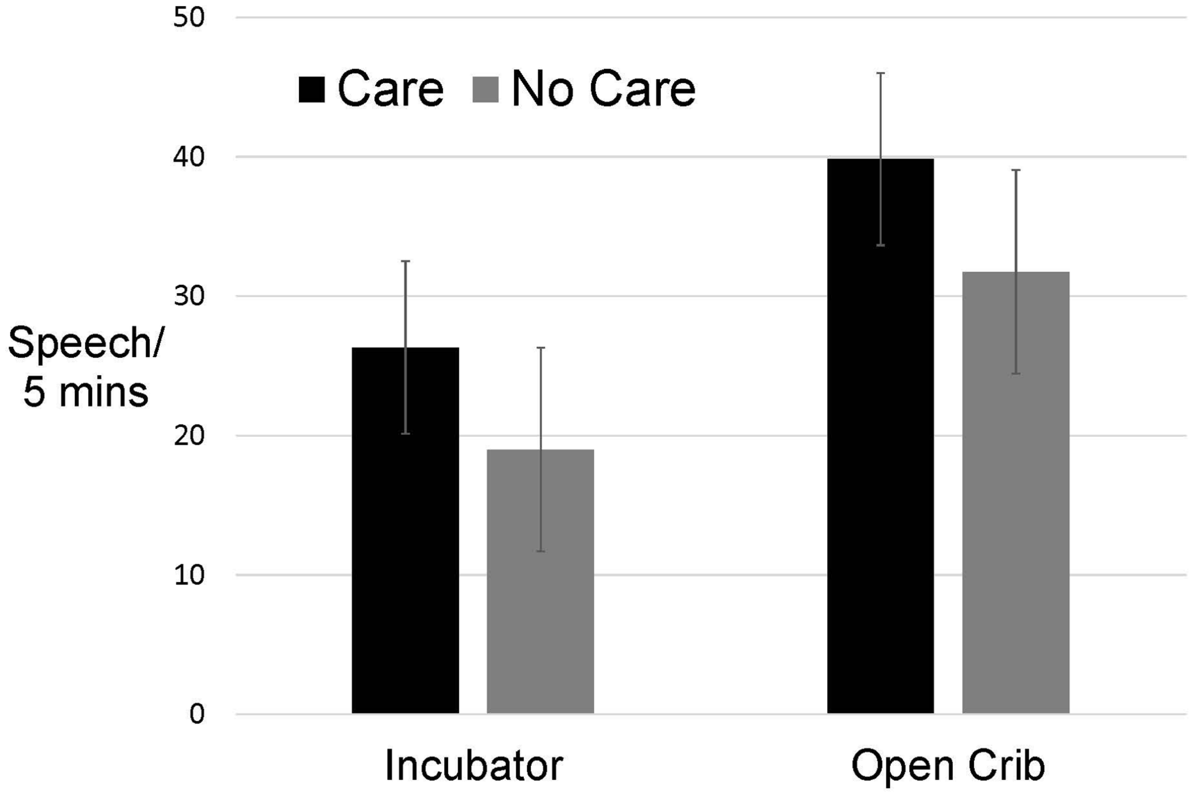

Figure 2.

Mean speech counts during Care vs. No Care periods as a function of Bed Type (*n* = 21)

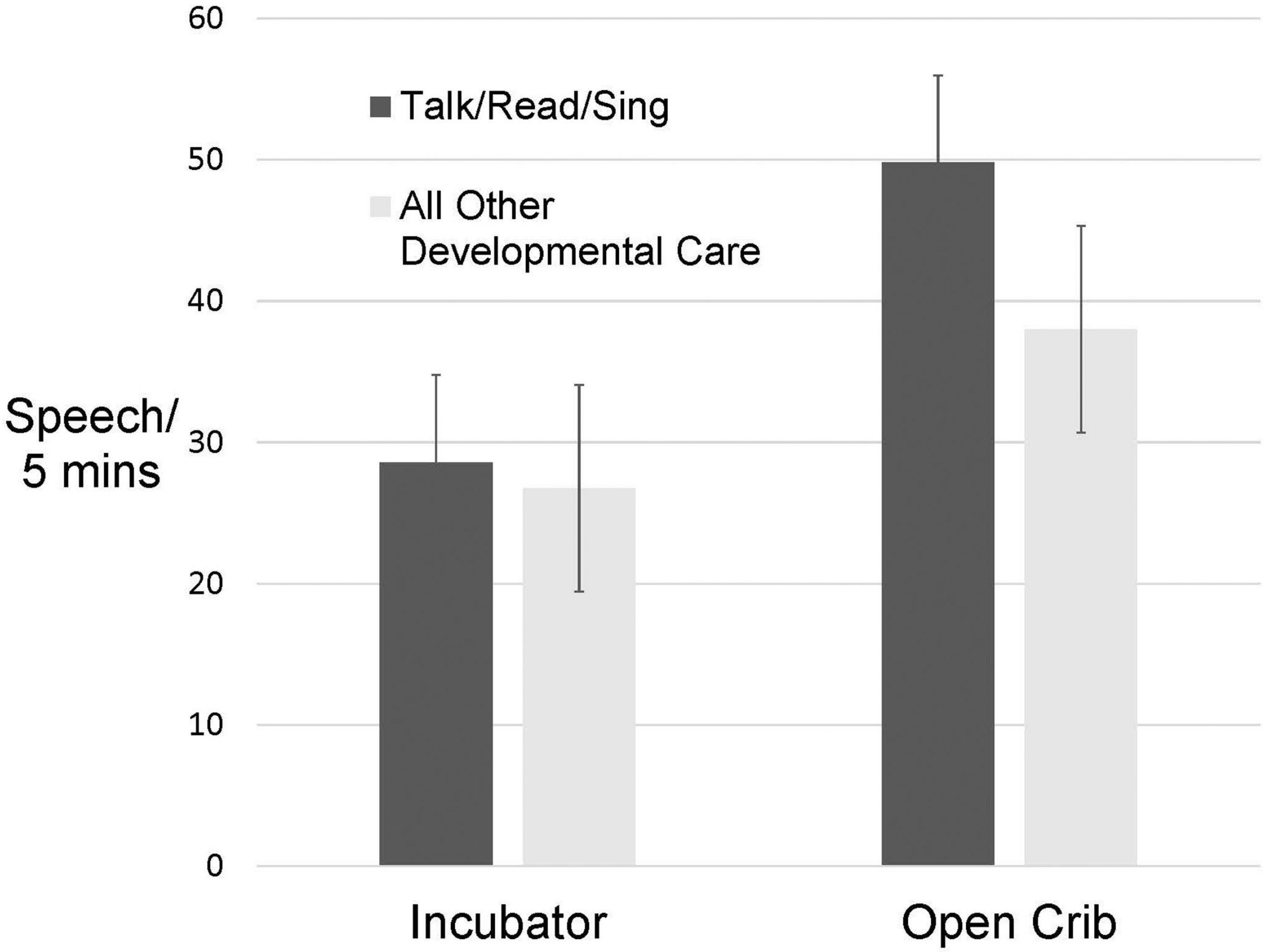

Figure 3.

Mean speech counts during Developmental Care activities that specifically encourage increased talk to infants through talking, singing or reading at bedside ($n = 21$)

Table 1.

Descriptives of participants and data collection characteristics as a function of bed type ($n = 21$)

	Incubator (n = 9)		**Open Crib (n = 12)**			
	M (SD) or %	**Min-Max**	**M (SD) or %**	**Min-Max**	**t(19) or χ^2**	**p-value**
GA[a] at birth (weeks)	28.0 (3.7)	23.0 – 32.6	28.6 (3.2)	24.0 – 33.4	0.37	.71
Birth weight (g)	1019 (383)	500–1550	1128 (421)	650–1950	0.61	.55
Sex (% male)	66.7%	--	50.0%	--	0.58	.38
PMA[b]	31.0 (2.8)	26.9–34.3	37.0 (4.6)	33.1–47.0	3.43	.003
Day of life[c]	22.1 (24.3)	8–80	59.3 (50.2)	7–155	2.04	.06
Sample Length (Hours)	12.0 (3.0)	6.1–16.6	9.2 (2.9)	5.3–14.3	2.2	.05

[a] Gestational Age;

[b] Post-menstrual Age at start of data collection;

[c] Day of life at start of data collection

Table 2.

Proportion of total time by Care Type (All Care, Routine Care, Developmental Care) and Bed Type ($n = 21$)

	Incubator ($n = 9$)			**Open Crib ($n = 12$)**				
	M (SD)	**Mdn**	**Min-Max**	**M (SD)**	**Mdn**	**Min-Max**	**U**	***p***
All	12.3 (3.0)	12.5	7.5 – 17.1	14.7 (4.2)	14.1	8.1 – 22.4	36.0	.22
Routine	3.3 (0.8)	3.3	2.1 – 4.6	4.6 (1.6)	4.0	2.9 – 7.3	28.0	.07
Developmental	9.0 (3.2)	8.9	4.0 – 13.8	10.1 (4.1)	9.8	4.5 – 17.5	46.0	.60

Table 3.

Proportion of time in care activities by Care Type (Routine vs. Developmental; Talk/Read/Sing vs. all other Developmental Care), Care Source (Medical, Family, Cuddler), and Bed Type ($n = 21$)

	Incubator (n = 9)			**Open Crib (n = 12)**				
	M (SD)	**Mdn**	**Min-Max**	**M (SD)**	**Mdn**	**Min-Max**	**U**	***p***
Routine	28.8 (10.9)	28.4	16.5 – 49.7	32.8 (12.6)	29.6	15.2 – 57.9	43.0	.46
Developmental	71.2 (10.9)	72.1	50.3 – 83.6	67.2 (12.6)	70.4	42.1 – 84.8	43.0	.46
Routine Source								
Medical	98.2 (3.7)	100.0	90.2 – 100.0	94.0 (5.7)	94.8	85.0 – 100.0	30.0	.10
Family	1.8 (3.7)	0.0	0 – 9.9	6.0 (5.7)	5.2	0 – 15.0	30.0	.10
Developmental Source								
Medical	26.6 (15.6)	25.8	6.9 – 46.0	41.6 (22.1)	40.6	12.5 – 89.6	26.0	.05
Family	73.2 (15.9)	74.2	53.0 – 93.1	51.9 (20.9)	52.2	10.4 – 80.4	22.0	.02
Cuddler	0.2 (0.7)	0.0	0 – 2.0	6.5 (5.7)	6.7	0 – 16.4	20.0	.02
Intentional Voice Exposure								
Talk/Read/Sing	13.8 (10.1)	13.5	1.1 – 31.7	10.1 (3.4)	10.1	4.8 – 17.8	42.0	.42
All Others	86.2 (10.1)	87.8	68.3 – 98.9	89.9 (3.5)	89.9	82.2 – 95.2	42.0	.42

Table 4.

Speech counts per 5 minutes by Care Type (Routine vs. Developmental; Talk/Read/Sing vs. all other Developmental Care), Care Source (Medical, Family, Cuddler), and Bed Type (*n* = 21)

	Incubator (*n* = 9)		**Open Crib (*n* = 12)**	
	M (SD)	**Min-Max**	**M (SD)**	**Min-Max**
Overall	17.4 (11.6)	6.5 – 46.6	33.3 (15.8)	13.0 – 66.5
No Care	16.0 (11.3)	5.9 – 44.3	32.1 (15.8)	11.8 – 65.8
All Care	27.3 (12.6)	11.2 – 58.0	40.5 (16.2)	14.8 – 74.1
Routine	27.2 (14.4)	9.4 – 62.8	43.9 (17.8)	14.4 – 79.2
Developmental	27.5 (12.5)	11.8 – 56.9	39.2 (15.6)	15.4 – 69.9
Routine Source				
Medical	27.4 (14.4)	9.4 – 62.8	43.8 (17.3)	13.8 – 75.3
Family	3.8 (7.8)	0 – 20.3	32.5 (42.5)	0 – 151.7
Developmental Source				
Medical	32.2 (18.6)	13.2 – 78.4	44.5 (19.3)	19.0 – 83.7
Family	28.5 (15.8)	9.7 – 66.2	39.2 (17.8)	15.9 – 78.7
Cuddler	4.9 (14.6)	0 – 43.7	28.7 (26.1)	0 – 78.1
Intentional Voice Exposure				
Talk/Read/Sing	28.6 (7.6)	15.3 – 35.2	49.8 (16.6)	29.3 – 89.4
All others	26.8 (13.0)	10.3 – 57.3	38.0 (16.1)	14.2 – 68.9