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ORIGINAL PAPER

Mother-Infant Sleeping Arrangements and Night-Time Touch Behaviors

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Abstract
Affective touch is interpersonal touch which carries an emotional valence and is important to humans and other primates for stress resilience and social bonding. It is acknowledged that infants who sleep in close proximity to a caregiver receive more touch. However, mother-infant night-time touch has not been investigated with an understanding of affective touch mechanisms and with infant night-time location treated as a continuous rather than categorical variable. In a secondary data analysis of sleep laboratory observations of 13 UK mother-infant dyads, some for multiple nights (19 total observations, averaged within participants), we used continuous coding to quantify the amount and type of touch that infants received, and how it related to the amount of time they spent in different locations during the night. At the time of the observations, infants were four months old or younger, except one infant who was observed three times, with the last observation being at 6 months of age. We found that infants who spent more time in the adult bed received significantly more touch overall, and specifically more static touch. However, the time the infants spent in the adult bed was not significantly associated with the amount of stroking touch the infants received, with very little stroking touch recorded overall. We propose that static touch received in the night-time environment during bed-sharing can be a type of affective touch, as it may communicate safety to the infant through the presence of a responsible adult caregiver.

Keywords Bed-sharing · Co-sleeping · Infant sleeping arrangements · Night-time caregiving · Affective touch · CT afferents

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Introduction

Touch is a central part of caregiving and is important for healthy infant development (Barnett et al., 2022). As the first sense to develop, at 7–8 weeks gestation, well before eyesight (Lejeune et al., 2012; Montagu, 1971), a fetus is able to distinguish between touch from a caregiver versus that of a stranger through the mother's womb (Marx & Nagy, 2017). The amount of touch an infant receives from their mother is greatest during the first few months postpartum (Jean et al., 2009), and throughout infancy, touch is an important means of communication, conveying a sense of safety from mother to infant (Hertenstein, 2002; McGlone & Rankin, 2025). In addition, many caregiving activities – being nursed or bottle-fed, held, transported, clothed, covered with a blanket, washed, and groomed – involve touch (Mobbs et al., 2016; Zoltowski et al., 2022), and the benefits of caregiver touch include enhanced immune function, improved physiological regulation, stress resilience, and positive social and attachment outcomes (Croy et al., 2022; Devine et al., 2020; Feldman et al., 2002, 2010; Field, 2010; Kidd et al., 2022; Van Puyvelde et al., 2021). However, touch can vary greatly depending on the context, and much of the literature on infant and caregiver touch has focused on daytime interactions (Barry, 2019; Brzozowska et al., 2021; Jean et al., 2009). Therefore, it is worthwhile also to consider the "forgotten third" of the day – the night-time (Barry, 2019, p.1). During the night, an infant's touch experiences may be different depending on where they sleep (Barry, 2019). Given the central role of touch, it is important to understand what amount and types of touch infants receive at night.

It has been noted that the main difference between bed-sharing (defined as an infant sleeping in an adult bed with a parent while the parent is also asleep) and co-sleeping (defined as being in the same room but on a different sleep surface) is the level of bodily contact (Ball, 2009; Raghunath et al., 2020), with bed-sharing infants receiving more touch (Barry, 2019).[1] However, in the literature on infant sleeping arrangements, touch is often measured secondarily to other variables (e.g., Baddock et al., 2006), and many coding schemes are developed without a framework to meaningfully distinguish between different types of touch (Botero et al., 2020). Indeed, although there are numerous ways that touch has been categorized in caregiving interactions (see reviews by Barnett et al. (2022) and Serra et al. (2023)), including lower-level, descriptive categories such as patting or tapping, and higher-level, theoretical descriptions such as "affectionate touch" or "casual contact" (Brzozowska et al., 2021, p. 497; Lerner et al., 2020, p. 5),[2] to the best of our knowledge, no night-time caregiving study has quantified touch with an understanding of the physiological mechanisms underlying "affective" or "CT-optimal" touch, which is argued to be the mechanism behind many benefits of touch (McGlone et al., 2014; McGlone & Rankin, 2025).

Affective touch is largely associated with CT afferents ("CTs"), a class of nerve fibers which play an important role in how humans relate physically and emotionally to one

[1] The terms "bed-sharing" and "co-sleeping" are sometimes used interchangeably, and at other times, "co-sleeping" is an umbrella term which includes "bed-sharing." In the original article, Barry's use of "co-sleeping" is what we here refer to as "bed-sharing."

[2] An example of a higher-level category (to borrow Brzozowska et al.'s (2021) term) is when Lerner et al. (2020) coded touch as either "close" or "casual" physical contact, where "close" contact comprised holding the infant on or next to the mother's body, including holding, cuddling, and breastfeeding; and "casual" contact was defined as the mother and infant "touching, but not closely." Examples included "caressing, diaper changing, infant sitting on mother's lap with little contact between bodies" (p.5).

another (McGlone et al., 2014).[3] The CT system, found in hairy (as opposed to glabrous[4]) skin, is said to be evolutionarily conserved in primates, with nonhuman primates spending more time activating CTs through grooming than would be necessary for hygiene alone, suggesting that touch has provided additional benefits throughout our human evolutionary history (Dunbar, 2010). Among these benefits, the CT system is said to aid the development of an infant's social brain and stress response, which affect other health outcomes throughout their lifespan (Holt-Lunstad, 2021; Jackson et al., 2022; McGlone & Rankin, 2025; Van Puyvelde & Mairesse, 2022). Touch is usually classified as CT-optimal and found to have the most pleasurable effects when delivered at skin temperature and at a velocity of 3–5 cm per second (Ackerley et al., 2014; McGlone et al., 2014). A number of affective touch studies therefore focus on gentle stroking touch at skin temperature; for example, mothers have been found to instinctively stroke their infants at CT-optimal velocities (Croy et al., 2016), and daily stroking at a CT-optimal velocity was found to improve infants' behavioral self-regulation and stress resilience (Van Puyvelde et al., 2021). However, CTs can also be stimulated through low-force static (not moving) touch, such as resting a hand on someone's back (Ali et al., 2023).[5] In contrast to other static activities like hugging, which exert a higher force but are not CT-optimal (Ali et al., 2023), the activation of CTs through low-force static touch may explain some of the physiological benefits found from activities like skin-to-skin contact, where for an infant lying chest-to-chest on their caregiver, the only movement is the mother's chest slowly undulating as she breathes (Croy et al., 2016). In an adult context, Van Puyvelde and Mairesse (2022) propose that couples sleeping in the same bed experience CT afferent activation. However, to the best of our knowledge, no study in the literature on infant sleeping arrangements, or in a night-time context, has measured touch from a CT-optimal perspective. Given evidence suggesting that CT-optimal touch is important during early infancy, further research is needed on its role at night.

A number of previous studies have examined mother-infant night-time touch in relation to different sleeping arrangements. In a study examining the relationship between different sleeping arrangements and infant affect and behavior, Lerner et al. (2020) compared full bed-sharing, operationalized as bed-sharing for the whole night; partial bed-sharing, operationalized as bed-sharing for some of the night; and no bed-sharing; they found that full bed-sharing infants received more physical contact. In another study that did not include bed-sharing, but examined two distinct levels of proximity – a cot/crib attached to the mother's bed (colloquially known as a "sidecar cot" in the United Kingdom or "co-sleeper crib" in the USA) versus a freestanding cot/crib – Tully and Ball (2012) found that infants in a sidecar cot/crib received more touch during the night than infants in a separate cot/crib. In addition, Baddock et al. (2006) found that bed-sharing infants were touched more by their mothers compared to infants who slept in a cot/crib. Taken together, these studies suggest that touch increases with the proximity of an infant's sleeping arrangements to their care-

[3] The terms "affective" and "CT-optimal" touch are often conflated; technically, "affective" touch is any touch that carries an emotional valence (e.g., pleasantness), and it is often, but not always, CT-optimal (Schirmer et al., 2023).

[4] "Skin is classified as either glabrous, found only on the plantar and palmar surfaces, or hairy, which is found on the rest of the body" (McGlone et al., 2014, p. 737).

[5] In terms of force, both static *and* stroking touch are preferred at a low force of 0.4 N, considered to be the force of light, actively supported touch (Ali et al., 2023).

giver, which is particularly relevant to the case of bed-sharing, and that the amount of touch received is positively related to the quantity of time spent in close proximity.

A limitation of many studies on infant sleeping arrangements is that they treat infant sleeping location as a categorical variable for ease of coding and/or analysis – dyads are categorized based on what they have done for the majority of the night, week, or month (Bilgin & Wolke, 2022; Lerner et al., 2020; McKenna et al., 2007). In reality, infants often do not spend even an entire night in one place; for example, the infant may start the night in a cot/crib, but the mother may move the infant into her bed at night to feed and then either keep her infant in her bed, or move them back to a cot/crib (Ball, 2007; Lerner et al., 2020). Because infant sleep practices vary, measuring infant night-time location as a categorical variable, rather than a continuous one, potentially obscures the nuances of individual dyads' sleeping arrangements (Ball, 2007).

The current study therefore extends previous research in this area in three key ways. First, guided by the extensive literature on affective touch (Croy et al., 2016, 2022; McGlone et al., 2014; McGlone & Rankin, 2025; Van Puyvelde et al., 2021), we used a detailed coding scheme which included both static and stroking touch, in order to consider CT-optimal touch. In addition, with touch being the primary interest, we also included other types of touch, such as patting or tapping. Second, over the course of the night, touch serves many functions to an infant, whether or not they are asleep. For example, in addition to the caregiving activities highlighted earlier (being transported, fed, clothed), infants may be touched while they are awake and having their nappy/diaper changed, or may be patted or tapped as their mothers are soothing them. We therefore coded not only touch delivered in bed while asleep, but all touch received in any location, asleep or awake, including the adult bed, sidecar cot/crib, separate cot/crib, and other places in the room, in order to obtain a complete view of touch over the course of the night. Third, rather than treating infant sleeping location as a categorical variable, we continuously recorded the infant's location over the course of the night and calculated the proportion of time infants spent in each sleeping location. This more accurately reflects the reality that infant sleeping location is not fixed for the whole night, but can change over the course of the night (Ball, 2007; Lerner et al., 2020).

Therefore, the aim of this study was to examine the amount and type of touch that infants received from their mothers at night in different locations and to consider how this fits within the literature on "affective" or "CT-optimal" touch. Touch was recorded objectively through observation of mothers and infants in a sleep laboratory. Mothers were instructed to behave as they normally would with their infants, with the opportunity to prepare the adult bed for bed-sharing, or to use a cot/crib in a sidecar or separate position. We examined how the proportion of time the infants spent in different locations (bed-sharing, sidecar cot/crib, separate cot/crib, or elsewhere in the room) was related to the amount and type of touch they received.

Based on previous research demonstrating that the amount of touch an infant receives increases with the proximity of their sleeping arrangements (Baddock et al., 2006; Lerner et al., 2020; Tully & Ball, 2012), we focus this analysis on the proportion of time infants spent in the adult bed and predict:

Hypothesis 1 *Infants who spend a greater proportion of the observation period bed-sharing will receive a greater amount of overall touch.*

Hypothesis 2 *Infants who spend a greater proportion of the observation period bed-sharing will receive a greater amount of static touch.*

Hypothesis 3 *Infants who spend a greater proportion of the observation period bed-sharing will receive a greater amount of stroking touch.*

Methods

Participants

We performed a secondary data analysis combining data from two studies, New Mum Sleep (Tugwell, 2021) and the Swaddle Sleep Study (Dixley, 2022), which had both been conducted at the Durham Infancy and Sleep Centre (Durham, United Kingdom). Neither of these studies examined associations between infant sleeping location and night-time infant touch. As this secondary analysis was planned post hoc to the primary data collections, any available videos that met the ethical criteria (including permission to be reused in future studies) were considered. The total sample size was 13 mother-infant dyads, nine from New Mum Sleep and four from the Swaddle Sleep Study.

New Mum Sleep

New Mum Sleep was conducted in 2019 and focused on sleep and mood disorders in women. Participants were recruited on the basis of (i) being non-smokers; (ii) being over the age of 18; (iii) living locally to County Durham; (iv) having an infant under three months of age; (iv) either formula-feeding or breastfeeding, but not combination feeding.[6] As part of the recruitment strategy, participants were offered £100 in shopping vouchers for completing the entire study. Participants were asked to make three overnight visits to the Durham Infancy and Sleep Centre Parent-Infant Sleep Lab; however, the Covid-19 pandemic interrupted recruitment shortly after the study began. In addition, one observation was excluded because there was an older child present, and another observation was excluded because it was less than six hours long. Therefore, four participants spent only one night in the lab, four two nights, and one all three nights. The sample is described as homogenous, primarily white, middle class, and educated, with mothers' age range between 24 and 40 (mean and SD are not reported).[7] Seven infants were male and two were female; seven were breastfed and two were formula fed. Further details can be found in Tugwell (2021).

Swaddle Sleep Study

The Swaddle Sleep Study was conducted between 2019 and 2020 and focused on the impact of swaddling on infants. Mother-infant dyads were recruited on the basis of the mother (i) being able to read and understand English; (ii) having an infant less than four months old

[6] As the study compared feeding types, mothers were required to be either formula-feeding or breastfeeding but not combination feeding.

[7] As the original demographic data were not retained, our descriptions of the sample are based on those in Tugwell (2021).

with no previous experience of swaddling; and (iii) exclusively breastfeeding. They were excluded on the basis of (i) having any risk factors for Sudden Infant Death Syndrome (SIDS); (ii) regular use of dummies/pacifiers; and (iii) if they routinely bed-shared.

Participants were asked to attend the Durham Infancy and Sleep Centre Parent-Infant Sleep Lab on two consecutive nights to compare the effects of swaddling versus non-swaddling, and the order of the conditions was randomized on the first night. Since swaddling could affect touch behavior, only the data from the non-swaddled nights were included in the current study. In addition, at the time of the analysis, some of the video files were corrupted. Therefore, although a total of 12 mother-infant dyads were recorded, only videos from four dyads on unswaddled nights were available at the time of this secondary analysis. Of the total sample in the Dixley (2022) study, the mothers' age range was 27 to 43 (M = 31.91 years, SD = 5.12), and all defined themselves as white British. The mothers had a high educational level (university-level 58%; post-graduate-level 42%), had a family income of over £40,000 and were all either married (75%) or living with a partner (25%). Further details can be found in Dixley (2022).[8]

In summary, we used data from nine dyads from New Mum Sleep; four were observed for one night, four were observed for two nights, and one was observed for three nights. From the Swaddle Sleep Study, we used data from four dyads, each of whom was observed for one night. Figure 1 shows the composition of the sample.

Ethics

New Mum Sleep and the Swaddle Sleep Study received ethical approval from Durham University, which gave permission for secondary analyses provided that the video data did not leave Durham University. Research governance approval was also obtained for the current analysis from Liverpool John Moores University, the researcher's primary affiliation (Ref: 24/PSY/028). Data coding was performed onsite at the Durham Infancy and Sleep Centre and followed the Helsinki Declaration guidelines.

Facility

Durham Infancy and Sleep Centre *Parent-Infant Sleep Lab*

Video data from New Mum Sleep and the Swaddle Sleep Study were collected at the Durham Infancy and Sleep Centre (DISC; formerly the Parent-Infant Sleep Lab), located in Hilton Cottage at Durham University. Hilton Cottage is an Edwardian detached house (built circa 1914) overlooking playing fields that maintains many features of a house, including a ground floor kitchen, first floor bedroom and bathroom, and laundry facilities. The sleep lab comprises a realistic bedroom with a UK king size bed (equivalent to a US queen size bed), a sofa, nursing chair, cot/crib, wardrobe, nightstands with reading lights on either side of the bed, and an adjacent bathroom. The cot/crib has an adjustable side rail that can be lowered to the level of the adult bed's mattress and used as a sidecar cot/crib, or heightened to be used as a standalone cot/crib. To increase the ecological validity of the observations, lab

[8] As the original demographic data were not retained, we provide the demographics from the full sample of 12 mothers from the Dixley (2022) study, rather than the sub-sample of four mothers who were included in the current study.

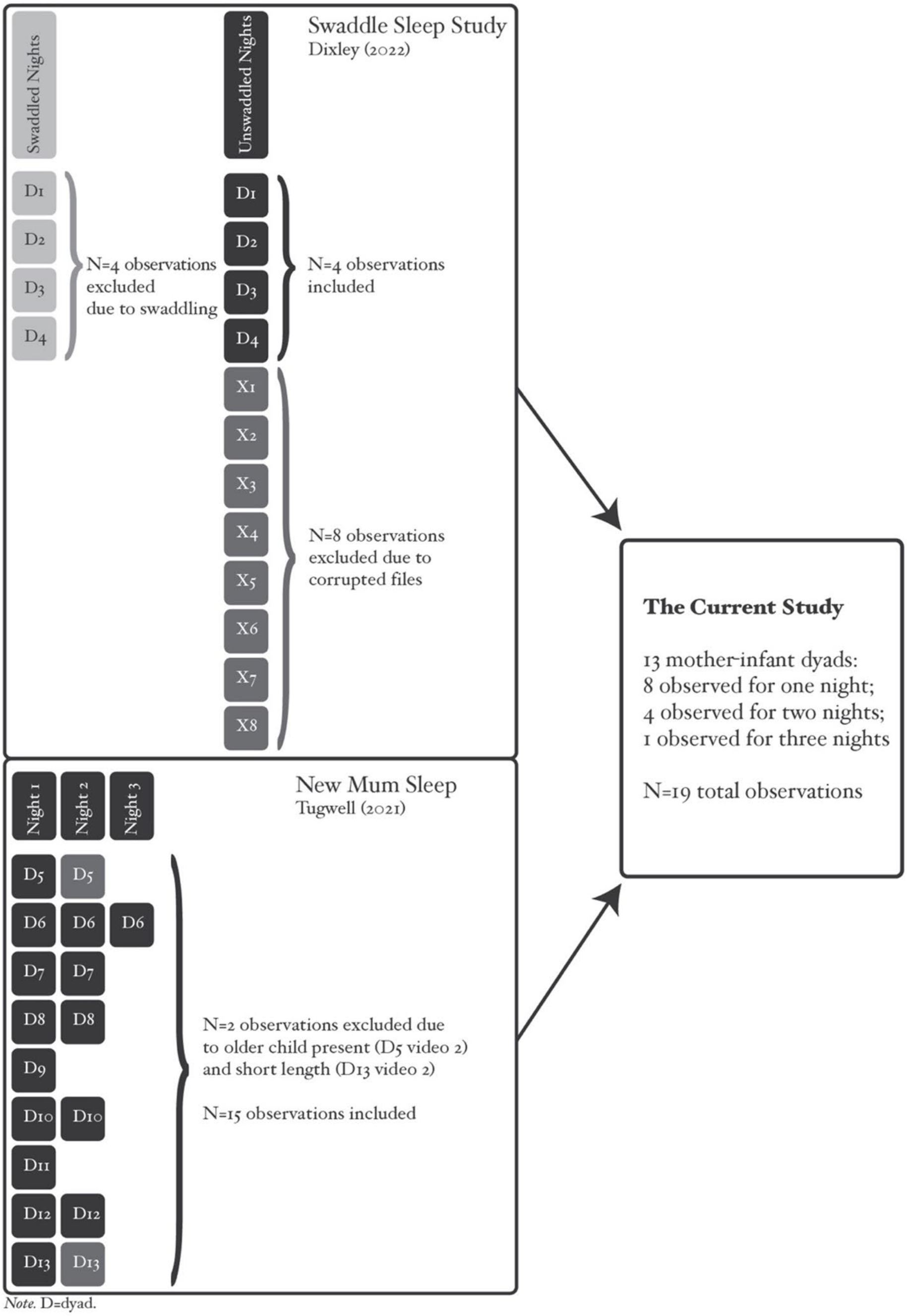

Fig. 1 Participant selection from Swaddle Sleep Study and New Mum Sleep Study

participants are afforded the opportunity to arrange the furniture as they would do on a typical night at home, such as moving the infant cot/crib into a sidecar position next to the bed or a standalone position across the room. Participants also had use of a dedicated bathroom equipped with a bath, toilet, sink, and baby changing facilities.

As a sleep laboratory, the bedroom is also equipped with three Hikvision infrared cameras mounted to the ceiling which allow the researcher to record the participants' activity from different angles of the room, including panning when the participants move around. The cameras are controlled in an adjacent data recording and storage room which is accessible by keycard only to authorized members of the DISC team. For further description, see Dixley (2022) and Tugwell (2021).

Procedure

For New Mum Sleep, mother-infant dyads were invited to attend the laboratory on three non-consecutive nights, when their infants were two to three, four, and six months old. Mothers were instructed to arrive prior to when they would normally start their bedtime routine and were given a tour of the facilities. Afterwards participants were instructed to sleep as they normally would, i.e., bed-sharing or using the cot/crib as necessary (Tugwell, 2021). In the Swaddle Sleep Study, infants less than four months old and their mothers were invited to attend the laboratory on two consecutive nights. Only data for the non-swaddled condition were included in this analysis; however, videos from the swaddled condition were used to develop the coding scheme. The recording intervals began at approximately 8 p.m. and ended at approximately 8 a.m. (Dixley, 2022). Videos were recorded using MediaRecorder (Version 4.0, Noldus Information Technology, Wageningen, Netherlands, October 2017).

Coding

Behaviors were coded using The Observer XT (Version 14, Noldus Information Technology, Wageningen, Netherlands, March 2021). We used continuous event sampling to enable us to calculate the total time spent doing each behavior.

The length of each observation varied between 7 h 43 min and 13 h 53 min. However, the videos included periods of settling in and unpacking/packing during the early evening and once the dyads woke in the morning. Therefore, in line with other studies that have only coded periods of interest (Anders, 2023), and to standardize the length of the videos, only the middle 6 h of each video were coded. Start times were calculated in an Excel spreadsheet by subtracting 6 h from the total length of each night's recording and halving that number. For example, an observation of 9 h 28 min would be calculated thus: 9 h 28 min – 6 h = 3 h 28 min. 3 h 28 min / 2 = 1 h 44 min. Therefore, the start time would be 1 h 44 min. Within the Noldus Observer control panel, the time resets to zero where the researcher indicates recording should begin. Therefore, it was not necessary to calculate an end time, as it was clearly displayed when six hours had elapsed. In some cases, one or two more seconds than 6 h was coded, as it was difficult to stop at a precise location.

Behaviors

To enable continuous event sampling of the behavior, for both touch and infant location we developed the coding scheme to be mutually exclusive and exhaustive. Thus infants could only be recorded in one activity state at a time and their behavior could always be categorized.

Mother to infant touch. We adapted a coding scheme from the Caregiver Infant Touch Scale (Stack et al., 1996, as cited in Serra et al., 2023) and coded 11 categories of touch (Table 1). To ensure the coding scheme was mutually exclusive and exhaustive, we added a "no touch" category to the original Caregiver Infant Touch Scale (Stack et al., 1996, as cited in Serra et al., 2023). Additionally, the original Caregiver Infant Touch Scale (Stack et al., 1996, as cited in Serra et al., 2023) had an "other" category and we replaced this with commonly observed behaviors for more precision: changing nappy, adjusting clothing/blanket/sleep sack, mum giving pacifier, and other instrumental touch. As touch behaviors shifted frequently and were the main focus of the study, they were stopped and started frequently. Static touch was coded if any part of the mother's body was touching any part of the infant, unless, additionally, the mother was doing something else (e.g., patting or stroking).

Infant location. Infant locations were coded as being in the adult bed, sidecar cot/crib (a cot/crib placed alongside adult bed with side rail lowered), separate cot/crib (cot/crib placed away from adult bed with side rail raised), or nursing chair or sofa; as being carried out of bed; or as off-camera (Table 1).

Coding Scheme for Behaviors

At the beginning of each observation, a behavior was selected within each behavior group (mother to infant touch, infant location). During the observation period, each change of behavior was recorded, using the categories described in Table 1. If, at the start of each observation, it was unclear which behaviors were present, the researcher watched a portion of the observation prior to the beginning of the start of the recording, but only recorded

Table 1 Coded behaviors for mother-infant touch and infant location

Touch	Infant location
Behavior group	
No touch	Adult bed
Static touch	Sidecar cot
Stroke/rub/caress/massage	Separate cot
Pat/tap	Nursing chair or sofa
Grab/squeeze/pinch	Being carried out of bed
Tickle/fingerwalk/prod/poke/push	Off-camera
Shake/wiggle	
Pull/lift/flexion/clap	
Changing nappy	
Adjusting clothing/blanket/sleep sack	
Mum giving pacifier	
Other instrumental touch	

the behaviors from the start time of the observation.[9] The coding scheme was developed by watching videos that were not included in the final sample as they involved the use of swaddling.

All videos (N=19) were coded by IB and a proportion (N=3) were second-coded by HB to test reliability. We counted the number of matched versus unmatched behaviors (behaviors observed or unobserved by both coders, versus behaviors observed by only one coder, respectively). From the matched behaviors, we calculated inter-coder reliability using intraclass correlation coefficients (ICC) in R Statistical Software Version 4.4.2 (R Core Team, 2024) using the psych (Revelle, 2025) readxl (Wickham & Bryan, 2023), tidyverse (Wickham et al., 2019), rstudioapi (Ushey et al., 2025), and gt (Iannone et al., 2025) packages. We used ICC (2,1) to evaluate absolute agreement between the two coders across matched subject-behavior pairs. We also calculated for what percentage of the observation there was disagreement.

Preprocessing

Noldus Observer Output was read into R Statistical Software Version 4.4.2 (R Core Team, 2024) and preprocessed using the readxl (Wickham & Bryan, 2023), tidyverse (Wickham et al., 2019), and rstudioapi (Ushey et al., 2025) packages. We fixed naming errors in the source file, removed redundant rows, and calculated the proportion of time that each behavior was observed within each six-hour recording interval. Thus for each of the behaviors in Table 1, the proportion of time that behavior was observed was calculated and this varied between zero and one. We prepared an aggregated data frame which averaged the data for each participant over multiple nights (if applicable). We also categorized each set of mutually exclusive behaviors into a "behavior type" category (e.g., "sidecar cot/crib" and "separate cot/crib" were added to the category "infant location.") We created sums of some variables, e.g., all touch behaviors (except for "no touch") were combined into a variable called "all touch." Further details can be found in the code, on the Open Science Framework (OSF).

Data Analysis

We used R Statistical Software Version 4.4.2 (R Core Team, 2024) and the rstudioapi (Ushey et al., 2025), gt (Iannone et al., 2025), corrr (Kuhn et al., 2024), and ppcor (Kim, 2015) packages for our analysis. We performed descriptive statistics and created correlations tables for the behavior groups "infant location" and "touch." Visual inspection of the Q-Q plots suggested that none of the variables were normally distributed. Given the data were not normally distributed and the small sample size, we used bivariate Spearman's correlations to examine the associations between infant location and amount of touch infants received, while also reporting the Pearson's correlations as a sensitivity test of whether the choice of correlation method influences the results. As bed-sharing is known to have a strong positive relationship with breastfeeding (Blair et al., 2010), we also report partial correlations controlled for feeding type (11 breastfeeding dyads vs. 2 formula-feeding dyads).

[9] Based on similar night-time studies (Ball et al., 2006; Lerner et al., 2020; Philbrook & Teti, 2016; Tully & Ball, 2012), other nocturnal behaviors were coded, e.g., sleep, but not included in this analysis.

Inter-Coder Reliability

The number of matched behaviors (the behaviors observed or unobserved by both coders) was 16 out of 19, indicating 84.2% agreement (see Table S1, supplementary materials). We used ICC(2,1), a two-way random effects, absolute agreement, single-measurement model (Koo & Li, 2016). Of the matched behaviors, ICC(2,1) performed on the durations of the behaviors indicated excellent agreement between coders (ICC = 0.99, 95% CI [0.97, 0.99], $p < .001$). For the three behaviors coder 2 observed which coder 1 did not (grab/squeeze/pinch, mum giving pacifier, infant off-camera), the average proportion of the total observation time these behaviors occurred was less than 0.02. This suggests that for the most common behaviors (e.g. static touch, infant in adult bed), there was good agreement between the two coders; however, this should be interpreted alongside the 0.02 proportion of the observation time when grab/squeeze/pinch, mum giving pacifier, and infant off-camera were not observed by coder 1.

Results

Descriptive Statistics

Touch. During the 6-hour (360 min) observation windows, on average, infants spent the largest proportion of the observation period receiving no touch, with a large amount of variation between dyads (Table 2). For the proportion of the observation period infants received *any* type of touch ("all touch,") there were infants at both extremes, ranging from receiving no touch to spending the whole night receiving touch. Of the types of touch infants received, the largest amount was static touch, followed by pat/tap.

Infant location. On average, infants spent the largest proportion of the observation period in a sidecar cot/crib, but this varied greatly by infant (Table 3). This was closely followed by infants being in the adult bed and separate cot/crib. The amount of time infants spent being carried out of bed, or in the nursing chair or sofa, was negligible.

Table 2 Mother-infant touch descriptive statistics

Behavior	Mean	SD	Min	Max	IQR
Adjusting clothing/blanket/sleep sack	0.00	0.00	0.00	0.01	0.00
All touch	0.37	0.34	0.00	1.00	0.30
Changing nappy	0.00	0.01	0.00	0.02	0.00
Grab/squeeze/pinch	0.00	0.00	0.00	0.00	0.00
Mum giving pacifier	0.00	0.00	0.00	0.01	0.00
No touch	0.63	0.34	0.00	1.00	0.30
Other instrumental touch	0.00	0.00	0.00	0.00	0.00
Pat/tap	0.01	0.01	0.00	0.03	0.01
Static touch	0.35	0.34	0.00	1.00	0.31
Stroke/rub/caress/massage	0.00	0.01	0.00	0.02	0.01

Mean, standard deviation, minimum, maximum, and interquartile range (IQR) calculated as proportion of night-time observation period (360 min), averaged across nights within dyads

Table 3 Infant location descriptive statistics

Behavior	Mean	SD	Min	Max	IQR
Being carried out of bed	0.01	0.01	0.00	0.04	0.01
In adult bed	0.32	0.35	0.00	1.00	0.33
In nursing chair or sofa	0.00	0.01	0.00	0.03	0.00
In separate cot	0.22	0.36	0.00	0.87	0.48
In sidecar cot	0.44	0.45	0.00	1.00	0.93

Mean, standard deviation, minimum, maximum, and inter-quartile range (IQR) calculated as proportion of night-time observation period (360 min), averaged across nights within dyads

Table 4 Pearson and Spearman bivariate correlations between proportion of time infant spent in adult bed and proportion of time they received different types of touch

	n	df	Pearson			Spearman		
			Pearson's *r*	95% CI	*p*-value	Spearman's ρ	95% CI	*p*-value
Static touch	13	11	0.954	[0.849, 0.986]	<0.001	0.835	[0.526, 0.949]	0.001
All touch	13	11	0.955	[0.853, 0.987]	<0.001	0.830	[0.513, 0.948]	0.001
Stroke/rub/caress/massage	13	11	− 0.074	[− 0.600, 0.497]	0.810	0.144	[− 0.442, 0.644]	0.640

Table 5 Pearson and Spearman partial correlations between proportion of time infant spent in adult bed and proportion of time they received different types of touch

	n	df	Pearson			Spearman		
			Pearson's *r*	95% CI	*p*-value	Spearman's ρ	95% CI	*p*-value
Static touch	13	10	0.949	[0.823, 0.986]	<0.001	0.812	[0.446, 0.945]	0.001
All touch	13	10	0.950	[0.828, 0.986]	<0.001	0.807	[0.434, 0.944]	0.002
Stroke/rub/caress/massage	13	10	0.205	[− 0.418, 0.697]	0.522	0.397	[− 0.229, 0.791]	0.201

Note. Controlled for: Feeding type (11 breastfeeding dyads vs. 2 formula-feeding dyads).

Correlations

In the main analyses, for all correlations, the pattern of significance was the same for the Spearman's correlations and Pearson's correlations (Table 4), and for the bivariate and partial correlations which controlled for feeding type (Table 5).

There was a strong and significant positive correlation between the proportion of time the infant spent in the adult bed and the proportion of time they received any type of touch ("all touch,") supporting hypothesis 1 (Table 4; Fig. 2). When broken down into type of touch, there was also a strong and significant positive correlation between the proportion of time the infant spent in the adult bed and the proportion of time they received static touch (Table 4; Fig. 3). This supports hypothesis 2. However, there was no significant correlation between proportion of time the infant spent in the adult bed and the proportion of time they received stroking touch (stroke/rub/caress/massage; Table 4; Fig. 4). Therefore, hypothesis 3 is rejected.

In Figs. 2, 3, and 4, there is an outlier infant which spent a relatively low proportion of time in the adult bed but received a large amount of touch. To check the robustness of the

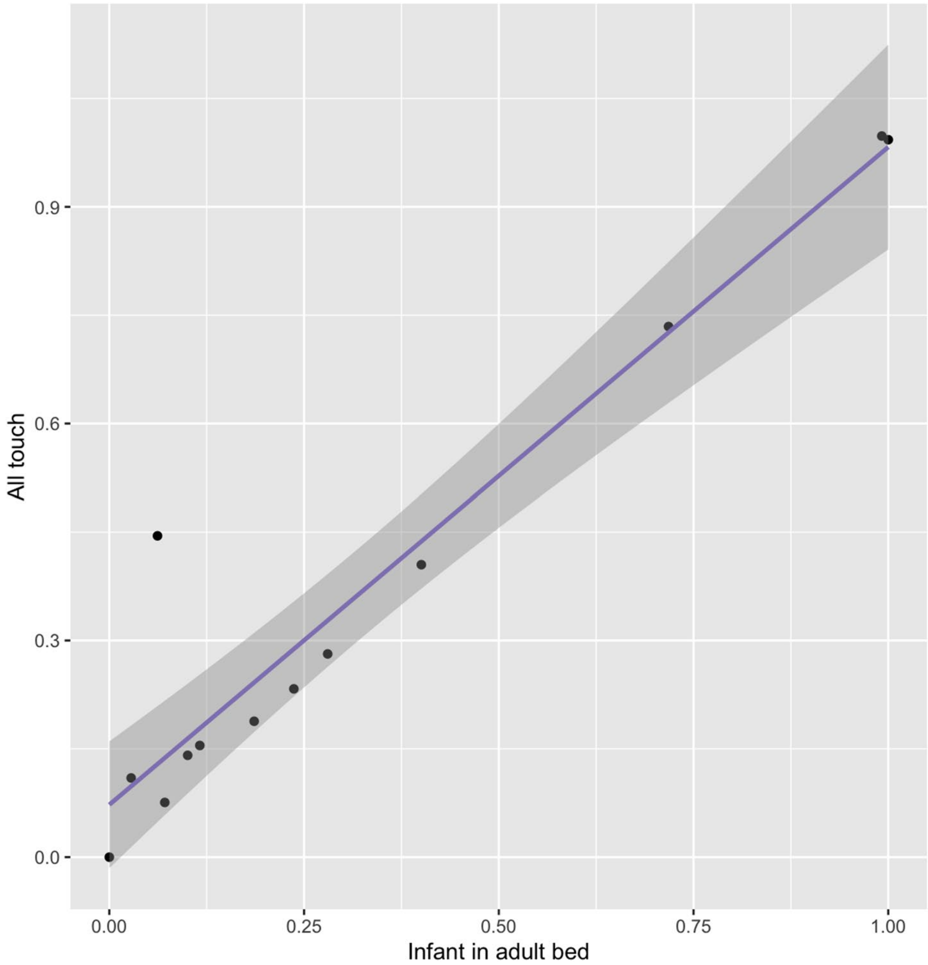

Fig. 2 All touch received as a function of infant time in the adult bed. *Note* Scatterplot of all touch received by infants from mothers and time infants spent in adult bed. Behaviors calculated as proportion of night-time observation period (360 min), averaged within dyads. Line of best fit and 95% confidence intervals displayed

findings, we repeated the analyses with this dyad removed; details of this can be found in the Supplementary Materials.

Discussion

In this study, we used night-time videos of mothers and infants in a sleep laboratory to objectively and continuously record what kind of touch behaviors infants received and the time that infants spent in different locations, including the adult bed, sidecar cot/crib, and separate cot/crib, using a detailed coding scheme which distinguished between different types of touch, including static and stroking touch. In night-time observations, we found

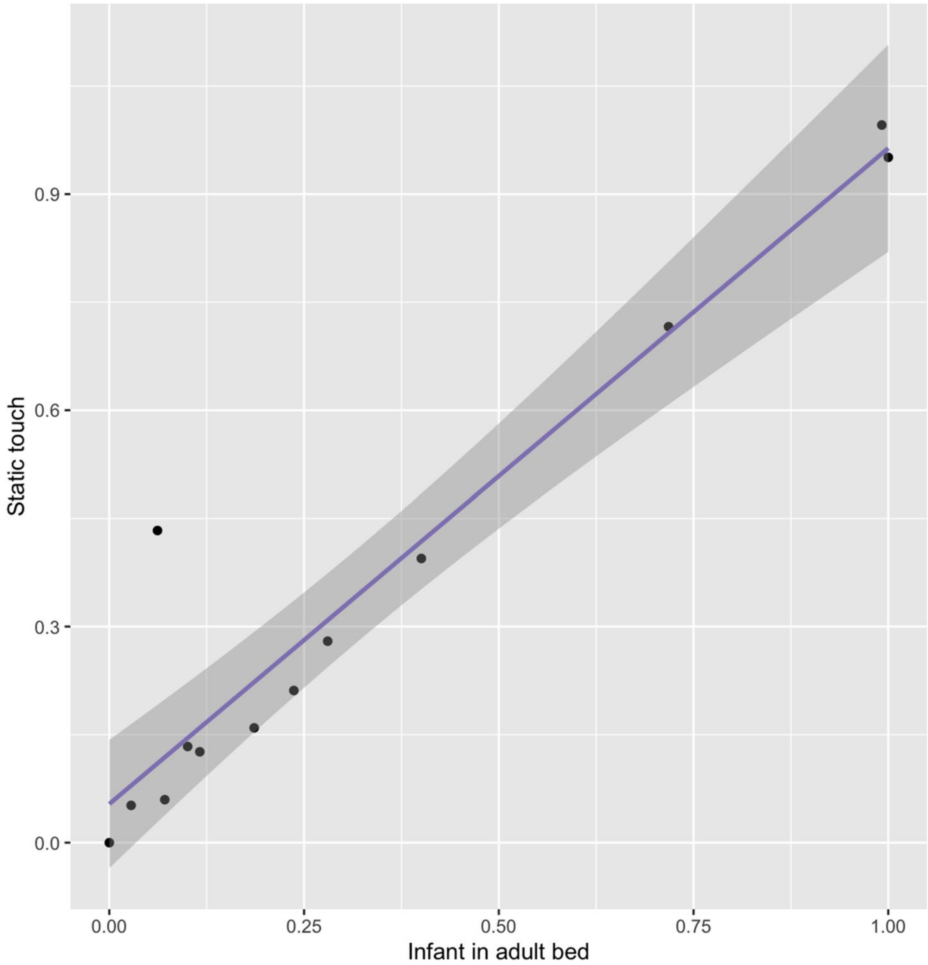

Fig. 3 Static touch received as a function of infant time in the adult bed. *Note* Scatterplot of static touch received by infants from mothers and time infant spent in adult bed. Behaviors calculated as proportion of night-time observation period (360 min), averaged within dyads. Line of best fit and 95% confidence intervals displayed

that infants who spent a greater proportion of the observation period in their mothers' beds received more touch overall, and more static touch, but not more stroking touch.

The first hypothesis was accepted – there was a very strong positive correlation (r_s = 0.83) between the proportion of the observation period the infants spent in the adult bed and the proportion of the observation period they received any type of touch (categorized as "all touch"). This in line with studies showing that touch increases with the proximity of an infant's sleeping arrangements to their caregiver (Baddock et al., 2006; Lerner et al., 2020; Tully & Ball, 2012). However, previous studies used sleeping location as a categorical variable, whereas the current study measured the infant's location continuously throughout the night. In reality, bed-sharing often occurs only for part of the night (Ball et al., 2016). The

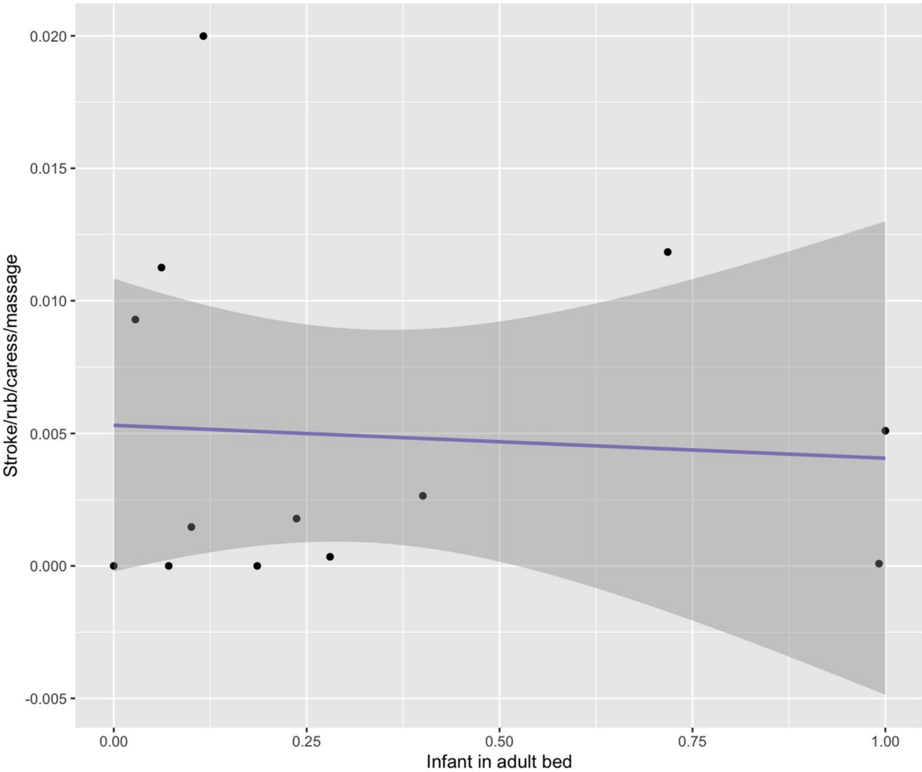

Fig. 4 Stroke/rub/caress/massage received as a function infant time in the adult bed. *Note* Scatterplot of stroke/rub/caress/massage touch received by infants from mothers and time infant spent in adult bed. Behaviors calculated as proportion of night-time observation period (360 min), averaged within dyads. Line of best fit and 95% confidence intervals displayed

current study therefore contributes a more nuanced view of time spent bed-sharing in this sample of mother-infant dyads.

The second hypothesis was also accepted – there was a very strong positive correlation ($r_s = 0.84$) between the proportion of the observation period the infant spent in the adult bed and the proportion of the observation period they received static touch. This reflects the fact that almost all the night-time touch infants received was static touch rather than any other type of touch. The strength of these two correlations suggests that when infants were in the bed with their mother, they were in physical contact with them for the majority of the time (~80%). The bed in the sleep laboratory was a UK king/US queen size bed, so there was sufficient room for the mother and infant to bed-share and not be in physical contact, for example if the mother were concerned about the risk of accidental overlay. However, it is common for breastfeeding mothers, of which this sample was predominantly comprised, to adopt a bed-sharing position known as the "C-position" or "Cuddle Curl" which both (i) provides easy access to the mother's breast; and (ii) makes it virtually impossible to roll over on the infant (Blair et al., 2020). In this position, the mother is also passively touching the infant, and as our results have demonstrated, there is a strong significant relationship between an infant being in the adult bed and receiving static touch. After static touch the most frequent type of night-time touch experienced was pat/tap. Following this, other types of touch occurred less than 1% of the night. Notably, pull/lift/flexion/clap was not observed in any of the videos. Pull/lift/flexion/clap has been described as "playful/stimulating" (Mercuri et al., 2019). Therefore, parents may have wanted to avoid stimulating their infants during the night.

However, the third hypothesis was not accepted – in the main analyses, there was not a significant correlation between the proportion of the observation period the infant spent in the adult bed and the proportion of the observation period they received stroking touch. Further, very little stroking touch was observed overall. Although the majority of studies on "affective" touch focus on gentle, stroking touch at skin temperature, these are usually conducted in daytime environments. This was one of the reasons why we used a coding scheme that differentiated between static and stroking touch, instead of grouping them together within the same category. The relative absence of stroking touch and its lack of correlation with time spent in the adult bed is an important finding given that "affective" touch is often associated with stroking CT-optimal touch. However, in our study static touch was much more common. In interpreting the results, it is worth noting that "all touch" as a category included any type of touch; therefore, with static touch being the most commonly observed type of touch, it represented a large portion of all the touch received.

It is plausible that the form of touch often associated with "affective" touch – stroking – by virtue of also being active touch, might be more typical when an infant is aroused and awake (e.g., during the daytime). In contrast, an infant sleeping soundly next to their parent would not "need" more active forms of touch to feel safe, and static touch still serves a communicative function (Hertenstein, 2002) by signaling the mother's presence. If a mother's presence signals "safety" to an infant, then this type of touch is still "affective" in evoking an affective or emotional response. This is interesting to consider alongside evidence that CT activation also happens, not only through stroking, but also through low-force static touch, such as what an infant might feel in the rising and falling of their mother's chest during skin-to-skin contact (Croy et al., 2016; Vallbo et al., 1999). Therefore, it is plausible, but remains untested, that in a night-time context, static touch is sufficient when an infant's arousal is low, when they are asleep. Indeed, helping an infant to fall asleep involves removing the barriers to sleep – the stressors – and allowing sleep pressure to take over (Ball, 2025). Perhaps an infant would not seek active touch from the mother (e.g., stroking) unless they were aroused, and instead the infant is relaxed by the mother's presence through static touch.

The rewarding properties of touch that promote social and affiliative behavior (McGlone et al., 2014) have also been found to increase parasympathetic activity in infants, which is necessary in the regulation of an infant's stress response (Raghunath et al., 2020). Therefore, if it is correct that infants who are in close contact maintain a lower state of arousal throughout the night, and do not need more active forms of touch to be soothed, this would be in line with findings that infants who bed-share are more resilient to stress (Raghunath et al., 2020). Future studies are needed to explore the CT-fiber's role underlying bed-sharing's positive outcomes on an infant's parasympathetic activity. We suggest that the same underlying mechanism proposed by Van Puyvelde and Mairesse (2022) for adult partners sharing a bed may also apply to mothers and infants; namely, that bed-sharing may be an important context for CT activation through low-force static touch.

In terms of infant location, the finding that infants spent the most time in a sidecar cot/crib (a mean of 44% of the night), followed by the adult bed (32%) and separate cot/crib (22%) may reflect uptake of the current guidance from the National Health Service in the United Kingdom, where this study took place, which advises that infants sleep in the same room as their parent, but not on the same sleep surface due to safety concerns (NHS, 2023).[10] Proximal sleep, either in the same bed or in a sidecar arrangement, is widely practiced among mothers who breastfeed, and has been shown to increase the frequency of successful feeding attempts in an early postnatal sample (Ball et al., 2006). The majority of our study participants were breastfeeding ($N=11$). Therefore, this may partially account for the sidecar cot/crib and adult bed rates being relatively higher as compared to separate cot/crib. In addition, bed-sharing is associated with stronger prenatal breastfeeding intent and longer breastfeeding duration (Ball et al., 2016). Therefore, the high rates of bed-sharing in this sample of predominantly breastfeeding mothers could indicate a strong intention to breastfeed. On the other hand, part of the sample recruited were not routine bed-sharers (Dixley, 2022); therefore the bed-sharing rates may have been artificially low.

While this study was based on detailed, objective measures of mother-infant touch behaviors and infant location, there were several limitations. The first limitation relates to the sample. The sample size of 13 mother-infant dyads and number of separate night observations was small, which reduces the extent to which the findings can be generalized, and which prevented us from running a more detailed analysis by dyad and night for those participants who provided multiple nights of data. In addition, although we controlled for feeding type in our analyses, there were only two formula-feeding infants; therefore, our partial correlations, rather than being meaningful controls, could be more accurately described as exploratory sensitivity checks. In addition, in sleep laboratory studies, a "first night effect" is often observed where there are more awake periods and less deep sleep, but our aggregated analyses precluded further investigation of this effect (Agnew et al., 1966). However as sleep was not a primary measure of interest, this first night effect was less of a limitation. Also pertaining to the sample, the four participants who originated from the Swaddle Sleep Study had to meet that study's criterion of not routinely bed-sharing, which meant that the time spent in the adult bed may have been lower than the population average. Furthermore, as the original demographic data were not retained and we only used a portion of the samples from the original studies, we could not provide complete information on the participants' characteristics. However, they were described as primarily white, middle-class, highly educated, and most of them (85%) breastfed, which is much higher than the English national average of 52.7% (Office for Health Improvement and Disparities, 2024). Given differences in sleeping arrangements among different socioeconomic groups (Mileva-Seitz et al., 2017), the homogeneity of the sample and higher than average breastfeeding rates also limit the generalizability of the findings. The combined sample used for this secondary analysis included observations where infants were between two and six months old (Dixley, 2022; Tugwell, 2021). Given one study showed that overall touch decreases over the first

[10] To put this into context, the NHS has been moving away from a risk-elimination model ("Do not share a bed with your baby"; NHS Digital, 2022) to a risk-reduction model ("Be safe if you share a bed with your baby"; NHS Digital, 2024). This is in line with guidance from NICE, Lullaby Trust, and UNICEF UK Baby Friendly Initiative, and in contrast to the American Academy of Pediatrics, who do not endorse bed-sharing (American Academy of Pediatrics, 2016; Lullaby Trust, 2025; NICE, 2013; UNICEF UK, 2019). Although a review of bed-sharing safety is beyond the scope of this paper, see McKenna et al. (2007) and Moon et al. (2022) for contrasting arguments.

few months of an infant's life (Jean et al., 2009), it would have been interesting to see how these dyads' touch behaviors changed over time, but this was not possible with the aggregated data and small sample size. In addition, the sample from Swaddle Sleep Study excluded self-identified "routine" bed-sharers, which at face value could mean that they were underrepresented. However, bed-sharing tends to be underreported by parents and to covary with breastfeeding (Ball, 2007). Through objective measures, our current study reports that most infants spent a significant amount of the observation period in the adult bed.

A second set of limitations relates to this being a secondary analysis, meaning it was not possible to collect further data on these dyads. This precluded us from drawing wider conclusions about any behavioral and physiological outcomes associated with different infant sleeping arrangements or amounts of touch received by infants. That is, we did not directly test infant state, physiology, or what motivated the mothers to choose their sleeping arrangements. For example, there are individual differences in touch attitudes and behaviors (Trotter et al., 2018), and further studies are needed to explore whether a mother's touch attitudes influence the sleeping arrangements that she chooses. On the other hand, where the baby sleeps may be also influenced by cultural attitudes, medical reasons, or an infant's individual characteristics (Ball et al., 1999; Boedker et al., 2024; McKenna & Volpe, 2007). Third, sleeping arrangements were not randomly assigned in this study (see Ball et al., 2006, for a rare example of this); therefore our findings are only correlational and do not indicate that more bed-sharing causes more touching. Fourth, the current analysis does not take into account whether the infant was awake or asleep when the touching occurred and future studies could examine whether the type of touch received by the infant differs when they are awake and asleep. Fifth, in order to standardize the observation period, we coded only the middle six hours of the observations; touch behaviors may have been different during settling and waking periods, which our observations did not include for the majority of participants. On the other hand, it may have been better that we did not include these settling and waking periods due to potential differences in when the mothers themselves went to bed. Sixth, although intra-class correlation coefficients indicated excellent agreement, these do not give the full picture as 3 out of 19 of behaviors were not picked up by the first coder. However, when we average the percentage of the total observations in which this occurred, it was less than 2% of the time.

Finally, this study has further limitations related to mother-infant proximity and how we coded touch. In this study we did not directly measure proximity – that is, if an infant was not touching the mother, we did not measure their distance apart. Therefore, there could be a potential effect of proximity, e.g., differences whether an infant was half a meter away versus three meters away, for which we did not control. In addition, due to the nature of the videos, we could not code the velocity of the stroking touch as in previous studies (Ackerley et al., 2014; Croy et al., 2016; Löken et al., 2009; Walker et al., 2017). However, as discussed above there was very little stroking touch observed for any of the dyads, and it has been demonstrated that mothers instinctively stroke their infants at a velocity which is CT-optimal (Croy et al., 2016). Furthermore, while we believe it is important to consider the mechanism behind touch outcomes when choosing a coding scheme, as this theoretical underpinning has been omitted from many touch studies to date (Botero et al., 2020), we prefer to use existing scales wherever possible for ease of comparison with other studies. Therefore, we adapted the Caregiver Infant Touch Scale (CITS; Stack et al., 1996, as cited in Serra et al., 2023), where stroking touch and static touch were in separate categories. However, from a CT-optimal touch standpoint, one criticism of the scale is that it combines stroke, rub, caress, and massage into the same category, when it is understood that massage may involve deep pressure which is not CT-optimal (Brzozowska et al., 2021). However, this limitation also applies somewhat generally to observational studies where force is not measured, given that CTs are known to be activated through low-force static and stroking touch, not deep pressure, and we do not know what force an individual participant uses to stroke or massage their infant (Ali et al., 2023). Furthermore, we were unable to directly test CT afferent activation; however, this is common for many studies in the field, as CTs can be only directly tested through microneurography, a highly invasive procedure where tungsten microelectrodes are inserted into the skin to measure nerve impulses (McGlone et al., 2014). This would be unusual in a sleep study, as ecological validity is a major concern, as well as unethical and dangerous to do with infants who experience involuntary limb movements during sleep due to their relatively undeveloped nervous systems (McKenna et al., 2007; Van Puyvelde et al., 2019). Given these limitations, we cannot demonstrate in this study the involvement of CT afferents when mothers and infants are touching at night, but the idea is plausible and has also been put forth in a study about adult sleep by Van Puyvelde and Mairesse (2022). Therefore, in general, although our study had some limitations, the available videos were adequate to test our specific hypotheses. Beyond what we could practically test, we propose that infants may experience CT activation through touch received when bed-sharing, and that this is a form of affective touch.

Conclusions and Future Directions

It is often assumed, but rarely objectively measured, that infants who bed-share more receive more touch from their mothers. In our study, we quantified the amount and type of night-time touch infants received, and how it related to the time infants spent in different locations, such as the adult bed, sidecar cot/crib, and separate cot/crib. We used a coding scheme which allowed us to measure different types of potentially CT-optimal touch in different infant sleeping arrangements. In line with our first and second hypotheses, infants who spent more time in the adult bed received significantly more touch overall and significantly more static touch. Contrary to our third hypothesis, infants who spent more time in the adult bed did not receive more stroking touch. In the context of affective touch research, we argue that bed-sharing may be an optimal environment for low-force static touch. Given that touch serves a communicative function (Hertenstein, 2002), we suggest that static touch during bed-sharing may communicate a sense of safety to infants, and could therefore be categorized as "affective" (Schirmer et al., 2023) in evoking an affective or emotional response. While previous research demonstrates that gentle stroking touch is CT-optimal, affective touch in an active, daytime context (Ackerley et al., 2014; McGlone et al., 2014), we hypothesize that infants who are in a low state of arousal at night may experience CT activation through low-force static contact during bed-sharing. Separate lines of research have shown that both gentle touch and bed-sharing are correlated with improved physiological regulation in infants (Raghunath et al., 2020; Van Puyvelde et al., 2021), and future research would benefit from combining these lines of enquiry to compare infants' physiological responses and the amount and type of touch they receive, day *and* night.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10919-026-00518-2.

Author Contributions IB - Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing - Original draft, Writing - review & editing; HB - Investigation, Resources, Supervision, Writing - review & editing; MR - Formal analysis, Supervision, Writing - review & editing; SR - Funding acquisition, Formal analysis, Supervision, Validation, Writing - review & editing.

Data Availability The data and code for this study are available on the Open Science Framework (OSF) https://osf.io/awrgv/overview?view_only=155a06217b064ba6948e19d3cc8188ff.

Declarations

Competing Interests Helen Ball serves as Chair of Grants Committee and Member of Scientific Advisory Board for Lullaby Trust (unpaid); Member of Qualifications Board and ad hoc advisor on infant sleep for Unicef UK Baby Friendly Initiative (unpaid). The other authors have no competing interests to declare.

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