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This study investigated the quantity of audible and intelligible ('near and clear') educator talk directly experienced by under-two-year-old infants attending early childhood education and care (ECEC) programs and examined whether the quantity of educator talk was related to characteristics of quality in their ECEC room. Participants were 57 infants attending separate infant rooms in and around the Sydney metropolitan area, Australia. Each infant was observed for 3 hours, wearing a small, custom-designed digital language processor (DLP) which digitally recorded and generated measures of 'near and clear' adult talk, unclear talk and infant vocalisations. Structural quality indicators include educator qualification, group size and educator-infant ratios, and Interaction Quality was assessed using the ITERS-R Interaction and Listening and Talking subscales. Infants' experience with 'near and clear' talk was predicted by Interaction Quality, the presence of a degree-qualified teacher and group size. 'Near and clear' talk was also significantly and positively related to the quantity of infant vocalisation and, negatively, to their level of exposure to unclear talk. Findings are discussed in terms of conceptualisations of quality in infant ECEC rooms, as well as the potentials and limitations of the 'near and clear' talk measure for use in future studies of language development in this context.

Keywords: early childhood education; infants; quality; language development; teacher-child interactions; qualifications.

Introduction

The first two years of a child's life are a critical period for language development. While infants' innate language-learning dispositions and mechanisms contribute to their developmental progression, a wealth of studies demonstrate the importance of a language-rich environment for current and future language development and academic outcomes (e.g., Hoff and Naigles 2002; Huttenlocher et al. 2010; Walker et al. 1994; Zauch et al. 2016). Most of this data has been derived from research in home contexts with very few studies focusing on the characteristics of the language environment in early childhood education and care (ECEC) infant rooms. As a result, little is known about the nature or extent of variability in features of infants' ECEC language environment and how variation is related to other indices of quality.

In this study, we investigate one feature of infants' ECEC language environment: the quantity of clear, audible adult talk (referred to hereafter as 'near and clear' talk) directly experienced by infants during their normal activities at the centre. 'Near and clear' talk is defined as talk that is clearly intelligible to the infant which, while largely comprising infant-directed talk, may also include the talk to other adults or infants that occurs within a close proximity of the infant. We examine the variability associated with infants' experience with 'near and clear' talk and investigate relationships with other program and language-environment quality indicators. In doing so, our aim is to enhance current understandings of the characteristics that comprise a language-supporting environment for these very young children.

The significance of infants' talk experience

For some time, studies have detected predictive associations between the quantity of adult talk to infants and their subsequent language development. Hart and Risley (1995) collected naturally occurring monthly 1-hour talk samples in the homes of 42 infants aged 10 months to 3 years and found considerable variation in the quantity of words addressed to these infants. Variation in talk input predicted vocabulary growth by the age of three as well as differences in language and literacy outcomes at age 9 (Walker et al. 1994). More recent home-based studies have confirmed that the quantity of infants' experience with adult words predicts variability in infants' expressive vocabulary some months later (Hoff 2003; Hoff and Naigles 2002; Hurtado et al. 2008; Weisleder and Fernald 2013). While most studies have measured the amount of talk that is spoken directly to infants, Zimmerman et al. (2009) longitudinally examined the effect of the sheer quantity of audible and intelligible parent talk, either infant-directed or occurring close to the infant. They found that the average daily quantity of this 'near and clear' talk significantly predicted infants' subsequent language development.

While the quantity of infants' talk experience appears to constitute a facilitative aspect of their language environment, interaction quality is also significant (Zauch et al. 2016), and evidence exists to suggest that quantity and quality measures are related. Hart and Risley (1995) found that more talkative parents included affirmative, encouraging, and child-responsive talk into their talk repertoire – features that were much less apparent in homes where infants experienced very low levels of talk. Hoff (1994) reported that the quantity of infant-directed talk during meal times was positively associated with mothers' tendency to extend their topic of conversation over multiple utterances as well as infants' tendency to

respond to the topic. In ECEC contexts, Degotardi, Torr and Nguyen (2016a) found that the quantity of educator talk to infants during a mealtime was related to the quality of their turn-taking efforts and question use. While, these studies suggest that the quantity of talk is associated with important qualities of adult-infant interactions**,** further research is needed in order to understand these associations more clearly in infant ECEC contexts.

The language environment in infant ECEC rooms

A body of research demonstrates the effects of positive educator-infant interactions on children's cognitive development, pre-academic scores and language development in preschool (Burchinal et al. 2000; National Institute of Child Health and Human Development Early Child Care Research Network (NICHD) 2000a) and beyond (Li et al. 2013). However, quality measures in these studies have tended to comprise broad assessments of the social-emotional and stimulation features of educator-infant interactions, rather than specific characteristics of the language environment. Very few studies have specifically examined the prevalence of educator talk to infants in ECEC centres. Degotardi, Torr and Nguyen's (2016a) meal time analysis reports that educators averaged 56 words per minute in this context. Much lower talk input was reported by Murray et al. (2006), who found that the number of words addressed during play episodes to 16- to 34-month-old children attending high-quality ECEC centres was, on average, 25 words per minute. These findings indicate that infants' talk experience may be context specific and that short data extracts, while producing snapshots of individual differences, may not necessarily provide a representative quantity estimate of infants' overall experience with educator talk.

Recently, technological advances have permitted the analysis of longer, naturalistic data episodes. The LENA system comprises audio-recording and digital data processing

technology that permits the analysis of longer language environment recordings. Specifically developed for use with infants, high quality audio data is recorded using a small digital processor (DLP) that fits into a custom designed vest worn by the infant, thus eliminating a reliance on external microphones which contaminate recordings with extraneous noise (Greenwood et al. 2011). The vest maintains the proximity of the DLP to the infant's mouth and body, permitting a high-quality audio-recording of the language environment directly experienced by that infant. Once recorded, sophisticated audio-engineered software processes the sound file to segment and yield quantity estimates of 'near and clear' talk, defined as clearly audible and discernible adult words, infant vocalisations, unclear speech sounds and extraneous noise (For technical details, see Xu et al. 2008).

The present study

In this study, we employed the LENA system to derive a measure of infants' experience with 'near and clear' educator talk over the course of a 3-hour episode, during which they were engaged in their normal play, caregiving and routine activities in that setting. We examined these infants' average exposure to 'near and clear' educator talk, and investigated whether other established infant classroom quality indicators were associated with individual variation.

One quality indicator hypothesised to relate to the infants' experience with 'near and clear' talk is the quality of the educator-infant interactions, generally characterised by levels of responsiveness, sensitivity, emotional warmth and stimulation (Jamison et al. 2014). High levels of educator responsiveness and sensitivity demonstrate a child-centred teaching approach that could result in more frequent and extended interactions (Girolametto and Weitzman 2002). Emotional warmth could be evident in a more encouraging and approving

interaction style that was identified as accompanying high levels of parental talkativeness (Hart and Risley 1995). Stimulating teaching practices may involve the use of language to draw infants' attention to salient objects or events, or to interact with them in order to stimulate their engagement and thinking (Degotardi, 2010; Jamison et al. 2014).

The quantity of educator 'near and clear' talk could also be related to structural quality indicators. One such indicator could be educators' level of early childhood qualification through its established relationship with the quality of educator-child interactions (Degotardi 2010; Degotardi et al., 2016; Manlove, Vazquez, and Vernon-Feagans 2008; Phillips et al. 2001). Group size and educator-child ratios may similarly be implicated, also due to their relationship with the quality of educator interactions (NICHD 2002a, Vermeer et al. 2016) and because these elements impact educators' opportunities to engage in proximal talk to the infants (Manlove, Frank, and Vernon-Feagans 2001).

Quality can also be conceptualised from a 'bottom-up' perspective, which pays attention to the quality of the direct experience of individual children as they encounter different inputs and contribute to their own experiences (Hallam et al. 2009). Infants' own vocalisation levels may be implicated, with research suggesting a degree of concordance between the quantity of adult talk and infants' verbal contributions (Girolametto and Weitzman 2002; Hoff 1994; Weisleder and Fernauld 2013). The question of whether these findings extend to infants' experience with 'near and clear' educator talk remains unanswered. Infants' direct experience with unclear speech is also important to consider. Too much unclear speech may be developmentally detrimental as competing, extraneous noise reduces infants' opportunities to detect and discriminate clear speech sounds, thus impacting negatively on their ability to derive language benefit (Linting et al. 2013; Manlove et al.

2001). Given that there is typically a high level of talk-based ‘noise’ in ECEC settings (Linting et al. 2013), the extent to which this talk is clear as opposed to unclear warrants investigation.

Research Questions

The aim of this research is to investigate the variability of infants’ experience with ‘near and clear’ educator talk as they go about their everyday activities in their ECEC room. Specifically we address the following research questions:

(1) How many ‘near and clear’ educator words do infants experience, and what is the extent of individual variation?

(2) Is individual variation related to interaction and structural quality indicators, infants’ own vocalisation levels, and the amount of unclear talk in their classroom?

Method

Participants and recruitment

The participants were 57 infants (28 males, 29 females), ranging in age from 7 to 24 months (M = 17.81; SD = 4.40), who attended ECEC programs catering for children under the age of two. The infants attended the ECEC centre between 2 to 5 days a week, with a mean of 3.38 days per week (SD = 1.02). Their period of attendance in the infant room averaged 8.82 months (SD = 4.58).

Email invitations to participate were extended to ECEC centres from ECEC provider organisations and to centres identified from a database used for teacher-education infant practicum purposes. Of the 89 services approached, 59 (66%) agreed to participate, with staff

changes and hesitation by educators volunteered as reasons for refusal. Due to scheduling and technical difficulties, data from two centres were not obtained and a further two had to be excluded from the analysis. Of the remaining 55 centres, 34 were not-for-profit services, 17 were for-profit, privately run services, and the remaining four were work-based services. The centres were all located within, or on the outskirts of, the XX (removed for review) metropolitan area, and represented 41 separate postcodes, with no more than 3 centres in any one area. These centres represented the diverse nature of the XX community, catering for families and employing staff from a range of socio-economic and cultural backgrounds. The latest (2011) Socio-Economic Indexes for Areas (SEIFA) for each centre provided a general index of SES. The SEIFA uses national census information to rank suburbs according to socio-economic advantage, with scores ranging 1 to 100 used to indicate the relative advantage of that postcode (1 = lowest to 100 = highest advantage) (Australian Bureau of Statistics 2011). The SEIFA ranks for the centres ranged from 8 to 100, with a mean rank of 77.18 (*SD* = 22.42), which is slightly higher than the average SEIFA score 73 for the Sydney metropolitan area.

In each participating infant room, the room leader was asked to invite one infant to participate in the study. Selection criteria included that the infant was settled and happy in the room, attended at least two days per week, and was unlikely to be upset or disturbed by wearing the LENA DLP and vest. Infants with identified with special educational needs were not selected. It is possible that allowing the team leader to choose the focus infant introduced bias into the selection process. However, ethical protocols required us to consider carefully the wellbeing of the chosen infant and respect the authority of the room staff, so it was determined that the selection was best undertaken by the room leader. In 53 centres, this

yielded one infant per centre. Two centres had two separate infant rooms, so these centres yielded two infants each, bringing the total to 57 focus infants.

Informed consent was obtained the parents/guardians of the focus infants, from all educators in the room and the parents of other infants attending on the data generation days. We also monitored infants' reaction to wearing the LENA vest and DLP to determine assent. The room leader fitted the vest and DLP on the focus infant in order to minimise the risk of discomfort. Many infants were understandably curious and tended to feel the DLP through the vest for a few minutes. However, none of the infants showed distress or concern and soon continued on with their normal activities. In one instance, after waking from sleep, one infant refused to put the vest back on, so the recording ceased and the data was excluded from the study.

Data generation and measures

Data were generated during two half-day visits to the infant room, during which the LENA data were recorded and assessment of interaction quality took place. Room leaders were informed of our aim to capture footage that represented normally occurring activities and interactions. With consideration given to infant attendance patterns and daily routines, the room leader and the research assistant (RA) determined appropriate times for the visits.

All data were recorded by one of four RAs with early childhood educator experience working with infants. A familiarisation visit occurred prior to the main data generation visits, during which the assigned RA discussed the study procedures with the room educators and became familiar with the room layout and schedule. At this time, the room leader provided details of the age, attendance pattern and attendance duration of the infant and the room

educators' qualifications levels. During the subsequent visits, observational data and quality measures were generated as follows:

LENA data

Each room leader nominated a start time for the visit that would permit the observation of that focus infant's participation across the range of typically occurring experiences including play, meal-time and diapering. As a general rule, visits commenced around 9am and progressed until midday, although schedules were adjusted to accommodate individual sleeping patterns.

Approximately 3 hours of LENA data were obtained for each focus infant, excluding sleep time (M = 179.90 minutes, SD = 9.55 minutes). Audio data were supplemented by a concurrent video-observation of the focus infant, recorded at a discrete distance by the RA using a small, hand-held camcorder. For technical reasons, if the infant slept, the LENA DLP had to remain active, so was placed next to the infant as he/she slept. On completion of the audio-recording, the LENA audio file was uploaded to the software. Digital processing, using iterative modelling algorithms, extracted statistical measures of the infant's language environment which could then be refined to the five-minute level. The video-recording permitted the identification and removal of sleep period segments from the data. We also removed the initial and end segment for each infant as we found that these segments largely captured RA and educator talk as they put on or took off the LENA vest and DLP.

For each infant we generated the following LENA measures:

Adult word count (AWC). This measure provides a count of clearly audible, 'near and clear' adult words spoken to, or near to the infant. Non-speech sounds such as coughs or other vegetative sounds are not counted.

Child vocalization count (CVC). This measure provides a count of vocalisations produced by the focus infant, including words, babbles and pre-communicative sounds such as squeals and raspberries. As above, non-speech sounds are not counted.

Unclear speech (US). This duration measure, in minutes and seconds, represents the amount of speech-related sounds that are audible to the infant, but are unclear. This speech may be faint or, more often, is speech that is rendered unclear due to competing, overlapping speech or other noise.

For each of these measures, we aggregated the 5-minute segments to obtain full-recording measures for each infant. Because of the difference in terms of total duration of the recording, we divided each variable by the duration of the audio-recording, resulting in measures per hour for AWC, CVC and US.

The accuracy of the LENA estimates has been established by the LENA foundation (Xu, Yapanel, and Gray 2009) and replicated in home-based studies (Oetting, Hartfield, and Pruitt 2009; Oller et al. 2010) and ECEC infant rooms (Soderstrom and Wittebolle 2013). Because Soderstrom and Wittebolle are the only researchers to have conducted reliability on the child vocalisation counts, we also checked the reliability by hand-tallying child vocalisations in 25 randomly-chosen five-minute blocks of audio and comparing them to the LENA-generated counts. This yielded a correlation of $r = .91$.

The LENA system also generates measures for silence, percussive noise, broadcasted TV/electronic sounds and other infant (not the focus infant) vocalisations. Together, these measures comprised 21.5% of the data. As this study was concerned with educator and focus infant speech-related data, these data were not included in the present analysis.

Interaction quality assessment

A measure of the Interaction Quality of each infant room was derived from the Infant-Toddler Environmental Rating Scale -Revised (ITERS-R, Harms, Cryer, and Clifford 2006), a widely used quality assessment tool for ECEC programs for children aged under 30 months. Due to their direct relevance to the study aims, two subscales were employed:

The 'Listening and talking' sub-scale comprised three items which rated how effectively educators help children to i) comprehend language, ii) produce language, and iii) the extent to which they use books to support language development.

The 'Interaction' subscale comprised four items which assessed i) the level of supervision and responsiveness to individuals and the group, ii) the emotional quality of educator-child interactions, iii) the quality of discipline methods, and the iv) extent to which educators support and encourage peer interactions.

ITERS-R scores are derived through the set procedure and scoring process (see Harms et al., 2006 for details). Each item is assessed during real-time observations by an observer who notes the presence or absence of indicators which the ITERS-R scale has determined to represent differing levels of quality. The process results in a score for each separate item out of seven, with one (1) designating *inadequate,* three (3) designating *minimal,* five (5) designating *'good'* and seven (7) designating *excellent*. The standard scoring procedure

involves deriving a score by averaging the mean scores for individual items to produce a score for that subscale[1].

Scores for the two subscales were derived through a 2-hour observation by the RA allocated to collect data in that centre. Prior to commencement, all RAs underwent ITERS-R training in order to understand and recognise the indicators of each criterion. The training was conducted by a senior RA, who was experienced in using the ITERS assessment tool. Training continued until the RAs reliably assigned observed indicators to the correct criterion descriptor at least 90% of the time.

The RA was seated in a classroom area where she could observe interactions and took written notes in order to align the observed practices with the set criteria in each scale item. Once the observations concluded, these notes were used to determine the score for each item. The notes and item scores were progressively assessed by the senior RA to ensure the continued accuracy of the ITERS-R scoring. Discussions about the observations occurred if there were any questions about the assignment of the rating. Refresher training was also conducted half way through data collection to ensure consistency and accuracy.

The mean ITERS-R score for 'Listening and talking' was 5.35 (SD = 1.31, range = 1.67 – 7.00) and for 'Interaction' was 5.76 (SD = 1.25, range = 2.00 – 7.00). We found that the two subscale scores were strongly correlated (r = .76, p < .01), and further examination showed that the individual items were also significantly intercorrelated (statistics available from authors on request). An exploratory factor analysis with the seven items yielded one

[1] While the individual scores could be regarded as ordinal, they represent increasing levels of quality for that particular item, and therefore yield a final numerical score for that item.

factor solution (.55 ≤ rotated item factor loadings ≤ .92) with a Cronbach's alpha reliability of .89. We therefore combined the two subscale scores to create a composite mean score of 5.56 (*SD* = 1.28) to represent the Interaction Quality of each infant room.

Structural quality measures

Group size. The group size was dynamic as children arrive and departed during the observation period. We therefore determined group size by counting the number of infants at the middle of the LENA observation. Although the ITERS-R assessment and the LENA recording were not obtained on the same day, the two mid-way group size measures were strongly correlated ($r = .90$, $p < .01$) confirming the measure as a reliable estimation of the average group size (range = 4 to 28 infants; *M* = 10.41, *SD* = 4.49).

Educator-infant ratio. Educator-infant ratios were similarly dynamic, so the ratio was calculated by dividing number of educators by the number of infants present in the middle of the LENA observation (range = 0.18 to 0.60; *M* = 0.33, *SD* = 0.09).

Educator qualifications. Infant rooms with university-qualified teachers have been found to exhibit higher overall quality levels (Burchinal et al. 2002; Hestenes et al. 2007) and higher language and interaction environment quality than those led by lower qualified educators (King et al. 2016). On this basis, we indexed qualification according to whether the infant room employed a university qualified early childhood teacher, which, in the Australian context, requires a specialized degree in early childhood education. This yielded 33 rooms with no university qualified teacher and 24 rooms with at least one.

Data analysis plan

Data analysis was carried out in three steps. First, we examined the descriptive statistics for the LENA measures. We then carried out correlation analysis to examine pairwise relationships among the variables of interest. Our last step was to conduct a path analysis based on correlation analysis. The path analysis has advantages over multiple regression analysis because it allows simultaneous analysis of all the variables in the model and it is able to control measurement error so that errors are not aggregated in a residual error term (Chin 1998). Steps 1 and 2 were conducted with IBM SPSS 21, and the path analysis was carried out with Mplus 7.

Results

Variability in infants' language environment experience

Table 1 presents the descriptive statistics of the LENA variables. There was broad variation in terms of measures of the 'near and clear' talk experienced by the focus infant (range of AWC = 343.61 per hour to 3,552.00 per hour. Infant vocalisation (CVC) had a similarly wide range, from 58.66 to 358.55 per hour. The amount of time per hour processed as unclear speech (US) varied from 18.85 to 51.32 minutes per hour.

Table 1. Descriptive statistics of the LENA measures

LENA measures	*N*	Minimum	Maximum	Mean	*SD*
AWC/per hour	57	343.61	3,552.00	1,362.11	701.71
CVC/per hour	57	58.66	358.55	161.84	70.07
US duration/per hour (in minutes)	57	18.85	51.32	37.66	6.72

There were no significant relationships between the LENA measures or quality indicators and infant gender, days of attendance or the centre SIEFA (SES) rank, so these variables were excluded from further analysis (analyses available from authors on request).

How is individual variation related to interaction quality indicators?

Table 2 shows pairwise correlations between the LENA, structural and process quality measures. AWC was positively correlated with CVC (r = .39, p < .01) and Interaction Quality (r = .33, p < .05), and negatively correlated with US (r = -.55, p < .01). CVC was negatively correlated with US (r = -.41, p < .01). Infant age was positively correlated with CVC (r = .50, p < .01) indicating that older infants tended to produce more vocalisations than younger infants. Interaction Quality was negatively correlated with group size (r = -.30, p < .05) and positively related to presence of a university-qualified early childhood teacher (r = .31, p < .05). Group size, educator- infant ratio, and educator qualification did not show any significant association with AWC. However, group size and educator- infant ratio were negatively correlated (r = -.34, p < .05), indicating that rooms with higher group sizes tended to have lower educator- infant ratios.

Table 2. Pairwise Pearson correlations between LENA and quality indicators

Variables	1	2	3	4	5	6	7	8
1 Infant Age	---							
2 AWC	.11	---						
3 CVC	.50**	.39**	---					
4 US	.11	-.55**	-.41**	---				
5 Interaction Quality	.09	.33*	-.05	-.09	---			
6 Group Size	.23	-.05	.20	.13	-.30*	---		
7 Ratio	-.12	.06	-.03	-.10	.18	-.34*	---	
8 Qualification	.11	.24	.03	-.02	.31*	.17	.26	---

Note: ** $p < .01$; *$p < .05$.

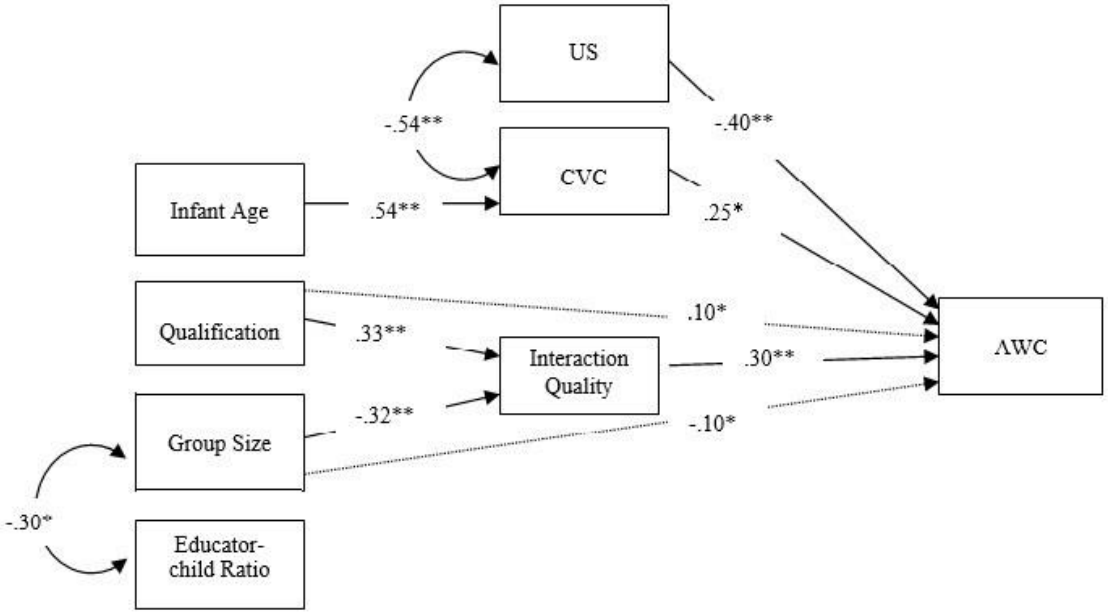
The results of pairwise correlation analysis provided the basis for us to conduct a path analysis to further examine the relationships between AWC and the quality indicators. Based on the correlation analysis, a hypothesised path model was constructed to test direct paths from two variables of language environment (i.e., CVC and US) and Interaction Quality, as indexed by the ITERS-R assessment, to AWC. At the same time, the model specified direct paths from two structural features, group size and qualifications, to Interaction Quality, and tested indirect paths from these two structural features to AWC. The model also included a path from infant age to CVC, and a correlation between educator- infant ratio and group size.

The criteria of evaluation of path model followed the procedures proposed by Jöreskog and Sörbom (2005). We used Chi-square and three fit statistics as indicators of model fit, namely the Tucker-Lewis Index (TLI, Tucker and Lewis 1973), the Comparative Fit Index

(CFI, Bentler 1990), and the root mean square error of approximation (RMSEA, Browne and Cudeck 1993). According to Bentler (1990), the values of TLI and CFI higher than .90 are generally considered an acceptable fit to the data. For the value of RMSEA, Browne and Cudeck (1993) suggest that RMSEA values below .06 are indicative a good fit between the hypothesized model and the observed data.

Our data fit the hypothesized model well: χ^2 (18) = 16.85, p = .53, CFI = 1.00, TLI = 1.02, RMSEA = .00. The resulting paths are shown in Figure 1. There were significant, positive paths from CVC (β = .25, p < .05) and Interaction Quality to AWC (β = .30, p < .01). US had a significant negative path to AWC (β = -.40, p < .01), and was also negatively correlated with CVC (r = -.54, p < .01). There was a positive path from infant age to CVC (β = .54, p < .01). There was a positive path from educator qualification to interaction quality (β = .33, p < .01), a negative path from group size to interaction quality (β = -.32, p < .01), and a negative correlation between group size and educators- infant ratio (r = -.30, p < .05). At the same time, educator qualification had a significant and positive indirect path to AWC (β = .10, p < .05) whereas group size had a significant and negative indirect path to AWC (β = -.10, p < .05).

Figure 1. Results of adult word count path analysis.



Note: ** $p < .01$;* $p < .05$; AWC = Adult Word Count, CVC = Child Vocalization Count, US = Unclear Speech.

Discussion

Individual variation in infants' experience with 'near and clear' talk

The first aim of this study was to investigate infants' experience with 'near and clear' educator talk to determine the extent of individual variation. Consistent with previous studies in home and ECEC contexts (Hart and Risley 1995; Soderstrom and Wittebolle 2013; Weisleder and Fernauld 2013) we found evidence of broad individual variation to suggest that infant classrooms differ widely in opportunities for infants to experience clear, audible adult words. Infants' experience with adult talk provides them with varying opportunities to be exposed to new words, to develop phonological awareness, and to become familiar with the structure and rules of spoken language; all of which contribute to their language

development (Zauch et al. 2016). It follows, therefore, that low exposure to adult talk could be identified as a risk factor for short- and long-term language development and cognitive outcomes (Hart and Risley 1995; Hoff 2003; Walker et al. 1994; Weisleder and Fernauld 2013; Zimmerman et al. 2009).

Our findings, however, should not be used to argue that more 'near and clear' talk is unequivocally facilitative of language development. The present analysis did not determine how much of the LENA measure of 'near and clear' adult talk was infant-directed and how much was overheard speech to other staff or children in the infant's proximity. Recent research suggests that a proportion of talk that occurs close to infants in early childhood centres is talk between educators, and that this talk does not relate to the activity that the infant is currently focused on (Degotardi et al., 2016, Torr & Pham 2016). While older children have been found to learn some language features by overhearing talk addressed to others (Akhtar et al. 2001), infant-directed talk around a shared attentional focus has been found to be particularly facilitative of younger infants' language development (e.g., Rudd, Cain, and Saxon 2008; Weisleder and Fernauld 2013). Infant-directed talk during shared experiences provides the context for important language supporting strategies include the provision of contingent responses, waiting and listening, encouraging turn-taking, and providing expansions and extensions to infants' communicative attempts (Girolametto and Weitzman 2002). This work indicates that the quality as well as the quantity of language experience is important, and leads to the conclusion that more research is needed to examine precisely which of these quality features are associated with the quantity of 'near and clear' educator talk before firm conclusions can be made of its facilitative value in the ECEC context.

Associations between 'near and clear' talk and quality indicators

Our second aim was to investigate whether the quantity of 'near and clear' educator talk was related to interaction quality indicators. In line with previous research that has associated talk quantity with interaction quality (Degotardi et al. 2016, Hart and Risley 1995; Hoff 1994), these infants' experience with 'near and clear' talk was significantly related to our composite measure of Interaction Quality. This suggests that infants in rooms assessed as having high quality interactions were afforded greater opportunities to engage in talk-rich educator-infant interactions, than those in rooms rated as having a lower interaction quality.

Educators' qualifications and group size were not directly related to 'near and clear' talk, but our findings align with others who found that these structural quality indicators are related to the interaction quality of the room (Degotardi 2010; Manlove et al. 2008; NICHD 2002a; Phillips et al. 2001). Infants in rooms with larger group sizes tended to experience lower ITERS-R-derived interaction quality than those in smaller group sizes, which explained a significant indirect path to 'near and clear' talk. Rooms with larger group sizes in this study also tended to have lower educator-infant ratios, so it is possible that the competing demands of high numbers of infants mean that educators struggle to engage in, and sustain positive, developmentally-supportive interactions with these infants. This may manifest itself in a more managerial and less interactive style of interaction among all staff within the room, which would consequently attract lower Interaction Quality scores.

A significant indirect path between educator qualifications and 'near and clear' talk indicated that in rooms where there was a degree-qualified teacher, higher Interaction Quality explained the difference in infants' experience with 'near and clear' educator talk. While in line with previous research affirming the importance of early childhood degree qualified

educators for infant program quality (Hestenes et al. 2007; King et al. 2016), the precise reason for the indirect relationship cannot be ascertained from these data. The degree-qualified teacher was only one educator in the room, and both the Interaction Quality and the AWC measure captures interactions and talk from all present educators. Our findings do, however, reinforce the importance of having well-qualified room leaders and suggest that enhanced knowledge and pedagogical skills of the lead educator may raise the overall interaction quality in the room.

Associations with infants vocalisation and unclear speech

The second pathway explaining infants' variable experience with 'near and clear' talk saw the identification of specific features of the language environment, captured by the LENA system and experienced directly by each individual infant. A 'bottom up' perspective on quality is largely absent from program-quality research, so our finding that these LENA measures were independent of the other, more frequently assessed quality indicators adds to current conceptualisations of language environment quality for infants. Consistent with previous research (Girolametto and Weitzman 2002; Hoff 1994; Weisleder and Fernauld 2013), we found that the extent to which infants experienced educator talk was significantly related to the quantity of their vocalisations. It may be that high vocalising infants prompt educators to respond verbally to their communicative attempts. Alternatively, it is possible that infants experiencing a high volume of 'near and clear' talk are encouraged to vocalise more than those with less direct talk experience. While infant age was significantly related to their vocalisation levels, it was not related to their experience with 'near and clear' talk, suggesting that these educators were not simply responding to infant maturation. The reasons

behind the relationship between infant vocalisation and educator talk therefore remain a topic for future research.

We also found the level of unclear speech was negatively related to both 'near and clear' talk and infant vocalisation. This either suggests that higher levels of unclear talk constrain opportunities for infants and educators to communicate clearly (Linting et al. 2013; Manlove et al. 2001), or that a lack of 'near and clear' interactions lead to higher exposure to unclear talk. Whichever the case, our results suggest that high levels of unclear talk may represent an environmental risk factor which indicates a lack of opportunity for infants to directly participate in developmentally facilitative language interactions. As ECEC centres are characterised by high levels of activity and noise (Linting et al. 2013), future research is needed to examine this element of the language environment to determine whether there are thresholds that could be incorporated into conceptualisation of quality.

Limitations and future directions

Our findings raise questions about how input quantity is measured, and how the quality of infants' language environment is conceptualised. While the LENA measures were integral to the model of language and interaction quality presented here, it is important to reiterate that these measures are estimates, based on the digital processing of the audio files which is limited in regards to the information it can provide. Given the importance of shared experience, grammatical features and the content of infant-directed talk for early language development (e.g., Hoff and Naigles 2002; Huttenlocher et al. 2010; Rudd et al. 2008; Weisleder and Fernauld 2013; Zauch et al. 2016), future analyses using both video and LENA observations will yield a more precise understanding of the talk and language features that are implicated in the AWC measure. Furthermore, the use of the ITERS-R as a quality

measure, while well established in previous research, provides a broad assessment which comprises items assessing language environment quality as well as supervision, discipline and support of peer interactions. Other recently available tools, including the Classroom Assessment Scoring System (CLASS) infant and CLASS toddler (Hamre et al. 2014; La Paro, Hamre, and Pianta 2012) contain items that more specifically assess language support, so have the potential to be used to more closely examine language-environment quality.

Of interest, yet not pursued in the present analysis, was the detection of an average of 21.5% of non-speech-related data, comprising silence, percussive noise, and TV/electronic sounds. Research is beginning to consider the impact of features of the listening environment on children's language development and learning in general (Linting et al. 2013; Manlove et al. 2001; Zimmerman et al. 2009). The LENA system provides a useful tool to examine this issue further, so future studies have the potential to examine how speech-related and non-speech related sounds interact to support or constrain development.

Finally, our conclusions are limited by our focus on educator and classroom characteristics at the expense of infant characteristics. That infant age was a significant predictor of their vocalisation counts suggests that infants' language development will be an important factor to consider in the future. Analyses of other characteristics such as infant temperament or attachment relationships with educators may also be informative. By concentrating our analysis on one time point, we are unable to derive implications of the variability in infants' experience with educator talk for their future development. Longitudinal research is clearly required if these important questions are to be addressed and if we are to develop a more comprehensive understanding of the ways that variability in

various features of the infants' language environment in ECEC settings may be both influenced by, and influence their language development.

Conclusion

This study is one of the first in ECEC infant-room contexts to demonstrate the extent of variation in infants' experience with 'near and clear' talk. The presence of very broad individual differences, both in terms of infants' 'near and clear' talk experience and the Interaction Quality measure, suggests the need to increase some educators' awareness of the importance of providing rich language experience environments for very young children. A recent study of educators' beliefs about infant language development demonstrated that a proportion admitted to a lack of knowledge in this area, and expressed a need for increased pre- and in-service professional learning opportunities (Degotardi & Gill 2017). Our findings support this need, and thus advocate for professional learning programs that specifically address educators' capacity to engage infants in high quality, language-supporting interactions.

Finally, this study has presented evidence that the quality of infants' language and interaction experience is related to structural quality indicators. In particular, our analysis demonstrates the importance of degree qualified educators and smaller group sizes in infant ECEC rooms. It appears that optimal staff and organisational features may well support all room educators to engage in interactions which support infants' language development and their learning in general.

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