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Frequency of Premature Infant Engagement and Disengagement Behaviors During Two Maternally Administered Interventions

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Abstract

Although sensitive maternal behaviors improve later quality of mother-infant interaction and subsequently infant development, little is known regarding how an intervention might promote early premature infant social interactive behavior. This study compared the frequency of premature infant engagement and disengagement behaviors during two maternally administered interventions, the multi-sensory auditory, tactile, visual and vestibular intervention (ATVV) and kangaroo care (KC) for 26 infants between 31 and 46 weeks PMA. The ATVV intervention elicited more disengagement ($M = 24$ vs. 12 , $p = .0003$), trended toward more engagement ($M = 21$ vs. 15.7 , $p = .06$) and more potent engagement ($M = 24$ vs. 12 , $p = .0003$), subtle disengagement ($M = 25$ vs. 11.9 , $p < .0001$), and potent disengagement ($M = 22.9$ vs. 14 , $p = .006$) behaviors than did KC. The ATVV intervention may be an intervention to promote the infant's learning how to regulate engagement and disengagement behaviors.

Keywords

VLBW Infant; Premature Infant; Infant Behavior; Social Interaction; ATVV Intervention; Kangaroo Care; Social Competence; Mother-Infant Interaction

While sensitive maternal behaviors and mother-infant synchrony are known to improve later quality of mother-infant interactions and subsequently infant development, [1] little is known about how interventions might promote emerging premature infant social interactive behavior, thus facilitating the infant's role in the developing pattern of mother-infant interaction. [2] Two maternally administered interventions - the multi-sensory auditory,

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tactile, visual and vestibular intervention (ATVV) and kangaroo care (KC) - have been shown to support sleep and alert states in preterm infants as well as early growth and development. [3–7] However, few studies have examined the effects of these interventions on early infant social interactive behaviors that are likely to affect subsequent mother-infant interactions. This study compared the frequency of infant engagement and disengagement behavioral cues during two maternally administered interventions, the ATVV intervention and KC, among very low birth weight (VLBW) premature infants.

Social interactive behaviors start emerging around 32 weeks post-menstrual age (PMA) for infants born prematurely. [8] One of the benefits of social interactive behaviors is that they reinforce the mother's social actions and encourage her during early interactions. [9] For example, smiling, a potent engagement behavioral cue, emerges out of attentive engagement with an interactive caregiver. [10] In premature infants, early smiling most often occurs during REM sleep, [11, 12] yet our clinical experience has been that mothers interpret the smile as an engagement cue and are likely to respond by smiling back at their sleeping infants. In older infants, smiling is a potent engagement behavior that indicates the infant's interest in initiating/maintaining social interaction. [13]

The infant's capacity to become actively engaged in a social interaction is linked to his/her ability to regulate behavior by gazing away (disengaging or withdrawing) from their interactive partners and then re-engaging. [10] Ultimately, the infant's ability to control attention during social interaction supports the infant's use of smiles to initiate early communication with a partner. This engagement behavior may be an example of the emergence of early social behaviors that support dyadic responsivity and later patterns of social competence.

Early interventions that support development and theoretically the emergence of social interactive behaviors include the ATVV intervention and KC. The ATVV intervention (as described in more detail below) modulates infant behavioral state by influencing sleep-wake behaviors and increasing the frequency of alertness in premature infants between 32 and 35 weeks PMA. [5–7, 14–17] The ATVV intervention also has been found to improve patterns of early mother-infant interaction. [2] When performed by the mother, the ATVV intervention improved maternal sensitivity towards her infant's cues and cognitive-growth-fostering behaviors. Additionally, infant clarity of cues and responsiveness were significantly improved after the ATVV intervention. During the ATVV intervention, the mother provides social interaction (auditory and visual cues) and learns to modify her behavior based on the infant's engagement and disengagement cues. [9] The ATVV also offers infants the opportunity to learn social skills. Past studies have also shown that the ATVV has promising short-term benefits, including improved feeding progression leading to reduced length of hospital stay. [6]

KC, or holding the infant between the mother's breasts in skin-to-skin contact, is another popular neonatal intensive care unit (NICU) intervention. [18] KC is a safe intervention [19–23] and results in better head growth, more positive parenting, less distress and negative physiological responses to painful procedures, and possibly better development than hospital care. [24–30] In developed countries, KC is used as an intervention for sicker and smaller preterm infants that offers parents increased contact during visits. KC has been shown to have immediate behavioral benefits for the infant, including more sleep (especially quiet sleep) and less crying, as well as greater respiratory regularity than when the infant was in the incubator [4, 21, 31–33] though these effects were not maintained after the end of KC. [34] Thus, KC has an immediate effect of promoting sleep but does not appear to affect overall sleep-wake patterns. When KC was used throughout hospitalization, mothers were more likely to breastfeed. [35, 36]

The ATVV intervention provides infants with a greater variety of stimuli than does KC and promotes alertness, the optimal sleep-wake state for social interaction; whereas KC promotes sleep. Thus, the ATVV intervention provides more opportunities for infants to practice responding and communicating with their mothers and potentially to improve their neurological development. [9] Considering the effects of ATVV and KC, it was hypothesized that the ATVV intervention would elicit more engagement and disengagement behavioral cues in the infants while KC would elicit fewer of these behaviors. Therefore, the purpose of this study was to compare the frequency of premature infant engagement and disengagement behavioral cues during two maternally administered interventions, the ATVV intervention and KC.

Methods

Design

This report is part of a larger study that tested the effects of two maternally administered interventions for VLBW preterm infants on infant health and development, maternal psychological well-being, and the maternal-infant relationship. Infants and mothers were enrolled from the time the infant was no longer critically ill until the infant was 12 months of age corrected for prematurity. Mothers and infants were randomly assigned to the ATVV intervention, KC, or an attention control group. Mothers in the ATVV intervention or KC groups administered the intervention a minimum of three times weekly and were video recorded weekly during intervention sessions. Mothers in the attention control group (education about supplies needed for home care) were not included in this secondary analysis because their infants did not experience an intervention.

Setting and Sample

The research was conducted at the neonatal intensive care and intermediate care units of four hospitals: Brenner Children's Hospital in Winston-Salem, NC; Duke University Health System in Durham, NC; Mt. Sinai Hospital in Chicago, IL; and Stroger Hospital in Chicago, IL. These sites were selected because they serve different populations: Brenner and Duke are Southern and serve urban, suburban, and rural populations of diverse socioeconomic status, whereas Mt. Sinai and Stroger Medical Centers serve a Northern, urban, and low socioeconomic status population. Three of the hospitals have inborn infants and all of the nurseries received infants by transport. The physical settings of the four nurseries were similar. The intensive care rooms held between 10 – 18 infants in an open room design. The convalescent rooms were also open rooms and designed to care for 6 – 8 in one room.

Infants were enrolled when they were no longer critically ill. Gestational age at birth was assessed by mother's dates and exam. [37] If a discrepancy was identified between the mother's dates and the gestational age examination, gestational age was determined by the examination. For this secondary analysis, the first 26 mother-infant pairs were analyzed.

Data from thirteen mother infant dyads from North Carolina (7 KC and 6 ATVV) and thirteen mother-infant dyads from Chicago (6 KC and 7 ATVV) participated in this analysis. The participants ranged in age at birth from 21 to 32 weeks gestation with a mean of 27 weeks. Birth weight ranged from 490 to 1470 grams with a mean of 900 grams. PMA at the time of the videotapes ranged from 31 to 46 weeks during this pilot study. Weight at entry into the study ranged from 1030 to 2693 grams with a mean of 1650 grams. Twelve infants were female and fourteen infants were male. Eighteen Black, four Caucasian and four "Other" mothers participated in the research. Maternal age ranged from 18 to 41 years with a mean of 26 years. Seventeen mothers were primiparous and six were multiparous. Maternal educational level ranged from 11 to 18 years with a mean of 13 years of completed

education. More mothers delivered via cesarean section ($n = 19$) than normal spontaneous vaginal deliveries ($n = 7$). There were no significant differences between the ATVV and KC groups on these variables (see Table 1).

Developmental Interventions

The ATVV intervention. The ATVV intervention incorporates normal maternal behaviors with standardized stimuli. [38] The 15-minute intervention starts with auditory stimulation via infant-directed talk by the mother. The infant-directed talk (motherese) continues throughout the 15 minutes and is performed using a higher pitched voice with pauses, offering the infant the opportunity to respond. Following at least 30 seconds of talk, the infant is then placed in a supine position for a 10-minute moderate pressure massage. First the head is massaged, followed by strokes on the chest and abdomen, the arms from shoulder to wrist, and the legs from thigh to ankle. The infant is repositioned to the prone position and the back is massaged using straight continuous strokes and circular strokes directly over the spine. The head is then massaged from the hairline to the nape of the neck. Following massage, the infant is swaddled and rocked horizontally for the final 5 minutes. Throughout the entire 15-minute ATVV intervention, the mother attempts eye contact with the infant when the infant is alert. Furthermore, the intervention is designed to be contingent on infant behavior. [38] Mothers are taught how to recognize subtle and potent engagement and disengagement behavioral cues and how to respond to them. As a result, if the infant expresses disengagement cues during a particular component of the intervention, the mother pauses allowing the infant to disengage and then re-engage. When the infant is re-engaged, the massage continues. Infant individuality is continually assessed, e.g., some infants prefer different components of the massage. When the mother has determined which tactile components receive a positive response from the infant, these tactile components are repeated, and the tactile components that elicit potent disengagement cues are discontinued.

Mothers were taught the ATVV intervention and asked to administer the intervention for a minimum of three times weekly. The nurse taught the mother the intervention on a doll and also demonstrated the ATVV intervention on the infant for the mother to observe. Mothers gave a return demonstration to assure they were able to administer the ATVV intervention to criterion (85% or greater reliability with the ATVV intervention checklist).

Kangaroo care. KC is skin-to-skin contact between the mother and her infant. The infant, clad in a diaper only, is placed on the mother's chest, usually between the breasts, and then the mother is wrapped in a blanket for warmth and privacy. Mothers were taught this intervention and asked to administer KC for a minimum of three times weekly for 1.5 hours. Mothers were given support and their questions answered by the research nurse. Staff nurses were also trained in the administration of KC so that they could also offer support to others with handling and transfer of the infants from the incubator to the KC position.

Nursery environment and intervention fidelity. The interventions were provided in the NICU. Per our stress reduction protocol and to provide a similar nursery environment among the nurseries, the lights were dimmed and sound levels kept to a minimum prior and during the intervention and throughout the assessment period. Fidelity of both interventions was assessed by the research team via the video recordings used in this secondary analysis.

Outcome Measures

Infant behavioral cues were measured by the frequency of infant engagement and disengagement cues. [13] Engagement cues are behavioral cues that are indicators of the infant's interest in participating in social interaction while disengagement cues are indicators of the infant needing to break away from social interaction. Examples of engagement cues

include facial gaze, mutual facial gaze, eyes brightening, and relaxed posture. Examples of disengagement cues include yawning, looking away (gaze aversion), or crying. The engagement and disengagement cues were further categorized by subtle and potent behavioral cues (see Table 2 for the cues identified in our sample of VLBW infants). Engagement and disengagement behavioral cues were selected because previous research has shown that parents who can read subtle behavioral cues are better able to read and respond to their infants and are more sensitive in their interactions with their infants. [13]

Two research assistants were trained to criterion on the infant behavioral cues. One research assistant coded all of the video recordings. The second research assistant coded 25% of the video recordings. Since the coders viewed the two interventions during coding, the second research assistant was blinded to the purpose of the study. Initial inter-rater reliability between the two coders was established by measuring the intra-class correlation between the two coders. The intra-class correlation was maintained at .713 ($df = 8$, $p = .012$) for the total engagement behaviors and .649 ($df = 8$, $p = .012$) for the total disengagement behaviors, documenting significant inter rater agreement. [39, 40]

The frequency of engagement and disengagement behaviors were coded for each 15-second interval for a total of 15 minutes by the trained rater. In preparation for analysis, the frequencies for each behavioral cue were totaled for each 2.5 minute period and then grouped into engagement and disengagement behaviors. The behaviors were then totaled for the four different categories: subtle or potent and engagement or disengagement behaviors.

Procedure

The study was granted human subjects approval by the Institutional Review Boards at the respective universities and the clinical sites. After informed consent was obtained from the mother, the mother and her infant were randomly assigned to the ATVV intervention (Group 1), KC (Group 2) or the attention control groups. Mothers were taught their respective interventions and were asked to administer the intervention for a minimum of three times per week. The mothers and infants were video recorded weekly over the course of the infants' hospital stay while the mother was administering either the ATVV intervention or KC. These video recordings were used for this secondary analysis.

The interventions began when the infants were at least 1000 grams and were assessed as clinically stable. Per protocol, the ATVV Intervention was provided 30 minutes prior to the next anticipated feeding. If the mother missed the feeding, the intervention began 30 minutes after completion of the feeding. KC was provided at the same time intervals. Infants in the study were already on monitoring equipment and thus were continuously monitored during the intervention. Nurses also evaluated the infant's vital signs and temperature before and after the intervention session. Neither intervention was administered if the baby was scheduled for medical procedures or eye exams or if the baby was receiving mechanical or positive pressure ventilation.

Data Analysis

Sample characteristics were analyzed using descriptive statistics. To determine whether any significant differences existed between infants receiving different interventions, the frequency of the engagement and disengagement behavioral cues were analyzed using the Wilcoxon Two-Sample Rank Sum Test. The Wilcoxon Two Sample Rank Sum test was conducted for the total frequency of engagement and disengagement behavior as well as for the subtle and potent engagement and disengagement behavior scores.

Results

A total of 36 video recordings were coded. Frequency of the total engagement cues ranged from 4–65 and the total disengagement cues ranged from 17–122 for infants assigned to the ATVV group compared to 1–129 and 2–139 respectively for infants in the KC group. For infants assigned to the ATVV group, the frequency of subtle engagement cues ranged from 3–39, potent engagement cues ranged from 1–62, subtle disengagement cues ranged from 17–105, and potent disengagement cues ranged from 1–38. For infants assigned to the KC group, the frequency of subtle engagement cues ranged from 1–78, potent engagement cues ranged from 0–51 (twelve infants exhibited no potent engagement cues), subtle disengagement cues ranged from 1–99, and potent disengagement cues ranged from 0–47 (six infants exhibited no potent disengagement cues).

A one-sided Wilcoxon Two-Sample Rank Sum Test (normal approximation) was used for the analysis. The ATVV intervention elicited more disengagement (mean of 24.6 vs. 12.4, $p = .0003$) and a trend toward more engagement behaviors (mean of 21.3 vs. 15.7, $p = .06$) than did KC. Separate analysis of the subtle and potent behavioral cues revealed that the ATVV intervention elicited significantly more potent engagement (24.4 vs. 12.6), subtle disengagement (25.1 vs. 11.9), and potent disengagement (22.9 vs. 14.1) behaviors from infants than did KC. Table 3 summarizes the mean, median, and statistical significance between the two groups.

Discussion

VLBW premature infants in this research study exhibited a higher frequency of disengagement behavioral cues (subtle and potent behaviors combined) during the ATVV intervention than during KC. Infants also trended toward more engagement behaviors in response to the ATVV intervention. When the two categories of engagement and disengagement cues were further categorized into the subcategories of potent and subtle cues and then analyzed separately, infants receiving the ATVV intervention exhibited more potent engagement and subtle and potent disengagement behaviors when compared with KC. Thus, our findings show that the ATVV intervention offers an environment in which the infant is able to respond to the mother's behavior. The mother then has the opportunity to adapt or synchronize her behavior to the infant's cues. When the infant exhibits an engagement cue, a positive maternal response reinforces engagement. Likewise, when the infant exhibits a disengagement cue, the mother's sensitive response to the cue facilitates the infant's ability to regulate her behavior. Disengagement should not be considered a negative finding, rather it shows that the infant is learning how to regulate interaction – how to maintain attention to engage and then withdraw (disengage) and break away. Although additional research with a larger sample size is warranted to strengthen the validity of these findings, our findings support the use of ATVV in cultivating preterm infant social interactive behaviors.

VLBW infants face multiple challenges, including the risk of long-term medical and neurodevelopmental problems, decreased cognitive abilities, attentional deficits, and internalizing behavioral difficulties. [41–43] Positive mother-infant interaction has the ability to mitigate the adverse effects of prematurity on at-risk infants. [44] Mother-infant synchrony, the ability of the parent and child to reciprocate a shared behavior and affect, provides a stable foundation for growth and development. [45] As an active player in a synchronous mother-infant interaction, the infant's state and behavior elicit both positive and negative responses from the mother. Compared to term infants, premature infants are less responsive and clear in their cues, [46] which correlate with fewer maternal cognitive growth fostering behaviors. [47] Also, the premature infant's immature autonomic system

and decreased time spent in the alert state has been correlated with decreased maternal behavior. [48] Furthermore, the ability of the infant to self-regulate his/her behavior and the ability of infant and mother to synchronize their behavior influences infant attachment. [49] Interventions that foster synchronous mother-infant interactions have the ability to reduce the risk factors associated with prematurity, which lays the groundwork for future cognitive, social and emotional development. [50] Our findings show that the ATVV intervention elicits both positive and negative cues from the infant and our prior research shows that ATVV promotes the quiet alert state. [6] By facilitating the infant's behavior self-regulation and promoting the alert state, the ATVV intervention has the potential to strengthen mother-infant social interaction and attachment and improve infant development.

Based on our findings KC elicited fewer engagement and disengagement cues during the intervention, potentially limiting the opportunity for mother-infant social engagement. Previous research has shown KC to improve infant self-regulation, [51] reduce infant negative emotions, increase maternal sensitive behaviors [52] and increase infant alertness while reducing gaze aversion. [50] However, these results were obtained weeks to months following the actual implementation of KC, whereas our findings examine the influence of KC on immediate infant behaviors. While previous research has documented the benefits of KC, this intervention might best be used to decrease infant irritability, and promote infant sleep and comfort. Further research is needed to better understand the differing effect of KC and ATVV on infant social behavior.

This research has several limitations including a small sample size, conduct of the research in the NICU as opposed to a more controlled environment, and coding by the primary coder who was aware of the purpose of the larger study. The small sample size limits generalizability of the findings, yet they provide new data on infant behavioral responses to the ATVV intervention and KC. All mothers performed their assigned interventions in a NICU, thus the environment was not strictly controlled and may have provided additional stimuli unrelated to the interventions. The NICU environment may have elicited behavioral cues from the infants that were not directly related to KC or the ATVV intervention. However, the NICU is the natural environment in which mothers perform these interventions. Thus, by studying them in the NICU, we sacrificed some control in order to gain ecological validity. Although 25% of the videos were coded by a second coder who was blind to the purpose of this pilot study and the larger primary study, a larger scale clinical trial should be conducted with coders that are blind to the purpose of the study. However, true blinding will never be possible since coders will inevitably see the mothers performing different interventions.

Despite these limitations, this study is the first to compare KC and the ATVV interventions in regard to emerging social interactive behaviors. Future prospective research with a larger sample is warranted that addresses the benefits of the two interventions on neurobehavioral organization. Such information can be used to enhance existing protocols for promoting healthy development of preterm infants. Furthermore, research examining the impact of the ATVV intervention on social interactive behaviors at 3 and 6 months could strengthen our understanding of its short-term effects on social engagement. The potential for the ATVV intervention as a clinical application to teach parents how to recognize and respond to their premature infant's behavioral cues may lead to better support for the infants' emerging social interactions and promote developmental outcomes.

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Table 1

Characteristics of the Sample

	Group 1 – ATVV Intervention (n = 13)	Group 2 – Kangaroo care (n = 13)
GA at birth (weeks)	26.31 (21–31) *	26.77 (23 – 32)
Birth weight (grams)	830.15 (490 – 11470)	999.17 (500 – 1465)
PMA at entry into the study (weeks)	33.84 (28.14 – 39.71)	34.56 (31.14 – 39.00)
Weight at entry into the study (grams)	1603 (1030 – 2693)	1663.46 (1132 – 2435)
Infant Gender (M/F)	6/7	8/5
Maternal Race (Black/White/Other)	7/4/2	11/0/2
Maternal Age	26.54 (19–36)	26.85 (18–41)
Type of Delivery (Vaginal/C-Section)	2/11	5/8
Maternal Parity (Primip/Multip)	10/2 **	7/4 **
Maternal Educational Level (in years)	13.85 (11–16)	13.31 (10–18)

* Mean (range)

** Missing Data

Table 2

Engagement and Disengagement Behavioral Cues[13]

Behavior	Definition
Subtle Engagement	
Facial brightening	infant moves mouth or cheeks as if smiling
Hands open	fingers apart from palms but not stiff
Potent Engagement	
Facial gaze/focus	infant looks towards mother's face without making direct eye contact
Mutual gaze	infant makes direct eye contact with mother
Cyclic extremity movement	infant moves arms and/or legs in a slow, fluid manner
Relaxation posture	awake infant (behavioral state =1) lies still with extremities relaxed
Subtle Disengagement	
Eyes clinched	eyes narrow or shut tightly
Gaze aversion	infant breaks eye contact with mother or looks purposefully away
Finger splay	infant opens hands fully and stiffens fingers
Struggling movements	infant jerks extremities or tries to avoid mother's contact by moving away
Finger extension	infant extends and stiffens a single finger
Hunger posture	infant lies with arms drawn up to sides, fists clenched beside shoulders
Potent Disengagement	
Crying	infant wails loudly
Whining	infant makes soft cries or whimpers
Fussing	infant makes distressed sounds quieter than crying
Cry face	infant wrinkles face, clenches eyes as if crying but without making sound
Halt hand	infant stiffens hand as with finger splay but in addition extends it towards the mother as if trying to block something
Maximum lateral gaze aversion	infant turns head to the side to avoid mother's face/gaze

Table 3

Comparison of Engagement and Disengagement Behavioral Cues by Group

Category	ATVV (n = 18)		KC (n = 18)		Wilcoxon Two-Sample		p value
	mean	median	mean	median	Statistic	Rank Sum	
Total	21.3	31.0	15.7	20.5	383.0	.06	
Engagement							
Total	24.6	65.0	12.4	13.0	443.0	.0003	
Disengagement							
Subtle	18.6	18.5	18.4	17.0	334.5	.49	
Engagement							
Potent	24.4	11.5	12.6	0.0	440.0	.0003	
Engagement							
Subtle	25.1	51.0	11.9	8.5	451.0	<.0001	
Disengagement							
Potent	22.9	16.5	14.1	2.0	412.0	.006	
Disengagement							

* One-sided analysis with Wilcoxon Two-Sample Rank Sum Test (Normal approximation)