



Review

Effects of early communication intervention on speech and communication skills of preterm infants in the neonatal intensive care unit (NICU): A systematic review

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ARTICLE INFO

Keywords:

Parent stress
Parent – infant interaction
Communication
Speech & language

ABSTRACT

Having a preterm infant is challenging for parents and families, with increased risk of psychological stress. Being separated from an infant, and dealing with the disruption to family life can impact on the development of parent – infant interaction and early bonding. These early interactive experiences are important in the development of communication skills. The antecedents for receptive and expressive language development can be supported and shaped in the neonatal unit. As preterm infants are at risk of speech, language and communication difficulties, providing parents with information about language development and strategies to promote communication are essential to integrate into neonatal care. This systematic review identified only five papers which investigated parent – infant interaction and the specific attributes associated with providing a good communication environment on the NICU. Due to the small number and differing outcome measures, a full meta-analysis was not possible. The authors recommend a clearer distinction between language and communication literature alongside investigations which have studied bonding and improving mental health for carers post pre-term birth.

1. Introduction

Advances in neonatal care have improved the survival of preterm infants at earlier gestational ages (Moore et al., 2012). Whereas it is known that preterm infants are at risk of neurodevelopmental problems, infants born at term who experience birth asphyxia or hypoxic ischaemic encephalopathy (HIE) are also additionally at risk of developing lifelong complex needs, specifically cerebral palsy (Jacobs et al., 2013). In addition to potential risks of infant developmental problems, parents and carers who have an infant in a neonatal intensive care unit (NICU) are more likely to experience significant psychological stress and trauma which impacts on the establishment of successful parent – child interaction (Shaw et al., 2013). Infants born preterm are at risk of developing speech, language and communication problems (Rautava et al., 2010; Stene-Larsen et al., 2014; Johnson et al., 2015). This systematic review considers papers which focus on early communication development, and discusses the importance of early communication on the NICU.

1.1. Background

It is now recognised that parents of preterm infants experience psychological distress which impacts on family mental health, well – being and interaction (Shaw et al., 2013). For mothers of preterm infants, separation can significantly increase stress already experienced at having given birth earlier than expected (Muller – Nix et al., 2004). Mothers whose infants experience a neonatal stay are at higher risk of postpartum depression, which can affect up to 40% of the population. (Alkozei et al., 2014). Flacking et al. (2012) explored mothers' experiences of a neonatal unit, and identified that maternal feelings of disempowerment in knowing and understanding their own infant could lead to increased stress and anxiety not just on the neonatal unit, but in the longer term. For mothers of high risk infants, concerns about longer term outcomes can increase stress (Aagaard and Hall, 2008) This can have an impact not only on confident development of bonding between mother and infant but also on early interaction skills (Shaw et al., 2013). Language, cognitive and emotional development is closely linked to parent affect, and consequently any early negative

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<https://doi.org/10.1016/j.jnn.2019.04.004>

Received 18 March 2019; Accepted 19 April 2019

Available online 06 May 2019

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experiences can impair the development of these early skills (Treyvaud et al., 2009, 2013).

Learning to develop attachment to an infant through involvement in everyday care activities in the neonatal environment can support physical and emotional closeness for both the infant and carers, and therefore act as an important precursor for developing early parent – infant interaction and communication (Evans et al., 2014; Flacking et al., 2012). Specifically, vocal stimuli from carers can improve preterm infants' stability (i.e. heart rate, oxygen saturation, respiratory rate, behavioural measures) with better feeding development (Saliba et al., 2018). Infant states and oral readiness signs are an important aspect of feeding development but these can be hard for carers to interpret clearly (Harding et al., 2018). Promoting early communication strategies to enhance maternal/carer sensitivity to an infant through use of eye contact; initiating talking with and responding to the infant and using natural gestures can increase attachment and bonding, support improved parent well – being, and improve the interpretation of early infant communication signals during everyday care (Evans et al., 2014). However, there are variations in the types of intervention programmes which are carried out, and specifically, there have been few studies which have investigated in detail the impact of early communication intervention for preterm infants and their carers on the neonatal unit.

1.2. Prematurity and communication and language development

Hearing begins to develop at 25–26 weeks gestational age, with the development of cochlear hair cells which process sounds. At 26–28 weeks gestational age, infants can demonstrate responsiveness to voice (Kisilevsky et al., 2009). Around 30 weeks gestational age, active listening is developing and attunement to maternal voice occurs (Smith et al., 2007). At this stage, infants are reflexive in their responses, becoming reactive to events and people, and as they become familiar with their environments, they become anticipatory (Coupe and Goldbart, 2016). These reactions become more differentiated as infants begin to perceive consistencies in their routines and develop specific preferences. Carers tend to interpret infant behaviours as meaningful. They are likely to act in ways that are nurturing and contingent (Tomassello & Todd, 1983; Tomassello and Ferrar, 1986).

Preterm birth is a risk factor for a range of difficulties, including language development (Aylward, 2014). Children born preterm are at risk of communication and language problems (Rautava et al., 2010; Stene-Larsen et al., 2014; Johnson et al., 2015). Significant increases in the risk of mild or moderate language impairment in early preterm children (< 27 weeks) in comparison to term infants at 2.5 years of age was identified in one study (Serenius et al., 2013). Another study found that there were significantly increased risks of developmental speech and/or language delay between the ages of 3 and 5 years in preterm children (34–36 + 6 weeks) compared to those born at term (Rabie et al., 2015). In addition to potential speech, language and communication difficulties, children born preterm can have other problems which can impact on communication development; an increased risk of autistic spectrum conditions (Kuzneiwicz et al., 2014); an increased risk of learning and executive function problems in school, attention and listening difficulties, an increased risk of learning disabilities (and therefore having special educational needs), and increased risks of visual and/or hearing problems (Aylward, 2014).

Preterm infants spoken to when on a neonatal unit have better language and cognitive outcomes at 7 and 18 months (Caskey et al., 2014). Preterm infants also show better state regulation when hearing a familiar voice (Sajjadian et al., 2017). Early infant communication outcomes are improved if intonation (or Motherese) is used as pitch and stress help infants orientate to words and word learning, and is therefore an important strategy that promotes a good communication environment (Gerken and Aslin, 2005; Kuhl, 2004). However, preterm infants are likely to have receptive language problems and shorter mean

length of utterances expressively at 2 years, with persisting problems at 4 years (Jansson – Verkasalo et al., 2004). Delayed development of the use of gestures has also been noted in preterm infant development (Ortiz – Mantilla et al., 2008). Using gesture, specifically pointing has a strong relationship with language development, both receptively and expressively (Colonnesi et al., 2010).

1.3. Understanding infant responses

Development of oral readiness signals can enable carers to interpret the infant's responses to events and respond accordingly. Recognising early infant states are an important part of a cue based approach to oral feeding, where opportunities for introduction and progression of oral feeding are based on an infant's states and behavioral responses during feed times (Kirk et al., 2007). Kirk et al. (2007) investigated a cue – based infant driven approach with 28 infants aged 36 ± 1 post menstrual age, and found that the cue – based approach group achieved full oral feeding 6 days sooner than controls and decreased length of hospital stay by 6.63 days. Wellington and Perlman (2015) also investigated cue-based infant driven feeding. Infants less than 28 weeks gestational age were discharged 9 days earlier, and took full oral feeds 17 days sooner; infants aged 28–31 gestational age were discharged 9 days earlier, and took full oral feeds 11 days earlier, and infants aged 32–33 weeks gestational age were discharged 3 days sooner and took full oral feeds 3 days sooner also. Cue – based feeding involves learning to read and understand what the infant is attempting to express, and as such, this approach could be an important method to support, promote and integrate methods to support early parent – infant communication skills.

This systematic review sought to investigate evidence in the literature which targeted communication and interaction for preterm infants on a neonatal unit. The importance of neonatal interventions to improve responsive parenting, approaches which include bonding and relaxation and programmes such as individualised family based care are important in supporting both parent and infant mental health and well-being, and may well provide opportunities for the development of early communication skills (Evans et al., 2014; Saliba et al., 2018). However, these approaches do not specifically address early communication development using gaze, gesture and being a responsive interactor.

2. Material and methods

2.1. Search strategy

A search for papers was completed using the following electronic databases: Web of Science; MEDLINE; EMBASE; PubMed; PsycINFO and the Cochrane Central Register of Controlled Trials. In addition, a hand search was completed to ensure that a thorough search as possible had been conducted. To capture the communication aspect of early interaction, rather than infant physiological responses to environmental stimuli, the following MESH search terms were used: NICU; prem*; infant*; interaction; communicat*; parent*. Papers were sought in English from 1995 to 2018. The date range was selected as over the last 20 years, because preterm infants of a lower gestational age have had better survival rates, and are therefore experiencing longer NICU stays.

2.2. Study selection

Studies published in English, with access to a full text were included in the search. Randomized controlled trials (RCTs), quasi – randomized controlled trials and observational studies with clear outcome measures were sought. When searching, studies were included if they focused specifically on: i) preterm infants born < 37 weeks gestation with no additional neurodevelopmental difficulties; ii) interventions or observations which specifically focused on early communication with preterm infants with the purpose of promoting early communication

and interaction experiences through use of gaze and eye contact during interaction; positioning to enable interaction through gesture and vocalisation; talking directly to the infant, and responding to vocalisations initiated; use of gestures during communication, and, iii) interventions which targeted supporting and promoting communication and responsiveness between parents and infants within a NICU setting. Studies were excluded if they did not specify communication and language as a fundamental part of the approach as part of an interactive framework or management of care. For example, approaches related to mental health or skin to skin support which did not specify language and communication were excluded. Full – texts considered to be relevant from the titles were downloaded and screened for inclusion by five reviewers. Studies thought to be relevant were reviewed with subsequent data extraction by two reviewers (CH; AL). Findings were discussed with SC; LE-H and RM.

2.3. Data collection

Once suitable studies were identified, data were extracted onto a table. Data included the following: authors' names and date of study; study design; number of participants and participant characteristics; type of intervention; outcome measures and results/findings of the studies.

2.4. Data analysis

Five studies met the systematic review criteria for evaluation. Fig. 1 illustrates the procedure undertaken to identify the relevant studies for this systematic review. However, as the studies had variations in infant characteristics, and different types of interventions related to early communication, it was not possible to complete a meta-analysis of the data. Data will be described in the Results section (Table 1).

2.5. Challenges

The suggestions by Goh et al. (2016) in relation to completion of a mini meta – analysis for such a small number of studies was considered. However, the studies identified did not address the same concepts, neither did they have similar measures. It was therefore decided that a description of the methodologies used was presented in line with the Goh et al. (2016) recommendations, with an exploration of the calculated effect sizes in addition to *p* values.

3. Results

Although the completed search was between 1995 – 2018, studies included ranged from 2010 to 2018. Two studies were from Italy, one was from Japan, one was from the USA and one was from Australia. Although all of the studies investigated, or were planning to investigate, aspects of communication behaviours, there were diverse outcomes evaluated. One study measured infant – mother gaze during interactions (Coppola and Cassiba, 2010). Three studies measured specific communication used or initiated by both parents and infants (Coppola and Cassiba, 2010; Caskey et al., 2014; Benassi et al., 2018). One study discussed mother – child interaction (Kusanagi et al., 2011). Two studies investigated modulation of infant states, and/or the interpretation of infant cues (Kusanagi et al., 2011; Milgrom et al., 2013). Reduction of parent stress was identified as an outcome related to communication in one study (Kusanagi et al., 2011). Cognition was highlighted as an outcome in two studies (Kusanagi et al., 2011; Milgrom et al., 2013), and one study measured symbolic development (Milgrom et al., 2013). One study measured the benefits of positioning as an outcome in relation to communication (Coppola and Cassiba, 2010). All studies had outcomes where effect size could be measured (Table 2).

All the studies assessed demonstrated moderate (0.5) and large effect sizes (over 0.8) in the domains that they were investigating. The

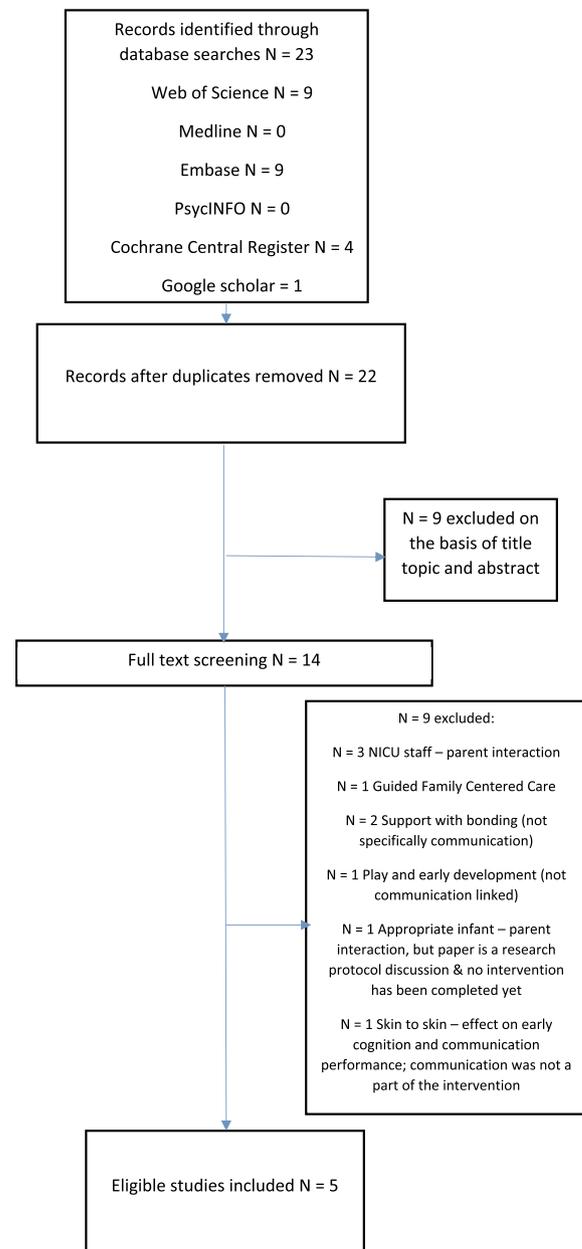


Fig. 1. Study selection methodology.

two studies which completed observations of maternal – infant interaction without a comparison group (Coppola and Cassiba, 2010; Caskey et al., 2014) noted changes over time. Coppola and Cassiba (2010) observed an increase in mother looking at the infant (effect size 0.5) and large effects with the mother decreasing her smiling with the infant over time 0.96 (from 15 to 30 days) and 1.08 (from 15 to 45 days). Caskey et al. (2014) asked parents to focus on using their language with their infants on NICU. They noted large to moderate effect sizes with the number of words adults used with infants at follow up (0.96), the number of conversational turns between adult and infant (0.60) and the number of vocalisations infants produced over time (0.62). Although these studies were observations, it seems likely that parents were aware that their language and communication was being examined as part of the investigations and made more efforts to use communication more consistently, increasing in confidence as the infants started to progress.

For the studies which compared groups, moderate and large effect sizes were also noted. Kusanagi et al. (2011) noted that the intervention group infants had a moderately lower duration of night crying (effect

Table 1
Characteristics of included studies.

Researchers (Date)	Study design	Participants	Enrollment age	Intervention	Outcome measures	Results
Coppola and Cassibba (2010)	Self-selecting observational study	N 20 (9 males 11 females)	GA at birth Mothers of VLBW infants born 25–35 weeks GA *Infants with complex needs excluded.	15 days post-partum	Gaze direction with the infant during interaction. Communication behaviours. Impact of positioning on interaction, i.e. in or out of an incubator.	There were significant increases with looking at the infant over time. The more serious an infant's condition, the less the mothers. There is more interaction when an infant is out of an incubator.
Kusanagi et al. (2011)	Allocation of mother–infant dyads to one of two groups	51 (24 males 27 females). Intervention group = 21 participants Control group = 30 participants	Group 1: Intensive Intervention group – mothers taught about infant states and cues, had support with interaction and were provided with printed information on NICU, and at 46 weeks corrected age & 60 weeks corrected age. Group 2: Mild Intervention group – mothers received training re: infant cues, had support with interaction and were provided with printed information at 46 and 60 weeks corrected age.	Group 1: Intensive Intervention group – mothers taught about infant states and cues, had support with interaction and were provided with printed information on NICU, and at 46 weeks corrected age & 60 weeks corrected age. Group 2: Mild Intervention group – mothers received training re: infant cues, had support with interaction and were provided with printed information at 46 and 60 weeks corrected age.	Infant – mother interaction. Mother modulation of infant states. Improved growth and cognitive skills through better interaction. Reduced parental stress.	There were no significant differences in the overall quality of mother–infant interaction between the two groups.
Milgrom et al. (2013)	Randomized clinical trial	109 mothers 123 infants (Group 1: Intervention; 30 males, 30 females/Group 2: Control; 22 males, 33 females). Follow – up, Intervention group 47 infants; Control group 45 infants	Mothers and their infants if born < 30 weeks gestational age (Range 26.1–29.5 GA). Infants with problems and mothers with social/mental health problems excluded.	Group 1: Mother – Infant Transaction Program 9 weeks (weekly) pre-discharge. Group 2: Mothers and infants received the usual care provided by the NICU.	Responsiveness to infant cues and infant stress using the Preterm Mother –Infant Interaction Scale. Short Temperament Scales for Infants. Communication and symbolic development using the Infant –Toddler Checklist of the Communication and Symbolic Behaviour Scales Developmental Profile.	Mothers who received the Infant Transaction Program responded more to their infant's cues; infants of mothers who had received the Infant Transaction Program showed fewer stress behaviours. At 6 months corrected age, infants of mothers who had received the Infant Transaction Program had higher scores on the Infant –Toddler Checklist of the Communication and Symbolic Behaviour Scales Developmental Profile.
Caskey et al. (2014)	Repeated measures – single group study	36 (15 males; 21 females) and their parents.	Premature infants of 23–30 weeks gestational age were recruited.	16 hours of adult communication and infant responses were recorded at 32 & 36 weeks GA. Follow up measures were completed at 7 & 18 months corrected age.	Adult language (mean adult word count). Infant responses (vocalisations) Communication skills at 7 & 18 months corrected age follow up using the Bayley III.	Increased levels of adult talk and infant responsiveness significantly increases communication and cognitive scores at 7 and 18 months corrected age.

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Table 1 (continued)

Researchers (Date)	Study design	Participants		Intervention	Outcome measures	Results
		N	GA at birth			
Benassi et al. (2018)	Allocation of mother–infant dyads to one of two groups	40 mother – infant dyads	ELGA infants and their mothers (20 pairs); Term infants and their mothers (20 pairs).	<p>Maternal responses to infant behaviours during play sessions were observed in two groups of infants at 12 months and 24 months. Group 1: ELGA infants; Group 2: Term infants.</p> <p>ELGA infants were recruited at 12 months corrected age. Term infants were recruited at 12 months.</p>	<p>Maternal responses for both the ELGA and the Term infant group at 12 and 24 months. Language (receptive and expressive skills) and cognitive skills using the Bayley III at 12 months and 24 months corrected age.</p>	<p>There were no significant differences with mothers providing contingent responses between the groups. Term infants produced more conventional/representative gestures than ELGA infants, but not significant.</p> <p>ELGA infants produced significantly more requesting/reaching/showing gestures, but fewer pointing/giving gestures compared to the Term infants.</p> <p>There were no significant differences between the ELGA and Term infants' non-word utterances and words. At 12 months, there were no significant differences between language composite scores or receptive/expressive scaled scores, but ELGA infants had significantly lower composite cognitive scores. At 24 months, there were significant differences between the groups for both cognitive and composite language scores, with Term infants performing better.</p>

Terms: ELBW = extremely low birth weight; GA = gestational age; PMA = post menstrual age; VLBW = very low birth weight.

Table 2
Impact of parent – infant interaction.

Study	Assessment measures	Intervention group or observation group n Mean (SD)	Control group n Mean (SD)	P value	Mean diff (95%CI)	Effect size		
Coppola and Cassibba (2010)	Changes in mothers behaviours (looking & smiling) at 15, 30 and 45 days. Correlations (at 15, 30 and 45 days of life) between gaze direction; security & maternal speaking and maternal annoyance with intrusion; maternal – infant gaze; Maternal communication; effect of infant position on maternal behaviour. Maternal smile in relation to interaction with the infant at 3 months corrected age.	n = 20 mother –infant dyads	No comparison group.	t(19) = 17.85, p = 0.0001*	0.6 (0.60, 0.97)	0.97		
		Increase in mother's looking at 15 days		15–30 days: t(19) = 24.27, p = 0.0003*	0.23 (0.12, 0.33)	0.71		
			Decrease in mother's smiling at the infant from 15 to 45 days t(18)		15–45 days: t(19) = 7.8, p = 0.0001*	0.07 (0.05, 0.08)	0.87	
			43, p < 0.05		p < 0.05	–	–	
			Gaze direction at 15 & 30 days (r = .42, p < 0.05).		p < 0.05	–	–	
			Security positively correlated to maternal speaking at 15 days (.44, p < 0.05), & at 30 days of life (.47, p < 0.05).		p < 0.5	–	–	
			Mothers talked more to the infant at 30 days of life (r = .42, p < 0.5).		p < 0.05	–	–	
			Mothers averted their gaze less from the infant at 45 days (r = -.68, p < 0.5).		p < 0.005	–	–	
			Mothers who had had more traumatic birth experiences displayed shorter gaze duration with the infant at 30 days of life (r = -.55, p < 0.5).		p < 0.05	–	–	
			Mothers reporting annoyance at intrusion at 30 days of life smiled and talked to the infant more (r = -.42, p < 0.5), and averted their gaze less from the infant at 45 days of life (r = -.68, p < 0.05).		p < 0.01	–	–	
			Mothers gaze at the infant was negatively associated with APGAR score from birth (r = -.69, p < 0.005).		p < 0.005	–	–	
			Mothers turning away from the infant was positively associated with APGAR scores (r = .62, p < 0.5).		p < 0.05	–	–	
			Mean gaze duration at 15 days associated with number of days on ventilation (r = .56, p < 0.5) & APGAR score, (r = -.73, p < 0.5).		p < 0.01	–	–	
			Mothers communication at 15 days of age associated with gestational age (r = .59, p < 0.005) & days in hospital (r = -.54, p < 0.05).		p < 0.01	–	–	
			Mothers spoke to the infant more when out of the incubator (Z = -2.60, p < 0.01), and looked at the monitors less when the infant was out of the incubator (Z = -2.86, p < 0.01).		p < 0.05	–	–	
			Mothers smile behaviour in NICU at 30 days of life predicted sensitivity in infant interaction at 3 months CA (R2 = .30; F(1,15) = 5.95, p < 0.05; β = .55, p < 0.05).		p < 0.05	–	–	
		Kusanagi et al. (2011)	NCATS TI questionnaire SAR PSI	n = 20	n = 27	t(45) = 0.00, p = 1.0	1.0 (-0.70, 0.70)	0.00
				Maternal: Maternal sensitivity to cues 0.1 (1.4)	Maternal: Maternal sensitivity to cues 0.1 (0.2)	t(45) = 1.09, p = 0.27	-0.50 (-1.41, 0.41)	0.32
				Response to infant distress -0.4 (1.6)	Response to infant distress 0.1 (1.5)	t(45) = 0.27, p = 0.78	0.10 (-0.63, 0.83)	0.07
				Social –emotional growth fostering 0.5 (1.4)	Social –emotional growth fostering 0.4 (1.1)	t(45) = 0.50, p = 0.61	0.40 (-1.88, 1.98)	0.14
Cognitive growth fostering 1.4 (3.3)	Cognitive growth fostering 1.0 (2.1)			t(45) = 0.00, p = 1.0	1.0 (-2.82, 2.82)	0.23		
Mother's total 1.6 (5.8)	Mother's total 1.6 (3.8)			t(45) = 0.83, p = 0.40	0.40 (-0.56, 1.36)	0.15		
Infant: Clarity of cues 1.2 (1.9)	Infant: Clarity of cues 0.8 (1.4)			t(45) = 0.54, p = 0.58	0.40 (-1.07, 1.87)	0.21		
Responsiveness to caregiver 0.2 (3.1)	Responsiveness to caregiver 0.2 (3.1)			t(45) = 0.54, p = 0.58	0.80 (-1.29, 2.89)	0.56		
Infant's total 1.4 (4.5)	Infant's total 1.6 (3.8)			t(45) = 1.96, p = 0.05	2.60 (-0.07, 5.27)	0.17		
Frequency of night crying 4.5 (5.3)	Frequency of night crying 4.5 (5.3)			t(45) = 0.61, p = 0.54	1.10 (-2.51, 4.71)	0.44		
				t(45) = 1.47, p = 0.14	41.10 (-14.88, 97.08)			

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Table 2 (continued)

Study	Assessment measures	Intervention group or observation group n Mean (SD)	Control group n Mean (SD)	P value	Mean diff (95%CI)	Effect size
Milgrom et al. (2013)	Preterm mother – infant interactions STSI CSBS DP	Frequency of prolonged crying 3.4 (6.9) Duration of consecutive nights' sleep 110.6 (79.8)	Responsiveness to caregiver –0.2 (1.9) Infant's total 0.6 (2.6) Frequency of night crying 1.9 (3.8) Frequency of prolonged crying 2.3 (5.4) Duration of consecutive nights' sleep 69.5 (103.5)			
		n = 54	n = 50			
		Awareness of positive infant cues 1.85 (1.03)	Awareness of positive infant cues 1.52 (0.89)	t(112) = 1.37, p = 0.17	–0.26 (–0.63, 0.11)	0.34
		Awareness of negative infant cues 2.32 (0.83)	Awareness of negative infant cues 1.92 (0.85)	t(112) = 2.42, p = 0.01*	0.40 (–0.72, 0.072)	0.47
		Appropriate responses to positive cues 1.77 (0.95)	Appropriate responses to positive cues 1.47 (0.87)	t(112) = 1.67, p = 0.09	0.30 (–0.05, 0.65)	0.32
		Appropriate responses to negative cues 2.06 (0.86)	Appropriate responses to negative cues 1.63 (0.83)	t(112) = 2.5, p = 0.01*	0.43 (0.10, 0.75)	0.58
		Inappropriate responses to positive cues 0.43 (0.69)	Appropriate responses to positive cues 1.02 (0.69)	t(112) = 1.42, p = 0.15	–0.22 (–0.5, 0.08)	0.27
		Inappropriate responses to negative cues 1.13 (0.85)	Maternal positive affect 2.41 (0.71)	t(112) = 2.51, p = 0.01*	–0.22 (–0.5, 0.08)	0.49
		Mother stresses infant 1.02 (0.69)	Maternal negative affect 0 (–)	t(112) = 4.09, p = 0.0001*	–0.41	0.80
		Maternal positive affect 2.41 (0.71)	Maternal inappropriate affect 0.29 (0.63)	t(112) = 3.04, p = 0.003*	–0.41	0.59
		Maternal negative affect 0 (–)	Infant motor stress cues 1.21 (0.72)	t(112) = 1.71, p = 0.08	(–0.73, 0.08)	0.00
		Maternal inappropriate affect 0.29 (0.63)	Infant physiological stress cues 1.28 (0.79)	t(112) = 1.99, p = 0.04*	–0.62	0.33
		Infant motor stress cues 1.21 (0.72)	Infant behavioural stress cues 1.45 (0.82)	t(112) = 0.46, p = 0.64	–0.62	0.39
		Infant physiological stress cues 1.28 (0.79)	Infant unstressed and exploring 1.70 (1.02)	t(112) = 0.56, p = 0.57	(–0.92, 0.31)	0.09
		Infant behavioural stress cues 1.45 (0.82)	Infant unstressed and attending 1.41 (0.96)	t(112) = 1.13, p = 0.25	0.47 (0.16, 0.77)	0.11
		Infant unstressed and exploring 1.70 (1.02)	Infant unstressed and relaxed 1.58 (1.06)	t(112) = 1.78, p = 0.07	–0.06 (–0.17, 0.05)	0.22
		Infant unstressed and attending 1.41 (0.96)	Overall severity of infant stress 1.50 (0.82)	t(112) = 2.16, p = 0.03*	–0.27 (–0.5, 0.04)	0.35
		Infant unstressed and relaxed 1.58 (1.06)	Mother's overall synchronicity 2.45 (0.91)	t(112) = 1.13, p = 0.25	–0.31 (–0.6, 0.002)	0.42
		Overall severity of infant stress 1.50 (0.82)	Infant's overall soothability 2.88 (1.09)	t(112) = 1.95, p = 0.05*	–0.07 (–0.36, 0.22)	0.22
		Mother's overall synchronicity 2.45 (0.91)	Approach 3.4 (0.39)	t(90) = 1.07, p = 0.28	–0.09 (–0.40, 0.22)	0.17
		Infant's overall soothability 2.88 (1.09)	Rhythmicity 3.7 (0.55)	t(90) = 0.85, p = 0.39	–0.09 (–0.40, 0.22)	0.17
		Approach 3.4 (0.39)	Coop/manageability 2.3 (0.51)	t(90) = 0.37, p = 0.71	0.22	0.17
		Rhythmicity 3.7 (0.55)	Activity/reactivity 3.8 (0.53)	t(90) = 0.95, p = 0.34	0.22 (–0.16, 0.60)	0.19
		Coop/manageability 2.3 (0.51)	Irritability 3.4 (0.36)	t(90) = 0.00, p = 1.00	0.29 (–0.03, 0.61)	0.00
		Activity/reactivity 3.8 (0.53)	Easy/diff scale 3.0 (0.31)	t(89) = 1.08, p = 0.27	0.44 (0.03, 0.84)	0.22
		Irritability 3.4 (0.36)	Emotion & eye gaze 6.2 (1.1)	t(89) = 0.99, p = 0.32	–0.18 (–0.4, 0.13)	0.20
Easy/diff scale 3.0 (0.31)	Communication 3.8 (2.1)	t(89) = 2.55, p = 0.01*	0.37 (–0.005, 0.74)	0.53		
Emotion & eye gaze 6.2 (1.1)	Gestures 0.93 (1.5)	t(89) = 1.63, p = 0.10	0.08 (–0.34, 0.50)	0.34		
Communication 3.8 (2.1)	Sounds 3.5 (1.8)	t(89) = 0.93, p = 0.93	–0.10 (–0.28, 0.08)	0.19		
Gestures 0.93 (1.5)	Words 0.2 (0.6)	t(89) = 2.37, p = 0.01*	–0.10 (–0.33, 0.13)	0.49		
Sounds 3.5 (1.8)	Understanding 2.1 (1.1)	t(89) = 1.27, p = 0.20	–0.10 (–0.28, 0.08)	0.26		
Words 0.2 (0.6)	Object use 2.8 (1.3)	t(89) = 1.60, p = 0.11	–0.10 (–0.33, 0.13)	0.33		
Understanding 2.1 (1.1)	Social 11.0 (3.8)	t(89) = 1.35, p = 0.17	0.10 (–0.10, 0.30)	0.28		
Object use 2.8 (1.3)	Speech 3.7 (2.3)	t(89) = 1.88, p = 0.06	1.0 (–0.17, 0.17)	0.39		
Social 11.0 (3.8)	Symbolic 4.9 (2.0)	t(89) = 2.00, p = 0.04*	0.10 (–0.44, 0.64)	0.42		
Speech 3.7 (2.3)	Total score 19.7 (6.8)		0.10 (–0.10, 0.30)	0.39		
Symbolic 4.9 (2.0)			1.0 (–0.17, 0.17)	0.42		
Total score 19.7 (6.8)			1.0 (–0.13, 0.13)	0.39		
			0.30 (–0.24, 0.84)	0.26		
			0.40 (–0.39, 1.19)	0.33		
			0.63 (0.14, 1.11)	0.28		
			0.60 (–0.13, 1.33)	0.33		
			0.10 (–0.11, 0.31)	0.28		

(continued on next page)

Table 2 (continued)

Study	Assessment measures	Intervention group or observation group n	Mean (SD)	Control group n	Mean (SD)	P value	Mean diff (95%CI)	Effect size	
Caskey et al. (2014)	LENA Bayley - III	Repeated measures of a single group; n = 35 at 32 weeks; n = 33 at 33 weeks Total adult words 3306 (4274) Total conversational turns 25(29) Total child vocalisations 113 (101) n = 32 (when assessed at 7 months) n = 31 (when assessed at 18 months)		No comparison group.		- Significant % increase in adult words = p = 0.0001* Significant % increase in conversational turns, p = 0.0009* Significant % increase in total child vocalisations, p = 0.0003*		0.50 (0.08, 0.91) 0.30 (-0.16, 0.76) 1.20 (-0.28, 2.68) 0.60 (-0.28, 1.48) 0.70 (-0.03, 1.43) 2.60 (0.02, 5.17)	
									Irritability 3.4 (0.48)
									Easy/diff scale 3.0 (0.34)
									Emotion & eye gaze 5.9 (1.5)
									Communication 3.4 (1.7)
									Gestures 0.3 (0.7)
									Sounds 2.9(1.7)
									Words 0.1 (0.4)
									Understanding 1.6 (0.9)
									Object use 2.5 (0.9)
									Social 9.8 (3.3)
									Speech 3.1 (1.9)
									Symbolic 4.2 (1.5)
									Total score 17.1 (5.5)
									Benassi et al. (2018)
Non- contingent 9.92(7.24)									
Contingent non-relevant 2.31 (1.97)									
Contingent with no label 10.53 (6.54)									
Contingent relevant with one label 3.42 (2.01)									
Contingent relevant with a repeated label 2.07 (1.54)									
Requesting/teaching & showing 3.88 (3.12)									
Pointing & giving 4.49 (3.89)									
Conventional & representational 2.71 (3.77)									

(continued on next page)

Table 2 (continued)

Study	Assessment measures	Intervention group or observation group n Mean (SD)	Control group n Mean (SD)	P value	Mean diff (95%CI)	Effect size
		Expressive score 9.60 (2.48)	Non- word vocal utterances	t(38) = 4.45, p = 0.0001*	3.86	1.40
		Cognitive score 85.50 (7.25)	21.38 (15.08)	t(38) = 2.16, p = 0.03*	-0.11 (-1.67,	0.68
		Language composite score 93.65 (15.27)	Words 1.10 (2.12)	t(38) = 1.35, p = 0.18	1.45	0.42
		Receptive score 10.20 (3.25)	Gestures & vocal utterances	t(38) = 1.51, p = 0.13	-4.52 (-16.17,	0.47
		Expressive score 8.10 (2.79)	33.57 (20.72)		7.13	
			Cognitive score 104.75 (10.70)		-10.25 (-17.34,	
			Language composite score		-3.15	
			103.55 (12.32)		-6.45 (-14.47,	
			Receptive score 10.85 (2.92)		1.57	
			Expressive score 10.40 (2.14)		-1.50 (-3.28,	
			Cognitive score 96.67 (8.57)		0.28	
			Language composite score		-0.80 (-2.28,	
			102.67 (10.75)		0.68	
			Receptive score 11.50 (2.81)		-11.17 (-16.24,	
			Expressive score 9.33 (2.33)		-6.09	
					-9.02 (-17.47,	
					-0.56	
					-1.30 (-3.24,	
					0.64	
					-1.23 (-2.87,	
					0.41	

Bayley Scales of Infant Development (BSID).
 Communication and Symbolic Behavior Scales Developmental Profile Infant-Toddler Checklist (CSBS DP).

LENA (Language Environment Analysis).
 Nursing Child Assessment Teaching Scale (NCATS).
 Parenting Stress Index (PSI).

Short temperament scale for infants (STSI).
 Sleep Activity Record (SAR).
 Tsumori & Inage Developmental questionnaire (TI questionnaire).
 • = significance identified.

Table 3
Methodological quality of the included studies.

Study	1	2	3	4	5
Coppola and Cassibba (2010)	N/A	0	0	1	?
Kusanagi et al. (2011)	0	0	0	1	?
Milgrom et al. (2013)	1	1	0	1	1
Caskey et al. (2014)	N/A	0	0	1	?
Benassi et al. (2018)	0	0	1	1	?

Rating of studies: Scale of study scores: 0 = absent; ? = unclear; 1 = present. Table key: 1 = Random sequence generation (selection bias); 2 = Allocation of concealment (selection bias); 3 = Blinding of participants & personnel (performance bias); 4 = Incomplete outcome data (attrition bias); 5 = Selective reporting (Reporting bias); 6 = Other bias.

size 0.56). No other moderate or large effect sizes were noted in this study. Milgrom et al. (2013) supported parent education and interaction – communication training using an Infant Transaction Program, evaluation at - term equivalent age identified a large effect size (0.80) in relation to maternal stressing of the infant in the intervention dyads. Moderate effects for the intervention participants were noted with mothers showing an increased positive effect when interacting with their infant (effect size 0.59), responsiveness to negative infant cues (effect size 0.58) and use of gesture to support communication (effect size 0.53). Benassi et al. (2018) also showed large effect sizes for reaching, requesting and showing gestures (effect size 0.77) with moderated effect sizes for pointing and giving (effect size 0.52), and mother – infant conversation (effect size 0.68). Though these are similar communication skills, Milgrom et al. (2013) were carrying out an intervention, whereas Benassi et al. (2018) were comparing preterm infants with typically developing infants. As preterm infants are at risk of speech, language and communication delay, it is highly likely that there would be significant reported differences in the outcomes (Benassi et al., 2018; Milgrom et al., 2013; Rautava et al., 2010; Stene-Larsen et al., 2014; Johnson et al., 2015). Two studies used the Bayley Infant Development Scales to assess language and cognition (Benassi et al., 2018; Caskey et al., 2014). However, Caskey et al. (2014) assessed infants at 7 months and 31 months, whereas Benassi et al. (2018) assessed infants at 12 and 24 months. Caskey et al. (2014) were investigating one sample of infants, whereas Benassi et al. (2018) were comparing typically developing infants with preterm infants, which may explain why the Bayley effect sizes are lower than the Caskey et al. (2014) sample.

3.1. Study designs and quality

Three studies evaluated participants over time (Coppola and Cassibba, 2010; Kusanagi et al., 2011; Caskey et al., 2014). Of these studies, two observed a single group of participant dyads only (Coppola and Cassibba, 2010; Caskey et al., 2014). Another study described itself as a repeated measures and observational design which compared two groups of infants (Benassi et al., 2018). One study was a randomized controlled trial (Milgrom et al., 2013). Methodological quality assessment focused on the following domains: random sequence generation; allocation of concealment; blinding of participants; incomplete outcome data and attrition reporting; selective reporting; and any other factors indicative of bias (Higgins and Altman, 2008) (Table 3).

3.2. Participants

All studies included infants who were medically stable, and who did not have any complex needs. However, there was variation in both gestational age of infants recruited, and the ages at which outcomes were measured. Infant participants' gestational ages ranged from 23 weeks to 24 months corrected age. They were all recruited at different ages; one study recruited infants at 15 days post - partum (Coppola and

Cassiba, 2010); another study recruited infants at 32 weeks post menstrual age (Caskey et al., 2014), and infants aged 32 weeks gestational age were recruited by Milgrom et al. (2013). In contrast, infants at 46 weeks corrected age and 60 weeks corrected age were recruited by Kusanagi et al. (2011). Finally, one study recruited infants at 12 and at 24 months corrected age (Benassi et al., 2018).

3.3. Setting

All studies reported on outcomes both on NICU and on discharge from NICU (Coppola and Cassibba, 2010; Kusanagi et al., 2011; Milgrom et al., 2013; Caskey et al., 2014; Stefana and Lavelli, 2017). One study investigated maternal responses and infant communication skills post discharge from NICU at 12 and 24 months corrected age (Benassi et al., 2018).

3.4. Outcomes

Short term outcomes included; infant gaze direction with mothers (one study) (Coppola and Cassiba, 2010); communication behaviours and mother – infant interactions (four studies) (Coppola and Cassiba, 2010; Kusanagi et al., 2011; Caskey et al., 2014; Stefana and Lavelli, 2017); comparing interactions with infants both in and out of an incubator (one study) (Coppola and Cassiba, 2010); growth, cognition and symbolic development (three studies) (Kusanagi et al., 2011; Milgrom et al., 2013; Benassi et al., 2018); parent stress (one study) (Kusanagi et al., 2011); responsiveness to infant cues (one study) (Milgrom et al., 2013).

Long term outcomes included; communication behaviours at 7 & 18 months corrected age (one study) (Caskey et al., 2014); receptive and expressive language skills at 12 & 24 months corrected age (Benassi et al., 2018).

4. Discussion

This systematic review sought to investigate studies involving pre-term infants which specifically identified language and communication as outcomes, or focused on language and communication as part of an intervention. This review is important as infants born preterm are at risk of speech, language and communication problems (Rautava et al., 2010; Stene-Larsen et al., 2014; Johnson et al., 2015). It is acknowledged that approaches which support maternal mental health and parent - infant bonding are crucial, and can also be important for supporting reciprocal early communication, but this systematic review wished to investigate papers which specifically investigated early language attributes. Responsiveness to maternal voice, ability to identify infant states, and parent – infant bonding are important precursor skills to support language development (Tomasello and Todd, 1983; Tomasello and Ferrar, 1986). Sameroff (2009) stresses the importance of positive early infant – parent interaction behaviours in influencing development. There are significant risks, both with maternal communication style and facilitation methods and infant responsiveness if communication is difficult for either participants in the dyad (Fiamenghi et al., 2010).

The heterogeneity of the outcome measures from all these studies make it hard to compare the results of the observations or interventions (Goh et al., 2016). Many of the outcome measures were based on expected early communication and responsiveness behaviours from mothers rather than specific rater-reliable measures. In addition, the sample sizes of the studies covered a wide range, with variable quality in design of the studies (Table 3). It is of concern that there are so few papers which specifically investigate language and communication development (Table 1). Even within these five papers, there was variation in describing the ages of the infants, e.g. post menstrual age and gestational age, and variety in the populations studied, e.g. very low birthweight infants (Coppola and Cassiba, 2010) or extremely low birth

weight infants (Benassi et al., 2018). The quality of papers was varied, with only one randomized controlled trial (Milgrom et al., 2013, Table 2; Table 3). There are many factors which can support and enable early interaction and communication, and encouraging these can support more consistent and positive interaction styles (Tomasello and Todd, 1983; Tomasello and Ferrar, 1986). Speech, language and communication development, especially in the first months of life deserves far greater consideration, and future studies need to carry out both observational and language and communication intervention studies on neonatal units. It may also be useful to consider using more specific early communication tools to assess infant progress such as the Pre-School Language Scales (Zimmerman et al., 2002). Integrating communication more clearly into neonatal environments is important in supporting parents to develop sustainable communication skills with their infants, and reduce parent stress.

It is possible to support the development of, and to incorporate communication strategies with infants and their carers that would provide a language learning environment in the neonatal unit. Parents and carers could initially be taught to observe the infant during different times, including during skin to skin time to identify consistency of responses to external and internal stimuli (Gonya et al., 2017). The *Als* (1986) descriptors could be used as an initial framework to support parent observations. In parallel with these observations, parents could also note physiological changes such as heart rate and saturation levels. More specifically, parents could note a change in an infant's sucking pattern when listening to a variety of auditory stimuli, in particular voices. Parents can be supported to develop contingent, responsive and consistent responses to their infant, specifically when communicating and interacting with the infant during daily cares, and when preparing for oral feeding through use of non – nutritive activities, as well as when directly feeding (Kirk et al., 2007; Wellington and Perlman, 2015). As early feeding is an intimate time for both the parent and the infant, it lends itself well to developing a setting where confidence with early communication skills can be encouraged.

Developing parent confidence with early interaction skills can help reduce parent stress, and therefore, encouraging parent – infant interaction needs to be an important part of NICU care and intervention (Muller-Nix et al., 2004). Once parents and carers are involved in developing early non – nutritive and feeding experiences (tube feeds, breast and bottle feeding), engaging in Kangaroo (skin to skin) care, washing/bathing the infant, changing the infant's clothes, changing the infant's position, and so on, support through communication modelling can be given to encourage commenting on what the infant is doing using simplified language (Gonya et al., 2017). In addition to this, parents and carers could be encouraged to make both natural gesture and intonation to engage the infant, and therefore provide a basic scaffold on which to build later language skills (Colonnaesi et al., 2010; Kuhl, 2004).

4.1. Strengths and limitations

This systematic review has highlighted the importance of specific language skills necessary for developing enabling communication contexts. It is the first review that has sought to define these skills specifically. In addition, a comprehensive search was undertaken, with wide inclusion criteria. There are, however, a number of limitations with this review. Two reviewers completed the literature search, quality appraisal and data analysis. Three peers reviewed the findings and agreed findings. Greater rigour could be achieved in future by involving unfamiliar peers to review findings.

5. Conclusion

This discussion paper and systematic review summarised key factors about early communication and parent – infant interaction with preterm infants. Having a preterm infant is highly stressful and can be a

risk factor for poor relationship development (Borghini et al., 2006). Communication needs to have a higher profile in both the management of infants on the NICU and further research in this area is imperative. Increased support for parents and carers to interpret clearly and confidently an infant's early non – verbal communication can potentially help to reduce mental health problems, increase parent awareness of early communication development, and thus alert families to early identification of communication difficulties. Finally, increased support with communication throughout the early developmental years will enable infants born preterm to experience language rich environments which can continue as they mature and develop. Further studies are needed to validate the efficacy of therapeutic interventions on NICU, in particular approaches which enhance communication for both developing infants and their carers (Spittle et al., 2015).

Declaration of interests

None.

Author contribution

CH conceived the idea for this topic, supported by LEH and AL. SLC and RW assisted with identification and analysis of relevant scripts.

Acknowledgements

The authors would like to thank Dr. Lucy Henry, Dr. C.Cane, A. Hollings & H.Cockerill.

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