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**This is the author version of an article published as:**

Degotardi, S., & Han, F. (2020). Quality of educator-infant conversational interactions among infants experiencing varying quantity of linguistic input. *European Early Childhood Education Research Journal*. 28(5), 743-757

**Access to the published version:**

<https://doi.org/10.1080/1350293X.2020.1817245>

This is an Accepted Manuscript of an article published by Taylor & Francis in *European Early Childhood Education Research Journal* on 09/09/2020, available online <https://doi.org/10.1080/1350293X.2020.1817245>

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**Quality of educator-infant conversational interactions among infants  
experiencing varying quantity of linguistic input**

Sheila Degotardi<sup>1</sup>  
Macquarie University  
[sheila.degotardi@mq.edu.au](mailto:sheila.degotardi@mq.edu.au)  
ORCID: 0000-0003-2066-2223

Feifei Han  
Griffith University  
[feifei.han@griffith.edu.au](mailto:feifei.han@griffith.edu.au)  
ORCID: 0000-0001-8464-0854

*Accepted for publication by the European Early Childhood Education Journal, May 2020*

**Acknowledgements**

We gratefully thank the educators and infants who were willing to participate in this study and generously allowed our research assistants to observe and film their practices.

**Funding**

This work was supported by the [Australian Research Council] under Grant [DP140101238].

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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<sup>1</sup> Corresponding author

## Quality of educator-infant conversational interactions among infants experiencing varying quantity of linguistic input

### Abstract

Evidence suggests that the quantity of linguistic input experienced by infants in early childhood centres relates to the quality of educator-infant interactions. However, little is known about the linguistic properties of mutually responsive educator-infant interactions. This study uses sequence analyses to identify patterns of educator-infant three-turn conversations, and examine whether these patterns are related to the quantity of educator words (AWC) experienced by infants. We selected 15-minute video segments representing the peak quantity of AWC experienced by 14 infants across a three-hour period. Educator initiations were coded as *knowledge-* or *non-knowledge-based*, infant responses and educator follow-ups were coded as *evaluative* and *elaborative*. Each conversation was coded as *terminate* or *continue*. Four patterns of educator-infant conversations were identified, revealing significant differences in the conversations experienced by infants in the high and low AWC cohorts. Findings inform educators on how best to engage infants in mutually responsive, language-rich and sustained conversations.

### Key words:

Infant, childcare, language development, educator-infant interactions, quality, early childhood education

## **Introduction**

The opportunity for infants to engage in language rich interactions with caregivers across a range of contexts has long been recognized as an important support for children's language development outcomes (Zauch et al. 2016; Hoff 2006). Both the quantity of linguistic input received by children and quality of adult-child interactions have been shown to predict children's language, cognitive, and academic development, and research in home contexts suggests that quantity and quality indicators are related (Hart and Risley 1995; Golinkoff et al. 2019; Montag, Jones, and Simit 2018). However, to date, in early child education and care (ECEC) centres, research on both quantity and quality indicators is limited. Existing research has focussed strongly on the contribution of the educator, tending to overlook the active contribution of infants to the interaction (Degotardi, under review).

Once the infant's contribution is acknowledged, attention is drawn to the linguistic features of mutually responsive conversations. Yet currently, there is little evidence to demonstrate whether the quantity of educator input is related to the occurrence and linguistic quality of educator-infant conversations. The present study addresses this by analysing both educators' and infants' contributions to their conversational interactions. Using a novel approach to describe the patterns of conversational interactions, the study ultimately examines how quantity of linguistic input and quality of conversational interactions are related in the ECEC settings.

### ***Quantity indicators of linguistic environments for infant language development***

Research in home settings has shown that children do not experience the same amount of linguistic input. Hart and Risley's (1995) seminal study revealed that 42 infants and toddlers (aged between 10 to 36 months) experienced considerable quantitative variation in adult talk input. In families with professional parents, children were exposed to an average of 2,153 words/hour, whereas those in working class and in welfare-dependent families were

exposed to 1,251 and 616 words/hour respectively. When SES was controlled, the quantity of infants' exposure to adult talk predicted their vocabulary size at the age of three and literacy outcomes at the age nine. The predictive power of the quantity of infants' linguistic input has been confirmed in other studies in home settings where the number of adult words experienced by infants in routine and play time repeatedly predicted their subsequent vocabulary size (Hoff and Naigles 2002; Hurtado, Marchman, and Ferauld 2008; Weisleder and Fernald 2013).

Evidence is emerging to suggest that the linguistic input of infants in ECEC settings also varies widely. Murray et al. (2006) conducted 20-minute observations of 14 infants and toddlers to determine the quantity of caregiver verbal input to each child, finding that the quantity and extent of individual variation was comparable to that reported in home contexts by Hart and Risley (1995). Degotardi, Han, and Torr (2018) used sophisticated LENA audio-recording technology that permits the recording and analysis of longer observation periods (see [Lena.org](http://Lena.org)) to determine the quantity of educator experienced by 57 infants in different ECEC rooms across a three-hour period. They also identified broad individual differences: while infants experienced 1,362 words/hour on average across the 3-hour period, the infant experiencing the maximum number of adult words (3,552 words/hour) exceeded ten-fold that of the infant who experienced the least (343 words/hour).

### ***The relation between quantity indicators and quality of adult-infant interactions***

Research on home language environments also indicates that the quantity of linguistic input may be related to the quality of caregiver-child interactions, with evidence to suggest that it is the quality of input that more strongly impacts infant language development (Golinkoff et al. 2019). In Hart and Risely's (1995) study, parents who talked more to their infants tended to engage in more information-rich and mutually responsive conversations than those who talked less. Similarly, Hoff (1994) reported that the quantity of infant-directed

talk during meal-time was positively associated with mothers' tendency to extend the topic of the interaction over multiple utterances and infants' tendency to respond contingently. These studies suggest that the quantity of input is related to both the function of the interaction, as well as the extent to which partners work together across a series of conversational turns to extend the topic.

Patterns of association between the quantity of linguistic input and quality of interactions have been observed in recent ECEC studies. In Degotardi et al. (2018) study mentioned earlier, the number of words directly experienced by infants in three-hour observation episodes was positively related to the classroom interaction quality, assessed with the Infant-Toddler Environmental Rating Scale-Revised (ITERS-R, Harms, Cryer, and Clifford 2006). The researchers' measure was a composite of the 'listening and talking' and the 'interaction' ITERS-R sub-scales, comprising items that assessed language-supporting, social-emotional and supervision interaction capabilities demonstrated by all educators in that room. As such, this study could not discern whether the quantity of educator input was related more specifically to the linguistic quality of educator-infant conversations. Another study investigating the mealtime interactions of 27 educators, Degotardi, Torr, and Nguyen (2016) found that the quantity of infant-addressed words was positively correlated with these educators' use of interaction promoting strategies as measured by Teacher Interaction and Language Rating Scale (Girolametto, Wietzman, and Greenburg 2000). Educators who talked more to infants were rated more highly than their less talkative counterparts on their ability to encourage infant participation and conversational turn taking. Although this study demonstrates again that the quantity and quality of educator input is related, the linguistic features of reciprocal conversational contributions of both educators and infants remains opaque.

### *Educator-infant conversations*

For some time, it has been accepted that infants, through their behaviours and capabilities, elicit responses from their adult caregivers (Karraker and Coleman 2005), and that mutually responsive conversations support infants' ability to understand and use conversational conventions (Casillas 2014; Hoff 1994). To date, however, there are few ECEC studies that investigate the mutuality of educators' and infants' contributions. In one rare example, White, Peter, and Redder (2015) examined the verbal and non-verbal initiations and responses in the two-turn interactions experienced by two under-12-month-old infants and their educators. The researchers found that infants were most likely to respond to an educator initiation when educators combined verbal and non-verbal overtures. Although infant initiations were relatively rare, when the infant initiation combined verbal and non-verbal communicative forms, educators tended to respond similarly. The study suggests that conversational exchanges are sensitive to the type of communicative overtures used by both parties, and that even pre-verbal infants contribute to the communicative quality of their conversational exchanges.

Three questions remain unanswered by the existing ECEC evidence base. The first relates to the linguistic function of the conversation. Those approaching child language development from a pragmatic theoretical stance have, for some time, distinguished the language and learning potential of information-rich verses managerial and interpersonal conversational exchanges (Halliday 1975; Tomasello 2003). Information-rich conversations build knowledge, with conversational partners conveying or seeking information about the attributes or actions of objects or events. In contrast, managerial and interpersonal conversations have an instrumental, regulative or relationship-building function, seeking to satisfy adults' or infants' wants, needs and expectations. In home contexts, research focussing on adult contributions suggests that it is the information-rich, rather than the managerial and

interpersonal utterances that encourage mutual contributions and, ultimately support children's language use and development (Hart and Risley 1995; Mascareno et al. 2017; Kuchirko, Tafuro, and Tamis LeMonda 2018).

The second question relates to the informational characteristic of *all* conversational turns. Few studies in home or ECEC contexts have focussed on the contribution of the infants, or the follow-up contributions of the adult. Yet infant and adult responses can also be distinguished according to their knowledge-constructing potential. Responses can add information, thus extending the topic, or they can simply repeat, reflect, or acknowledge the content of the previous response (Snow 1989; Girolametto and Weitzman 2000). It is the responses that build on previous conversational turns that increase the information content of conversation, potentially making it more engaging and conceptually rich for the child (Hoff 1994; Mascareno et al. 2017; Snow 2017).

The final issue relates to the sustained nature of the conversation. Most work has analysed the educators' contributions, and White and colleagues (2015) considered only the first two turns in an interaction. Yet in order to analyse responses by *both* parties, a minimum of three turns needs to be considered (Bloom et al. 1996). When conversations are extended, opportunities are increased for infants to both gain important linguistic input and to contribute meaningfully to the conversation (Hoff 1994; Casillas 2014).

### ***The present study***

The aims of this research are twofold. The first is to explicate the linguistic quality of the naturally-occurring conversational interactions between educators and infants that include at least three turns. We focus on those initiated by educators on the basis that educators' interaction-supporting efforts have been repeatedly argued to encourage infant participation in communicative exchanges (Girolametto and Weitzman 2002; White, Peter, and Redder 2015; Hu et al. 2019; Degotardi et al. 2018). We investigate associations between types



of educator initiation and infant response, between types of infant response and educator follow-up. We then employ sequence analysis (Abbott and Tsay 2000), more specifically, agglomerative hierarchical sequence clustering, a statistical method that is able to detect the patterns of categorical sequence data (Gabadinho et al. 2011) to capture the sequential patterns of naturally-occurring three-turn conversations, which either continue and terminate beyond three turns (initiation – response – follow-up – continuation/termination).

Findings from aim one informed the second study aim of this study, which is to determine whether the linguistic quality of educator-infant conversations is related to the level of quantity of linguistic input experienced by infants. Using the results from our sequence analysis, we compared the conversational patterns experienced by infants who were found to experience high and low quantities of educator talk during their naturally-occurring interactions in their ECEC centres.

## **Materials and methods**

### ***Sample and recruitment***

Data for this study was drawn from the participants from a larger research project involving 57 focus infants (7 to 24 months,  $M=17.81$ ,  $SD=4.40$ ), who attended ECEC programs for children under the age of two. All children attended at least two days per week ( $M=3.38$ ,  $SD=1.02$ ), and averaged 8.82 months of attendance ( $SD=4.58$ ). Invitation emails were sent to ECEC centres identified from a database used for teacher-education infant practicum. From the 89 invited centres, 55 ultimately participated, yielding one focus infant from each infant classroom (two centres had two infant rooms). All participating infants were identified by their educators as happy and settled and none had diagnosed learning difficulties. Ethical approval for the study was granted by the Macquarie University Human Ethics Committee, and informed consent was obtained from room leaders, all the educators

present in the room, the parents/guardians of the focus infants and all the other infants in the room.

### ***General procedure***

In the larger study, the language experience of each focus infant was generated using both video and audio recording. Three hours ( $M=179.90$  minutes,  $SD=9.55$  minutes) of awake-time of each focus infant was captured using the LENA system, which comprises a small audio recorder, worn by the infant, that records all speech and other sounds experienced and produced by that infant. The LENA audio files are uploaded to associated software which applies iterative modelling algorithms to generate a range of quantitative measures of the infant's language environment, including adult word count (AWC), child vocalization count, quantity of unclear or indistinct talk, and more. The accuracy and reliability of the LENA talk estimates has been validated in home-based studies (Oller et al. 2010) and ECEC infant room research (Soderstrom and Wittebolle 2013). More information about the LENA system, including its research applications and challenges can be found in a systematic review by Wang and colleagues (2017).

Because the LENA system only yields numerical counts, we supplemented the audio-recording with simultaneous video-recording to obtain data on the linguistic and contextual features of the interactions that occurred. These recordings were generated at a discrete distance from the focus infant via a hand-held video camera that enabled the videographer to obtain the best possible footage of the interactions.

### ***Data selection***

As our aim was to examine associations between the quantity of linguistic input and the linguistic quality of the infants' conversations, we adopted a purposeful sampling method to select data for analysis. We used the LENA AWC measure, which comprise a count of clearly audible adult words experienced by the focus infants, to identify in the total sample

the infants who experienced high and low AWC. Using the criterion of one *SD* above and below the AWC mean, fourteen infants were identified and formed into a high ( $N=7$ ) and low ( $N=7$ ) AWC cohort.

The second data selection step was to extract the peak continuous 15 minutes of AWC experienced by each focus child during their three-hour observation period. Previous research demonstrates clearly that infants' naturally-occurring exposure to adult talk has peaks and troughs across any extended period of time (Soderstrom and Wittebolle 2013). This raises the possibility that infants who experience overall low quantities of AWC may still have concentrated periods during which they engage in many conversational interactions with educators. We therefore selected the peak 15-minute AWC segments to maximise the possibility that this period would capture the conversations in both the high and low AWC cohorts. Most identified 15-minute periods occurred during play activities, but two included a large proportion of whole group activities, during which research has shown to be often dominated by educator talk rather than conversational exchanges (Soderstrom and Wittebolle 2013; Torr 2019). To maximise comparability, these cases were replaced with the second highest peak 15-minute AWC. The mean AWC/hour, and the total AWC in selected 15-minute segments experienced by the 14 focus infants are presented in Table 1.

Table 1. Mean AWC/hour experienced by infants in the high and low word count cohorts.

high	$M=2704.58$	$M=1255.57$	low	$M=504.46$	$M=414.71$
AWC	$(SD=431.57)$	$(SD=201.70)$	AWC	$(SD=99.68)$	$(SD=141.99)$
ID	$M$	total AWC	ID	$M$	total AWC
	AWC/hour	in 15 minutes		AWC/hour	in 15 minutes
3	2337.65	1215	4	538.73	524
10	2983.22	1092	5	620.50	397
11	2651.78	1358	7	430.33	241
12	3552.00	1531	23	496.73	568
32	2367.77	926	46	482.54	222
37	2556.05	1399	52	618.78	548
38	2483.58	1268	56	343.61	403

We synchronised the LENA audio file with the 15-minute video file, removing the external video sound using Adobe Premiere software in order to maximise the audibility and clarity of the conversational exchanges for coding purposes.

### ***Coding process***

A microanalytic approach was used to code the first three conversational turns in all educator-infant conversations within the 15-minute extract. A conversation was defined as a sequence of at least three turns that focused on a topic of interest. Turns had to demonstrate topical contingency, with conversations terminated when the topic changed or when the educator or infant did not respond with either an utterance or a conventional gesture.

The coding was conducted collaboratively by the two authors using the Mangold Interact video analysis program. The *play* and *stop* keys were used to scrutinise the video and identify three-turn conversations which, once identified, were coded independently by the

two authors using the scheme described below. Codes were compared and, in cases of disagreement, the segment was re-played until a final agreement was made. On average, each 15-minute segment took around 90 minutes to code.

Any unclear turn was marked as ‘uncodable’ and conversations which had an ‘uncodable’ turn ( $N=7$ ) were excluded from analyses. This left 102 three-turn conversations for analysis.

### ***Coding scheme***

A coding scheme was developed drawing on existing literature about the linguistic features of adult-child conversations identified previously. The coding scheme was exhaustive, with specific codes assigned to each of the three turns as follows:

Educator initiations were coded using the information/referential and the managerial/interpersonal distinction (Hart and Risley 1995; Mascareno et al. 2017; Kuchirko, Tafuro, and Tamis LeMonda 2018; Halliday 1975). Initiations which conveyed or sought information by labelling (‘There’s a truck.’), describing (‘The bucket is full.’) or asking an information-seeking question (‘Where has the train gone?’) were coded as *knowledge-based*. Initiations which communicated wants and needs (‘Do you want a banana?’), regulated behaviour (‘Please sit down.’), expressed or built relationships (‘Hello!’; ‘Love you Darling!’), or provided social affirmation (‘Good girl!’) were coded as *non-knowledge-based*.

Infant responses and educator follow-ups were coded according to whether or not the response extended on or reflected the representational content of the previous turn (Snow 1989; Girolametto and Weitzman 2002). When a response extended the topic by adding information or ideas (e.g., When responding to the educator’s initiation – ‘Can you see the plane?’, the infant responds ‘Plane. Fly, up sky!’), it was coded as *elaborative*. When a response only acknowledged, repeated, or re-cast (using correct grammar) the

representational content of the previous turn (e.g., In response to the infant turn above, the educator repeats ‘Up in the sky.’), it was coded as *evaluative*.

Finally, to examine the sustained nature of the conversations, each conversation was coded as either *continue* or *terminate* depending on whether or not it extended beyond the three coded turns.

### ***Inter-coder reliability***

A trained research assistant with a PhD in ECEC independently coded 22 randomly selected conversational interactions (approximately 20% of the data). Cohen’s Kappa for all values indicated substantial agreement: .82 for educator initiations, .82 for infant responses, .80 for educator follow-ups, and .82 for continuation or termination the conversations.

### ***Data analysis***

Data was exported from Mangold Interact to IBM SPSS 24 and R. Associations between initiation and response types and between infant response and follow-up types were examined with 2x2 cross-tabulation in SPSS. The detection of the sequential patterns of the conversations, including the continuation/termination code, was performed in TraMineR in R. To investigate the association between the conversational patterns generated by the agglomerative hierarchical sequence analysis (quality) and the high and low AWC cohorts (quantity), we performed a cross-tabulation.

## **Results**

### ***Association between educator initiation and infant response***

The results regarding the association between types of initiations and responses are presented in Table 2. There was a significant and moderate association ( $\chi^2(1)=17.40$ ,  $\phi=.41$ ,  $p<.01$ ), demonstrating that non-knowledge-based initiations were more likely to be followed

by evaluative responses from infants, whereas knowledge-based initiations tended to receive elaborative responses.

Table 2. Association between educator initiations and infant responses.

variables		evaluative	elaborative	row total
non-knowledge	observed	32	12	44
	expected	21.57	22.43	
	cell $\chi^2$	5.04	4.85	
knowledge	observed	18	40	58
	expected	28.43	29.57	
	cell $\chi^2$	3.83	3.68	
column total		50	52	102

Note:  $\chi^2(3)=17.40$ ,  $\phi=.41$ ,  $p<.01$ .

### ***Association between infant response and educator follow-up***

Table 3 shows that the association between infant response and educator follow-up was not significant ( $\chi^2(1)=0.98$ ,  $\phi=-.01$ ,  $p=.57$ ).

Table 3. Association between infant responses and educator follow-ups.

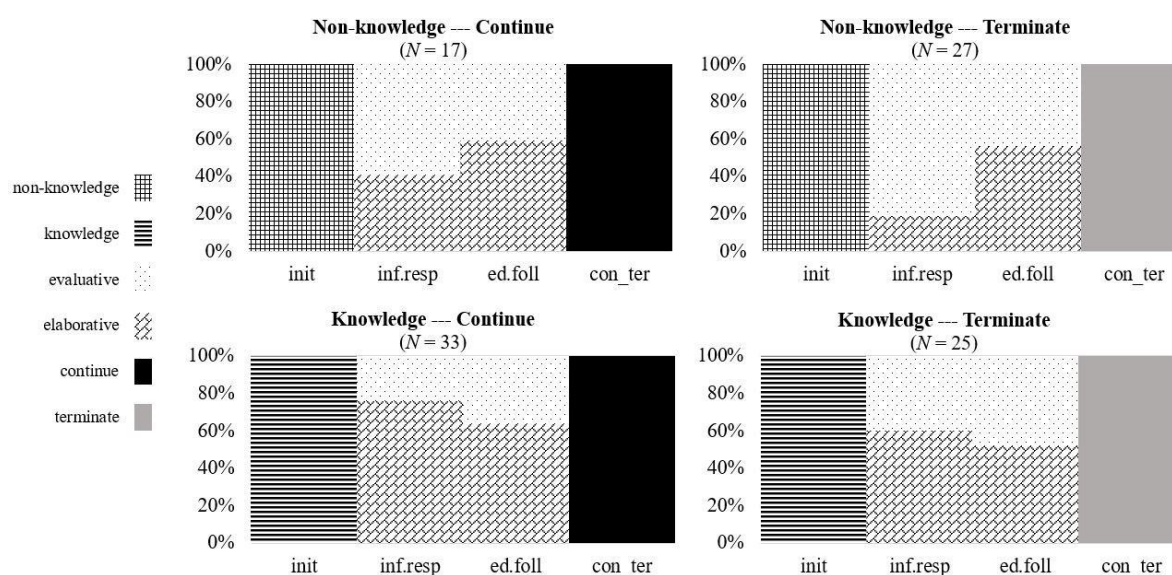
variables		educator evaluative	educator elaborative	row total
infant evaluative	observed	21	29	50
	expected	21.08	28.92	
	cell $\chi^2$	0.00	0.00	
infant elaborative	observed	22	30	52
	expected	21.92	30.08	
	cell $\chi^2$	0.00	0.00	
column total		43	59	102

Note:  $\chi^2(1)=0.98$ ,  $\phi=-.01$ ,  $p=.57$ .

### ***Sequential patterns of the three-turn conversations***

The results of the agglomerative hierarchical sequence analysis on the sequential pattern of the three-turn conversations are displayed in Figure 1. The analysis clustered 102 three-turn educator-infant conversations into four distinct patterns. Pattern 1 ( $N=17$ , 16.7%) captured conversations that commenced with a non-knowledge-based initiation and continued past three turns. In this pattern, 41.2% of infants' responses were elaborative and 59.8% of

educators' follow-ups were elaborative. Pattern 2 ( $N=27$ , 26.5%) represented conversations that also commenced with non-knowledge-based initiations but terminated at three turns. The infants' responses in this pattern were only 18.5% elaborative, while educator follow up were 55.4% elaborative. Patterns 3 conversations ( $N=33$ , 32.3%) commenced with knowledge-based initiations and continued past the third turn. In this pattern, 76% of infant responses were elaborative, and the proportion of the educators' elaborative follow-ups was 63.6%. Cluster 4 ( $N=25$ , 24.5%) were the conversations with knowledge-based initiations that terminated after the third turn. In this pattern, the proportion of the elaborative responses from infants was 60.0% and the proportion of the educator elaborative responses was 52.0%.



Note: init=initiation, inf.resp=infant response, ed.foll=education follow-up, con\_ter=continue or terminate

Figure 1. Conversational patterns of the three-turn conversations.

The patterns in Figure 1 demonstrate that the distinguishing feature of the four conversational patterns was the proportion of infant elaborative versus evaluative responses. To further verify this point of difference, a 4 (conversational patterns) x 2 (infant responses) cross-tabulation was conducted. Displayed in Table 4, the results show a significant association between conversational type and infant response ( $\chi^2(1)=16.91$ ,  $V=.41$ ,  $p<.01$ ). There were higher than expected evaluative infant responses and lower than expected



elaborative responses in Non-knowledge – Terminate conversations, while the opposite was observed in the Knowledge – Continue conversations.

Table 4. Association between conversational pattern and infant' response.

variables		infant evaluative	infant elaborative	row total
Non-knowledge – Continue	observed	10 <sup>a</sup>	7 <sup>a</sup>	17
	expected	8.33	8.67	
	cell $\chi^2$	0.33	0.32	
Non-knowledge – Terminate	observed	22 <sup>a</sup>	5 <sup>b</sup>	27
	expected	13.24	13.76	
	cell $\chi^2$	5.80	5.58	
Knowledge – Continue	observed	8 <sup>a</sup>	25 <sup>b</sup>	33
	expected	16.18	16.82	
	cell $\chi^2$	4.14	3.98	
Knowledge – Terminate	observed	10 <sup>a</sup>	15 <sup>a</sup>	25
	expected	12.25	12.75	
	cell $\chi^2$	0.41	0.40	
column total		50	52	102

Note:  $\chi^2(3)=20.96$ ,  $V=.45$ ,  $p<.01$ . Each subscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the .05 level.

***Association between the linguistic quality of three-turn conversations and the quantity of AWC experienced by infants***

To compare the conversation experience between infants in the low and high AWC cohorts differed in terms of their conversation experience, we first conducted a one-sample z-test. This revealed that the of 102 three-turn conversations, infants in the high AWC cohort experienced significantly more conversations ( $N=72$ , 70.6%) than their peers in the low AWC cohort ( $N=30$ , 29.4%) ( $z=11.31$ ,  $p<.01$ ). We then conducted a 4x2 cross-tabulation to examine if infants in low and high AWC cohorts differed in terms of the specific conversational patterns detected by sequence analysis. Displayed in Table 5, the results show significant association between conversational patterns and AWC cohorts ( $\chi^2(1)=16.91$ ,  $V=.41$ ,  $p<.01$ ).

Table 5. Association between conversational patterns and AWC cohorts.

variables		low AWC	high AWC	row total
Non-knowledge – Continue	observed	7 <sup>a</sup>	10 <sup>a</sup>	17
	expected	6	12	
	cell $\chi^2$	0.17	0.33	
Non-knowledge – Terminate	observed	15 <sup>a</sup>	12 <sup>b</sup>	27
	expected	7.94	19.06	
	cell $\chi^2$	6.28	2.62	
Knowledge – Continue	observed	5 <sup>a</sup>	28 <sup>a</sup>	33
	expected	9.71	23.29	
	cell $\chi^2$	2.28	0.95	
Knowledge – Terminate	observed	3 <sup>a</sup>	22 <sup>b</sup>	25
	expected	7.35	17.65	
	cell $\chi^2$	2.57	1.07	
column total		30	72	102

Note:  $\chi^2(3)=16.91$ ,  $V=.41$ ,  $p<.01$ . Each subscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the .05 level.

With the exception of the Non-knowledge – Continue conversations, the low and high cohorts significantly differed in all the other three conversational patterns. For the Non-knowledge – Terminate pattern, there were more conversations than expected in the low AWC cohort and fewer than expected in the high AWC cohort. In contrast, in both Knowledge – Continue and Knowledge – Terminate patterns, there were fewer conversations than expected in the low AWC cohort, and more than expected in the high AWC cohort.

## Discussion

### *Features of educator-infant conversations*

This study is one of the first to systematically and sequentially examine the linguistic features of conversations that occurred between educators and infants in ECEC centres. Our results shed light on how conversations are developed between educator and infant during their everyday interactions. As others have noted, educators play a significant role in establishing the conversational frame for infants, through their use of appropriate labelling,

describing and by asking information-seeking questions (Girolametto and Weitzman 2002; Degotardi, Torr, and Han 2018; Girolametto et al. 2000). Like research with older children (Mascareno et al. 2017), we found that more cognitively challenging educator initiations, in our case, knowledge-based initiations, were significantly more likely to attract elaborative responses from infants than the non-knowledge-based initiations.

Yet, by examining the patterns of the conversations, our study found that for both non-knowledge and knowledge-based conversations, infant responses were more likely to be elaborative in those that continued, compared with those that terminated at three turns. It is possible that an elaborative response indicated infants' interest in the conversational topic, thus increasing the likelihood that they would respond to the educators' follow-up and sustain the conversation. In contrast, an evaluative response, while demonstrating that the previous message has been heard and understood, may indicate less incentive and hence limit the opportunity for that conversation to develop further. Our findings thus demonstrate the significant role of both educator and infant in the development and maintenance of conversations, suggesting that knowledge-based initiations are particularly engaging for infants, thereby encouraging their participation and contributions.

Interestingly, our findings demonstrated no association between infant responses and educator follow-ups. Mascareno and colleagues (2017) analysis of conversations with older children also detected no significant relationship between turns two and three, but educators in their study demonstrated a high proportion of evaluative responses. In the present study, more educator follow-ups were elaborative (57.8%) than evaluative (42.2%), suggesting that, regardless of the infant type of infant contribution, the educators were adding informational detail to the conversation. Our findings thus pave the way for future studies to look closely at the features of the educator initiation – infant response – educator follow-up sequence to

determine more precisely how both partners work together linguistically to establish information-rich and sustained conversations.

### ***Association between quantity and quality indicators***

Our finding that the infants in our high and low AWC cohorts differed in the conversational patterns they experienced adds specificity to previous ECEC studies that report relationships between the quantity of talk experience and broad measures of interaction quality (Degotardi et al. 2016; 2018). Even during their peak word input experience, the low AWC cohort participated in significantly fewer conversations, specifically, knowledge-based conversations, than the high AWC cohort. While recent commentaries have cautioned against paying too much attention to word input rather than the quality of interactions (Wasik and Hindman 2015), our findings suggest that the quantity of educators' linguistic input is important, not for its own sake, but for the conversational opportunities that it presents. Recent initiatives in the home focus on increasing adult word input on the assumption that this will increase the occurrence and quality of adult-infant conversations (Ramirez et al. 2019; Suskind et al. 2016; Hannon 2019). However, the direction of this relationship is disputed. Snow (2017), in particular, argues that efforts should be on interacting with infants during cognitively engaging experiences, which will not only increase language input, but also motivate infants to use their developing language skills. At this point in time, neither argument should be rejected. The current findings suggest that efforts to converse frequently with infants about mutually engaging topics of interest is likely to be reflected in both quantity and quality indicators, which will ultimately have a positive flow on to infants' language environments (Golinkoff et al. 2019).

### ***Implications***

The present study has both methodological and pedagogical implications. Methodologically, our study demonstrates the value of sequence analysis techniques in

revealing conversational patterns. By simultaneously taking three conversational turns into consideration, the results and accompanying visual display of sequence using the agglomerative hierarchical clustering method clearly reveal differences in conversation types and the ways that both educators and infants contribute to these conversations. As such, this method complements those that have focused on educators' efforts alone, or on two-turn conversations to demonstrate the mutually contributing roles played by both conversational partners.

Pedagogically, our examination of the quality of knowledge- and non-knowledge-based conversations pinpoints the language opportunities and limitations related to these two fundamental interaction functions. Our findings should not be used to discourage managerial, instrumental and interpersonal conversations, as these interactions serve an essential socializing and relationship-building role (Degotardi and Pearson 2014). Nor should they suggest a mechanical or formulaic approach to engaging infants in conversations. However, our findings do suggest that efforts to improve infants' language environment need to include educators' ability to engage infants in knowledge-based conversations, as these conversations appear favourable for encouraging sustained exchanges that ultimately provide fundamental support for language development.

### ***Limitations and directions for future research***

Although methodologically and practically insightful, our study was limited by a number of factors. Firstly, the relatively small sample size of 14 infants means that our findings are exploratory and would benefit from replication. Future research is also needed that extends beyond investigations of three-turn conversations. This may be especially useful in terms of uncovering the responding strategies used by the educators to encourage infants' to continue the conversations.

Second, our study did not take into account the language capabilities of the infants. As previous research has shown that the quantity of infant vocalisations is positively related their quantity of educator word experience (Degotardi et al. 2018), future research is needed to examine how infant language capabilities and their own initiations may impact the quality of conversational interactions that occur in ECEC centres. Finally, while conversational exchanges appear to be emerging as the most significant language supporting feature in home environments, research is yet to determine its significance in ECEC settings. Hence, future longitudinal or intervention research is needed to establish the predictive strength of rich educator-infant conversations for their subsequent language development.

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