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Effect of holding on co-regulation in preterm infants: a randomized controlled trial

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Abstract

Objective—To determine whether kangaroo holding of healthy preterm infants over the first eight weeks of an infant's life facilitates co-regulation of salivary cortisol between mother and infant.

Study Design—Randomized control trial. Infants were assigned to receive one hour of daily kangaroo (skin-to-skin contact on chest of mother) or blanket holding (dressed and held in mother's arms). A registered nurse visited mothers weekly for eight weeks to encourage holding and provide information about infant development. A control group had no holding restrictions and received weekly brief social visits.

Subjects—The study included 79 preterm infants, born between 32 and 35 weeks gestation age and were a mean of 15 days (± 5.7) at enrollment.

Outcome Measures—Co-regulation was conceptualized as progressive reduction in the absolute difference between mother and infant cortisol levels across 60 minutes of holding at each holding session. Mother and infant cortisol levels were measured before holding and at 30 and 60

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minutes after holding began during three holding sessions (baseline and at two and eight weeks after study initiation). Primary analyses were conducted using hierarchical linear models.

Results—There was much variability in cortisol levels. Levels of mothers and infants cortisol decreased during holding. No significant co-regulation occurred in any group at any holding session or over time.

Conclusions—Decreasing level of cortisol in both mothers and infants suggest that holding promoted the expected decline in stress hormone levels. However, supported holding methods did not differentially affect co-regulation compared to controls. Holding is pleasurable and stress may need to be present in order for mothers and infants to demonstrate co-regulation in cortisol levels.

Keywords

randomized trial; kangaroo holding; skin-to-skin holding; prematurity; mother-infant; cortisol; co-regulation

1. Introduction

1.1 Preterm Birth

Stress from painful or disruptive procedures on infants hospitalized in the neonatal intensive care unit has been well documented [1–6]. Stress activates the hypothalamic-pituitary-adrenocortical (HPA) axis, initiating a complex feedback loop involving interaction among the hypothalamus and pituitary and adrenal glands, and results in the secretion of the glucocorticoid cortisol. In a well-regulated system the increase in cortisol levels suppresses further stimulation by the hypothalamus, ending glucocorticoid production [7]. Research using salivary cortisol as an indicator of the activity of the HPA system suggests that early developmental experiences influence long-term response of the HPA system to stress [8–11]. Even minor stressors, such as a non-invasive physical examination, can trigger an HPA response in young infants [12]. Stressful procedures and early trauma may contribute to a less resilient HPA response system in preterm infants throughout their development.

1.2 Holding as a Method to Decrease Stress in Preterm Infants

Holding is one of the earliest and most frequent caregiving events that mothers provide to their infants. The close physical contact between mother and infant during holding may reduce stress by facilitating maternal-infant co-regulation. Co-regulation is a form of supportive interaction in which each member of the dyad continuously adjusts their behavior by anticipating actions of their partner. Through repeated co-regulatory interchanges, each partner learns to expect a behavioral pattern in the other. Dyads who develop a strong co-regulatory relationship also adapt to novel behavior that occurs between them [13–15]. Infant self-regulation (e.g. smoothly transitioning from one state to another as in cry to calm or sleep to awake) may be enhanced with high quality mother-infant interaction such as co-regulation. Infants who are better self-regulated may demonstrate a more modulated stress response than less regulated infants.

In the kangaroo method of holding, the infant, naked except for a diaper, is placed between the mother's breasts. The infant's ventral surface is in tactile contact with the mother,

allowing both the mother and infant to sense the other's heartbeat and respiration. Close physical proximity may enable mothers to better co-regulate physiologically with the infant than with typical blanket holding in which the baby is dressed, wrapped in a blanket, and held in the mother's arms. In a randomized controlled trial (RCT), mothers and their infants who experienced kangaroo holding demonstrated better interactive co-regulation at 6 months infant age than those who experienced traditional blanket holding [15]. Co-regulation was operationalized as a joint focus of attention with mother and infant both contributing actively to the interaction [16]. When kangaroo holding is compared to infants lying in their beds, the physiologic stability, optimal gas exchange, enhanced sleep organization, and reduced pain responses and cortisol levels found in infants during kangaroo holding suggests an effect on physiological homeostasis as well [6, 17–21].

Salivary cortisol correlates highly with serum or plasma cortisol measured in preterm infants [22], yet few studies examining maternal-infant co-regulation and stress regulation in infants as measured by salivary cortisol levels addressing kangaroo holding exist in the literature. In one study, salivary cortisol levels of mothers and their hospitalized infants during kangaroo holding was examined, but not the relationship between them. After 30 minutes of holding, infant cortisol levels increased or decreased, while their mother's levels typically decreased. The authors reported substantial variability in the infants' cortisol levels [23]. In a study in which kangaroo and blanket holding methods were compared, co-regulation (smaller difference between maternal and infant salivary cortisol levels after holding compared to before holding) of hospitalized preterm infants was found in most dyads regardless of holding method. Holding condition was not randomized. Moreover, cortisol levels were examined on only a single occasion while infants were hospitalized in the first three weeks of life [24]. Because interactive co-regulation develops over time through repeated interactions, we propose that over time kangaroo holding also will result in better physiologic co-regulation as assessed through salivary cortisol.

The primary aim of this study was to determine whether kangaroo holding of healthy preterm infants over the first eight weeks of the infant's life would facilitate co-regulation in salivary cortisol (as defined above) between mother and infant. We hypothesized that co-regulation between mother and infant assessed using salivary cortisol would be greater during periods of infant holding when dyads practice the kangaroo method compared to either blanket holding or a control group.

2. Methods

2.1. Design and Sample

This was a randomized, 8-week controlled trial comparing supported kangaroo holding to supported blanket holding and a control group in promoting salivary cortisol coregulation between mothers and their preterm infants. Parents of eligible infants in 5 neonatal intensive care units in a mid-sized city in the western United States were approached for enrollment. The Colorado Multi-Institutional Review Board as well as the relevant review boards at each study site approved this research, and informed consent was obtained from the mothers before randomization to study groups. The project director who was not involved in data

collection coordinated randomization at each hospital using a computer random number generator.

Inclusion criteria for infants were: a) born between 32 and 35 weeks gestational age (determined by the attending physician), b) required less than 0.5 L oxygen per nasal cannula, and c) had no umbilical lines, intraventricular hemorrhage, physical anomalies, or anticipated major surgery. Inclusion criteria for mothers were: a) English or Spanish speaking, b) no recorded or stated illicit drug use, and c) no diagnosed serious chronic illness.

2.2 Instruments

Because maternal anxiety and depression may have influenced cortisol levels, mothers completed anxiety and depression questionnaires before the first holding assessment and again before the holding observation in Week 8. English or Spanish versions of all instruments were used. The first author or another RN (fluent in Spanish) conducted the supportive home visits and collected the questionnaires and daily holding diaries. Saliva samples were sent to the laboratory for assay coded by ID number only.

2.2.1. Demographic Questionnaires—At baseline, mothers completed a demographic questionnaire asking the mother's age, ethnicity, education, occupation, and health. Hospital records were used to obtain information about the infant, birth and pregnancy. The Hollingshead Four Factor Index was used to measure socioeconomic status [25].

2.2.2. State-Trait Anxiety Inventory—The State-Trait Anxiety Inventory (STAI) [26] is a self-report instrument with two 20-item scales, one assessing state anxiety and the other assessing trait anxiety. State anxiety refers to anxiety that is temporary and exists at a certain time and under certain circumstances. Trait anxiety refers to a relatively stable trait. On the state scale, choices range from “not at all” (1) to “very much so” (4). On the trait scale choices range from “almost never” (1) to “almost always” (4). Test retest was reported as 0.70 for the trait scale and 0.77 for state anxiety. Concurrent validity of both scales with the Minnesota Multiphasic Personality Inventory was 0.70 [26]. The Spanish translation of the STAI has reported internal consistency of 0.87 and has been validated with Hispanic populations [27].

2.2.3. Center for Epidemiologic Studies-Depression Scale—The 20-item self-report Center for Epidemiologic Studies-Depression Scale (CES-D) [28] assessed maternal depressive symptoms during the past week. CES-D scores show good internal consistency and test-retest reliability in postpartum first-time mothers [29]. The CES-D has been validated against five reliable depression scales. Response choices range from the symptom occurring less than once a week (1) to occurring on 5 or more days (4). The CES-D has well established reliability and validity as a measure of depressed mood in Latino samples [30,31].

2.2.4. Holding Diaries—Mothers were asked to record the total daily duration in minutes of kangaroo or blanket holding, holding while feeding or sleeping, and who held the infant in a holding diary. They kept this diary for 8 weeks.

2.2.5. Salivary Cortisol—Filter papers, used to collect saliva from the infants and mothers, have been described previously [32]. The study nurse folded the filter paper (Whatman Grade 42, specially cut to 2.4×9 cm) in half lengthwise and placed it on the infant's tongue angled toward the cheek for 30 seconds to 2 minutes, until approximately 1 inch of the paper was completely wetted. Mothers placed the filter paper on their tongue for 20 seconds to saturate at least the first 2 inches of the paper. The study nurse marked the furthest extent of absorption of the saliva with a pencil, then dried the filter paper by hanging the wet-end down. She placed the dried paper in separate sealed plastic bags for storage at room temperature until cortisol was extracted and assayed.

The extracted filters were assayed with a High Sensitivity Salivary Cortisol Enzyme Immunoassay Kit (HS Salivary Cortisol EIA; Salimetrics) according to standard directions in the assay kit. Samples from each dyad were included in the same assay batch to minimize within subject inter-assay variance. The samples were run in duplicate, and the mean value was used. The intra- and inter- coefficients of variability were both less than 7% for this assay. The detection limit was 0.07 μ g/dl for the extracted samples.

2.3 Procedure

2.3.1. Intervention—Dyads were randomly assigned to one of three groups. Mothers in two of the groups were assigned to support conditions encouraging them to hold their infants at least one consecutive hour each day using either: a) kangaroo holding, or b) blanket holding. Mothers assigned to the third, control group were given no restrictions or instructions regarding holding time or style. The study nurse visited mothers in the kangaroo and blanket holding groups weekly for 8 weeks. Visits lasted approximately 60 minutes. During the visits the nurse provided encouragement to mothers to hold their infants in their assigned manner, information about early infant development, and education about recognition and response to infant cues. Kangaroo holding was not prohibited in the blanket group, but it was tracked in the holding diaries. The control group received 10 to 20 minute weekly visits during which the holding diaries were collected and mothers often discussed general experiences with their infants. They received information about both types of holding during the consent procedure, but holding was not encouraged. Mothers in all three groups were financially reimbursed every week.

2.3.2. Assessment—At baseline and weeks 2 and 8 all mothers held their infants for 60 minutes using either their assigned method or their most usual method in the control group. All but two mothers in the control group held blanket style during all holding observations. Mothers sat in a comfortable chair during holding and typically watched television, listened to music, read, or slept. The study nurse was present during the holding sessions. If the assessment was conducted in the hospital, a screen was placed around the dyad for privacy. At home, the study nurse sat out of the mother's view. The nurse did not converse with the mother after holding began except during cortisol collections. All holding sessions were video recorded to assess duration of infant fussiness during observations.

During kangaroo holding, mothers held their infants in skin-to-skin contact between their breasts, with their blouse or gown and/or the infant's receiving blanket covering the infants'

backs. Infants' heads were covered with a cap or the blanket. During blanket holding, mothers typically wrapped their dressed infants in a blanket. Mothers awakened their infants briefly for a diaper change and to undress the infants in the kangaroo group before the baseline cortisol, but arousal was very limited for the mid- and post-holding samples. Infants were held one hour before the first afternoon feeding to standardize the holding condition and so that the infant's last feeding would be digested. Because cortisol has a diurnal pattern, collections always occurred between 10:30 AM and 2:00 PM. To avoid contaminating the saliva samples, mothers were asked to refrain from smoking, eating or drinking anything but water for 45 minutes before saliva collections.

The study nurse collected saliva from the mothers and infants three times during the holding observation: at baseline (when the mother first picked up her infant); 30 minutes after holding began; and 60 minutes after holding began.

3. Analysis

3.1. Primary Analysis

Co-regulation was conceptualized as the progressive reduction in the absolute difference between mother and infant cortisol levels across the 60 minutes of holding at each holding session. The primary analyses were conducted using hierarchical linear models in which each cortisol collection was nested within weeks which were in turn nested within dyads. Differences in maternal and infant cortisol were modeled as a function of minutes of holding (ranging from 0 to 60), week (0, 2, or 8), and group membership. The natural logs of cortisol scores were used due to typical positive skew of cortisol scores. The criterion variable in each analysis was the absolute difference between the natural logs of maternal and infant cortisol values (i.e., $|\ln(\text{mother cortisol}) - \ln(\text{infant cortisol})|$). An absolute difference score of 0 thus represented identical cortisol levels between mothers and infants, with larger values indicating larger differences in mother and child levels. A negative value for the effect of minutes over the course of a holding session (i.e., a decrease in absolute difference) was seen as evidence for co-regulation within that holding session. Group membership was dummy coded using two variables indicating membership in the kangaroo or blanket groups (member = 1; non-member = 0). Thus, the members of the control group scored as 0 on both variables. All analyses were conducted using Stata 12.1 using restricted maximum likelihood estimates and unstructured covariance matrices for random effects.

3.3 Identifying Control Variables

The study dataset contained more potential confounding variables than were reasonable to include in the analysis given the available power. Thus, seven likely confounding variables were identified: length of hospital stay; infant sex; antenatal steroid administration (yes/no); the average of 1 and 5 minute Apgar scores; infant fussing (percent of the observation during holding in which infants displayed crying, grimacing, or squirming); baseline maternal depression score; and baseline total maternal anxiety score. Each potential covariate was tested in separate hierarchical models to determine whether it had a main effect on the cortisol difference or interacted with session time or week of observation. All main and interaction effects were not significant for most variables (all p 's > .05), with the

exception of mean Apgar scores which predicted greater co-regulation across weeks ($p < .01$) and infant sex which was associated with slower co-regulation within testing sessions ($p = .03$). Thus, Apgar scores and infant sex were included as covariates in the primary analyses.

4. Results

4.1 Sample Characteristics

Figure 1 shows the recruitment flow chart. No baseline demographic differences were found between groups, confirming that the groups were equivalent at baseline. Detailed information about characteristics of the sample has been published previously [15]. Total holding time did not differ between groups and averaged 5 (SD = 2) hours per day. Holding patterns in the blanket and control groups were very similar [15]. Kangaroo holding was tried by 42% of mothers in the blanket and control groups combined, but 14 (67%) of these mothers practiced it for less than 9 days. Mean daily kangaroo holding time for dyads in the kangaroo group was 59 (SD = 7) minutes versus 17 (SD = 21) minutes for mothers who tried kangaroo holding in the blanket and control groups ($F(2, 76) = 22.15, p < .01$).

4.2 Cortisol Sampling

Of the 711 cortisol samples collected from mothers, 25 (3.5%) were below the detection limits of the assay. Of the 711 samples collected from infants, 27 (3.8%) were below the detection limits at the low end. These were randomly distributed through the sample so the standard low value of .5225 was inserted when the value was below detection limits. The low values were spread similarly among the groups for both mothers (kangaroo = 11 (4.2%); blanket = 8 (3.4%); control = 6 (2.9%) and infants (kangaroo = 9 (3.5%); blanket = 12 (5.1%); control = 6 (2.9%).

4.3 Preliminary Analysis: Cortisol levels During Holding

On average, mothers' cortisol values dropped over the course of each holding session ($b = -0.006, p < .01$), and the slope of decline was not significantly different over the weeks of the study ($b < .001, p = .09$). Likewise, babies' cortisol levels fell, on average, over the course of each holding session ($b = -0.005, p < .01$), and like their mothers, the rate of this decline did not vary over weeks ($b < .001, p = .18$).

4.4 Model of Co-regulation

At baseline, mother-infant differences in cortisol did not vary by group, (γ_{001} and γ_{002}), baby sex (γ_{003}), or Apgar scores (γ_{004}) after accounting for the other variables in the model. As seen in the first panel of Figure 2, there was no statistically significant change in mother-infant cortisol co-regulation over the 60 minutes of holding for the kangaroo group ($\gamma_{100} + \gamma_{101} = -0.002, p = .24$). In the control group, however, the absolute difference between maternal and infant cortisol values actually increased, on average, over the course of the holding period (γ_{100}), suggesting that mother and baby cortisol values were diverging from each other in the control group as the holding continued. Although the mean difference in co-regulation between the control and blanket groups at 60 minutes approached significance ($\gamma_{002} + 60 \times \gamma_{102} = -0.39, p = .06$), the kangaroo group did not exhibit greater cortisol

similarity throughout the session compared to the control group ($\gamma_{001} + 60 \times \gamma_{101} = -0.32, p = .12$). Meanwhile, there was no difference between the changes in cortisol between the control and blanket groups (γ_{102}), nor the blanket and kangaroo groups ($\gamma_{101} - \gamma_{102} = -0.003, p = .26$).

After the first holding experience, the control group improved in co-regulation in successive weeks (γ_{110}), as shown in the increasingly downward trends in weeks 2 and 8 in Figure 2. Like the kangaroo group at baseline, though, there was no evidence of increasing co-regulation over the 60 minutes of the holding procedure even at week 8 ($\gamma_{110} + 8 \times \gamma_{110} = -0.004, p = .11$). That is, mothers and infants in the control group were no longer moving away from each other over the holding period at week 8, but neither were their cortisol values converging. Similar changes in successive weeks, however, were not seen in the blanket group ($p = .94$) or the kangaroo group ($p = .20$). Indeed, the kangaroo group became somewhat less co-regulated compared to the control group (γ_{111}), as reflected in the acceleration of the kangaroo group's differences across weeks in Figure 2.

5. Discussion

We hypothesized that co-regulation between the mother and infant assessed via salivary cortisol would be greater during periods of infant holding for dyads practicing the kangaroo method compared to either blanket holding or a control group. When kangaroo holding was compared to blanket holding and the attention and encouragement to hold was measured and controlled (through group assignment), no differences were found between the groups in HPA co-regulation. Co-regulation, however, was marginally better ($p = .06$) in the blanket group after 60 minutes of holding than in the control group at baseline. We also hypothesized that co-regulation in salivary cortisol would increase over an eight-week period of time. Co-regulation increased over time only in the control group but not significantly.

Several possibilities may explain the findings in this study. There was considerable variability in maternal and infant cortisol levels, similar to findings of another study examining cortisol levels during a blood draw when infants were held kangaroo style [23]. Findings suggest the need for further research using larger samples in which patterns for infants and mothers with low, intermediate, and high cortisol levels can be compared. The sample size in this and the prior study ($n = 17$) were not large enough for these comparisons to be made [23].

At baseline, however, when infants were hospitalized, cortisol levels of mothers and infants in the control group diverged during holding. Because of the divergence, co-regulation was marginally better in the blanket group after 60 minutes. Dyads seemed to be maintaining co-regulation in the kangaroo and blanket groups during baseline holding. At baseline, most infants were still receiving intensive care. All mothers were naïve to the study and it is reasonable to believe that the first holding sessions would be stressful. We would expect all groups to co-regulate in response to the stress. Divergence in dyads in the control group could be a function of study group assignment. Mothers in the control group knew they would not be receiving home visits and encouragement to hold their infants. Mothers in both

support groups (kangaroo and blanket) may have felt more connection to their infants because they knew they would receive attention from study nurses that had the potential to enhance their confidence in interacting with their infant. Mothers in the kangaroo and blanket groups also were given instructions on how to hold their infant, while mothers in the control group were told to hold as they normally would. The lack of specific holding instruction for the control group may have created more uncertainty in the mothers for what should be happening during the observational hour. The physical closeness during kangaroo holding at a potentially stressful time may have been an additional factor in co-regulation in the kangaroo group.

The second hypothesis, that over time co-regulation would be improved, was based on research showing that each member of a dyad learn to expect behaviors of the other member through repeated reciprocal interactions [16]. It was thought that repeated physical interaction also might promote physiologic co-regulation. This may have been the case with the control group which was divergent at baseline, but appeared to increasingly co-regulate over time.

Stress seems to be key in promoting physiologic co-regulation. Gunnar and colleagues highlight the importance of having an adequate stressor in any study that tests HPA function [33]. Middlemiss and colleagues [34] found a positive correlation in mother-infant cortisol levels when the dyad had been in contact during the day. This correlation decreased when the dyad was separated and mothers observed that their infant was calm or sleeping, and increased when they observed outward signs of infant distress such as crying or grimacing. Stress signals of the infant seemed to trigger increased connection in dyad cortisol levels. The infants were term and tested at 4 to 10 months of age, but the process of eliciting physiologic maternal-infant co-regulation may be similar in less mature infants [34]. Necessity for stress to be present also was suggested when behavioral co-regulation was found to be greater only after a stressful event in 6 month-old prematurely born infants who had received kangaroo holding [17].

Thus, in the current study we might have seen lack of increased co-regulation in the nurse supported groups because they did not need enhancement. Most observations during the second and eighth weeks were performed at participants' homes. The dyads were together during the day, and were not experiencing the stress of the NICU. Physical contact during holding could have maintained adequate co-regulation. The control group may have shown increased co-regulation because mothers became more comfortable during the observations and were experiencing minimal stress at home. In addition, cortisol levels of mothers and infants generally decreased during the holding sessions. These decreasing cortisol levels indicate that holding was a pleasant experience regardless of method, and certainly not stressful.

Finally, other biological indicators may be better indicators of co-regulation during holding. Salivary cortisol only was measured three times during holding. The bouts of infant fussiness in this study may have been shorter than those in other studies because mothers were holding their infants and could calm them quickly. This interpretation is consistent with the finding that fussiness in this study did not influence co-regulation in cortisol levels

as it did in research in which dyads were separated during infant distress [34]. Thus, an indicator like vagal tone or heart rate that is monitored continuously might be better able to capture brief changes in co-regulation than salivary cortisol.

Limitations of the study should be noted. Salivary cortisol has a lag of 20 minutes between stressor onset and peak cortisol release [35]. The last cortisol sample was obtained 60 minutes after holding began and that may have only captured 40 minutes of holding. Waiting 20 minutes after 60 minutes of holding may have yielded significant differences among groups, especially at baseline. Sample size precluded an analysis of patterns in mothers and/or infants with habitually low or high cortisol levels. Only one physiologic indicator to measure stress was used. Infants were awakened for a diaper change before holding, but this was apparently not a sufficient stressor to find differences among groups. Further research could address these limitations by enrolling a larger sample so that patterns can be analyzed. A cross-over design in which a mother holds her distressed infant each way on separate occasions to see if co-regulation occurs quicker for one method than the other may better capture whether one method of holding is superior.

6. Conclusion

In this study we randomized infants and their mothers to eight weeks of either kangaroo or blanket holding, or a free choice of interactions while monitoring holding time. No significant differences were found among groups, although a trend was seen in which dyads in the blanket group showed better co-regulation after holding than dyads in the control group at baseline when infants were more likely to be stressed. Findings suggest that in nonstressful situations, co-regulation in salivary cortisol may not differ based on holding method. The strength of this study was the comparison of two holding methods and the control and measurement of attention and support that mothers received that typically are not done in holding studies. Use of large samples and a design in which a known stressor elicits an HPA response will allow more thorough examination of coregulation during various means of holding.

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Figure 1.

CONSORT Diagram of all Possible and Actual Dyads for 8-Week Cortisol Co-regulation
Adapted from Neu M, Robinson J. Maternal holding of preterm infants during the early weeks after birth and dyad interaction at six months. *J Obstet Gynecol Neonatal Nurs.* 2010; 39(4): 401–414.

Figure 2.
Fitted model of cortisol co-regulation over time

Table 1

Hierarchical model summary for primary analysis of co-regulation of cortisol

Predictor	Estimate	SE	p
Fixed Effects			
Constant, γ_{000}	0.860	0.155	< .01
Kangaroo group, γ_{001}	0.094	0.202	.64
Blanket Group, γ_{002}	-0.165	0.205	.42
Infant sex, γ_{003}	-0.084	0.115	.47
Mean Apgar score, γ_{004}	-0.019	0.042	.65
Week, γ_{010}	0.017	0.024	.48
Week $\times$ Kangaroo, γ_{011}	-0.029	0.032	.37
Week $\times$ Blanket, γ_{012}	-0.001	0.033	.98
Minute, γ_{100}	0.005*	0.002	.03
Minute $\times$ Kangaroo, γ_{101}	-0.007*	0.003	.02
Minute $\times$ Blanket, γ_{102}	-0.004	0.003	.20
Minute $\times$ Week, γ_{110}	-0.001*	< 0.001	.01
Minute $\times$ Week $\times$ Kangaroo, γ_{111}	0.002*	0.001	.01
Minute $\times$ Week $\times$ Blanket, γ_{112}	0.001	0.001	.08
Random Effects			
Within Dyad			
Constant, u_{00k}	.545		
Week, u_{01k}	.065		
Correlation(u_{00k} , u_{01k})	-.639		
Within Week			
Constant, r_{0jk}	.303		
Minute, r_{1jk}	.004		
Correlation(r_{0jk} , r_{1jk})	-.122		
Level-1 Residual, e	.515		

Note:

*
: $p < .05$.