IMPLEMENTING A SLEEP INTERVENTION WHILE SUPPORTING MOTHERS' BREASTFEEDING

A thesis submitted in partial fulfilment of the requirements for the

Degree of Master of Arts in Child and Family Psychology

in the University of Canterbury

by M.K. Morley

University of Canterbury

2019

Abstract

Behavioural infant sleep interventions (BSI's) have assisted parents in providing strategies to encourage their infants to sleep through the night without parental involvement for many years. However, recent comment in the literature has suggested they may create a barrier to successful breastfeeding. The purpose of this study is to establish whether breastfeeding mothers of infants above the age of six months can undergo a successful sleep intervention with their infants, without experiencing any risk to their breastfeeding capacity. In addition, the study sought to document mothers' experiences and any perceived challenges they faced with breastfeeding throughout the intervention process.

The study was split into three parts. Part One documented sleep intervention effectiveness and breastfeeding outcomes by way of visual analysis for three infants and their mothers. Part Two of the study sought to combine the quantitatively measured breastfeeding outcomes of mothers from Part One with the intervention and sleep outcomes of mother infant dyads who had participated in a previous sleep study (Akdoğan, 2018). Part Three of the study involved qualitative analysis of interviews about breastfeeding experiences throughout a BSI with all mothers from Part One and five from the Akdoğan study.

All mothers who underwent a BSI managed to continue breastfeeding throughout the entirety of the intervention and most continued for at least two months after, with the exception of two mothers. Ten themes emerged from the qualitative analysis: There were mixed early breastfeeding experiences; breastfeeding patterns prior to the intervention were largely on demand; there were several reasons for night feeding prior to the intervention; mothers reported mixed feelings about stopping breastfeeding overnight; maintaining breastfeeding during the intervention was

predominantly straightforward; outside of some changes in day feeding there were few changes to breastfeeding throughout the intervention; breastfeeding continued until after the end of intervention; reasons for later discontinuing breastfeeding included both parental decisions and child-led weaning; timing of stopping after the intervention varied; and stopping lead to no, or positive effects.

Clinical implications include evidence to assure parents and clinicians that infants sleeping through the night and breastfeeding are not mutually exclusive. Research implications include the need for more objective measures of breast milk intake and research with larger samples and younger babies.

Table of Contents

List of Figures

List of Tables

Abbreviations

AAP: American Academy of Pediatrics

BSI: Behavioural sleep intervention

CSP: Canterbury Sleep Programme

CSS: Composite Sleep Score

DV: Dependent variable

ISD: Infant sleep disturbance

IV: Independent variable

LSP: Longest sleep period

LSRSP: Longest self-regulated sleep period

N-REM: Non-rapid eye movement

NZPS: New Zealand Plunket Society

PERB: Post extinction response burst

REM: Rapid eye movement

SIDS: Sudden infant death syndrome

SOL: Sleep onset latency

WHO: World Health Organization

Acknowledgments

Foremost, I would like to thank my primary supervisor, Karyn France. Your unwavering support and extensive knowledge in the field of infant sleep throughout this process has been invaluable. I would also like to thank my second supervisor, Jacki Henderson for your appreciated contributions to this project and continued encouragement. Likewise, thank you to Neville Blampied, for spending your valuable time assisting me with the visual analysis and offering guidance with the interpretation of its results.

Thank you also to Gökçe Akdoğan for your generous sharing of data, friendship and reassurance during the initial phases of data gathering. I would also like to thank Jenna Van Deurs and Jolene Hunter for your help with the camera set-up.

A big thank you to my family and partner Sam, for your continued encouragement, patience, and help you gave in every possible way. I would not have been able to achieve this without you. Also, a special thanks to Dani for your editing skills, and John for your technology expertise.

Lastly, thank you to the families who offered their time, effort and contribution to the research. It would not have been possible without you.

Implementing a Sleep Intervention While Supporting Mothers' Breastfeeding

Behavioural infant sleep interventions have assisted parents in providing strategies to encourage their infants to sleep through the night without parental involvement for many years. Infant sleep outcomes are heavily influenced by parenting behaviours that occur throughout sleep and the sleep onset period. In particular, infants who receive high levels of parental involvement in order to fall asleep are more likely to have increased incidents of night waking. (Sadeh, Tikotzky, & Scher, 2009). There are a number of empirically supported interventions currently used to decrease night waking in infants such as behavioural techniques including extinction, bed-time fading, scheduled awakening, parental education and medication. Behavioural interventions and parental education aim to reduce or limit parental involvement at night-time in order for the infant to learn to initiate sleep without parental assistance. There is a strong empirical evidence base supporting the efficacy of behavioural interventions for infant sleep disturbance: it remains the most effective, potentially more desirable intervention method for parents. (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006).

Despite their efficacy, McKenna and Ball (2010) argue they create false expectations for parents that their infants should be sleeping through the night before they are ready, and create an unnecessary barrier to successful breastfeeding. Such claims should not go unchallenged. These claims have arisen without consideration of the age of infants receiving interventions. Traditional behavioural interventions to encourage successful sleep for infants are not recommended until six months of age. Six months is a time where breastfeeding is very much stable, and healthy infants have no developmental need to feed throughout the night (France, Henderson, & Hudson, 1996; Kent et al., 2006). This thesis aims to address McKenna and Ball's

concerns by assessing whether breastfeeding continues readily throughout the implementation of infant sleep interventions. A thorough search of the literature surrounding breastfeeding and infant sleep will be undertaken and the findings will be discussed.

Infant Sleep Development

Infants' patterns of sleep and wake periods consolidate throughout their first year of life (Henderson, France, Owens, & Blampied, 2010). As sleep consolidates in the first six months of life, it becomes more prevalent in the nocturnal hours of the 24 hour period (Coons & Guilleminault, 1984). The timing of sleep and wake patterns in infants is regulated by a circadian pacemaker of around 24 hours, which is appropriated by the cycle of light and dark and a homeostatic process. During this process, the need for sleep increases during wakeful hours, and dissolves during hours spent sleeping (Peirano, Algarín, & Uauy, 2003). Evidence of this circadian cycle begins to emerge around the age of five to six weeks, when sleep becomes more concentrated in the hours of the evening and wakefulness becomes more prevalent during the day (Coons & Guilleminault, 1984; Peirano et al., 2003).

Many studies have investigated the sleep cycle of infant sleep and all have indicated that the first year of life sees drastic changes in infant sleep states. The new-born infant sleeps an average of 16 hours per 24 hour period, with sleep and brief wake periods appearing throughout the day and night (Blampied & France, 1993). Infant sleep is characterised by faster cycles of active sleep (rapid eye movement or REM) and quiet sleep (non-rapid eye movement or NREM) than adults. When infants reach around six months of age, the proportion of active sleep diminishes to 25%, similar to that of an adults (Heraghty, Hilliard, Henderson, & Fleming, 2008). Infants are vulnerable to waking more frequently due to the regularity of which REM periods of sleep occur, and because REM periods typically precede arousal in infancy. Subsequently, parental responses to infant waking can result in infants being exposed to positive or negative reinforcement, and begin the initiation of a behaviour trap, where the infant signals upon awakenings to the parent by crying out, the parent

responds and soothes the infant to sleep and the infant fails to learn to reinitiate sleep alone (Blampied & France, 1993). The evidence for this idea will be discussed in further depth later on in this paper.

Infant sleep undergoes many changes across the first year of life. An observational, longitudinal study of infants aged one to twelve months by Henderson et al. (2010) found that the consolidation of self-regulated sleep in infants occurs most rapidly in the first four months of life. Sleep consolidation refers to the infants' capability to sustain continuous sleep for a period of time, which is age appropriate, without completely awakening (Sadeh & Anders, 1993). Research suggests that one month old infants sleep for three to four and a half hours at a time. The biggest increase in sleep happens between one and two months, with infants' averaging of 6.2 hours of continuous, sustained sleep by two months. The lengthening of sustained sleep begins to level out by three months, and between six and 12 months, there is little difference between the average lengths of sustained sleep (between 4.72-6.71 hour) age 12 months (Henderson, France, & Blampied, 2011)

Definitions of Sleeping Through the Night

12am to 5am. To date there have been several definitions of sleeping through the night as defined in the research. One of the most commonly used terms used to define sleeping through the night is a definition proposed in 1957 ((Moore & Ucko, 1957) when infants sleep without waking between 12am and 5am. Pinilla and Birch (1993) also classified infants as sleeping through the night if they did not wake between the hours of 12am and 5am. However this classification has been criticised in the literature for being out-dated as infants have the behavioural and physiological capability of sleeping for longer than 5 hours from 2 months of age (Henderson, France and Blampied, 2010).

10pm to 6am. Two further definitions for sleeping through the night Henderson et al. (2010) were investigated. The first was sleeping uninterrupted for eight hours, and the second criterion was between the hours of 10pm and 6am. Both of these criteria, together with Moore and Ucko's 5 hour definition found that most infants met the eight-hour criterion (and Moore and Ucko's criteria) of sleeping without waking between the hours of 12am and 5am by two months of age. Of these infants, 50% managed to reach the family-congruent, 10pm to 6am criterion at age five months. In summary, the research suggests that even young infants have the capability of sleeping for prolonged periods of time during night hours.

Definitions of Infant Sleep

The assertion that infants 'sleep through' the night, is a misnomer and parents typically assume that their baby should sleep through without any awakenings. Infants who can be classified as good sleepers do not necessarily sleep through the night without waking. Rather, they have the ability to reinitiate sleep without signalling to their parents for assistance in sleep resumption. Research by Minde et al. (1993) found in their study of 12-30 month old infants that infants whose parents considered them 'good sleepers' woke as often as infants whose parents considered their infants to be 'poor sleepers.' The difference between the two groups lay within their ability to resettle themselves. Infants in the good sleepers group were able to resettle themselves after waking in the night without disturbing anyone in the household. Whereas, those in the poor sleepers group did not appear to have that capability.

Longest self-regulated sleep period. The literature describes several definitions of infant sleep. One such definition is the longest self-regulated sleep period (LSRSP). The LSRSP is defined as the longest period of sleep, quiet wakefulness and resumption of sleep during the night that the infant sustains

independently without signalling to parents (Henderson et al., 2010). Essentially it describes the infant's behavioural capacity to maintain sleep without the involvement of parents to help soothe the infant and reinitiate sleep upon awakening.

Longest sleep period. Another definition of infant sleep that has been widely used throughout the years is the longest sleep period (LSP). This definition describes the longest period of sleep that the infant undergoes in a night, without waking.

Self-soothing. The majority of infants wake during the night, often without parental knowledge. The difference between good sleepers and those who are more problematic lies within the ability to reinitiate sleep without parental involvement. This ability is referred to in the literature as 'self-soothing'. In order for infants who sleep autonomously to develop healthy sleep and wakefulness patterns, self-soothing abilities are paramount. Self-soothing is the ability for infants to settle themselves from states of arousal without the involvement of parents. For example, an infant who at bedtime regularly gets put in their cot awake and takes themselves to sleep without the presence of their parent, then more often than not resettles themselves upon night awakenings without signalling to their parent would be considered to have good self-soothing capabilities. Much research around infant sleep has suggested that infants exposed to high levels of parenting behaviours at bedtime do not learn to develop self-soothing capabilities and wake more frequently than effective self-soothers (Sadeh, Tikotzky, et al., 2009). Consequently, when these infants wake in the night they require the assistance of parents to return to the sleep state.

Infant sleep disturbance (ISD). Sleep disturbance in infancy is not recognised until the infant is six months of age (France, Blampied, & Henderson, 2003). ISD is defined by a delay in sleep onset, night waking with infant crying and undesired co-sleeping (Blampied & France, 1993). Essentially, infants who do not

possess the ability to return to sleep unaided upon night awakenings are classified as having ISD. Infant sleep problems are prevalent in 20-30% of infants and toddlers (Twomey, 2016) and are one of the most prevailing complaints paediatricians receive from parents. Because sleep is a bio-behavioural mechanism (Blampied & France, 1993), a number of factors can influence infant sleep development. These factors include sex of the child, prematurity, temperament, parental income and behaviours, parent-infant bedtime interactions and co-sleeping (Sadeh, Tikotzky, et al., 2009; Touchette et al., 2005). Frequent night signalling in infants illustrates an absence of self-soothing and sleep consolidation. When significant enough, such disruptions in sleep can cause immense disruptions to family life and routines, at its best leading to exhaustion to all parties involved and in some cases has been associated with depressive symptoms in mothers (Dennis & Ross, 2005).

There are numerous factors that influence sleep disturbance in infants. Perpetuating and precipitating factors associated with sleep onset delay and night waking in infancy have been described by Mindell et al. (2006) as intrinsic factors (such as medical problems and temperament) and extrinsic factors (such as physical environment and parent factors). Research has also defined ISD as being predicted by many variables such as breastfeeding, infants receiving a bottle during the night, sleeping in the same room as parents, the child being moved into the parents room upon awakening and having inconsistent bed routines (Sadeh, Mindell, Luedtke, & Wiegand, 2009). Parental involvement at initial sleep onset and during night waking in infancy is one of the most common factors associated with ISD, and is often a target for reduction during behavioural sleep interventions.

Parental Involvement at Sleep Onset

High levels of parental involvement at bedtime are known to be associated with poorer infant sleep outcomes. A literature review by Sadeh, Tikotzky, et al. (2009) found that increased parental involvement at bedtime was associated with more fragmented infant sleep. However, they also noted that this relationship was dynamic and bidirectional, so that poorer infant sleep may also influence the increased parental behaviours. The high levels of parental behaviours at bedtime likely impair an infant's ability to develop adequate self-soothing abilities, reinforcing the need for parental involvement and creating a behavioural trap that the parents and infant fall victim to. Recent studies provide further support for Sadeh, Tikotzky, et al. Mindell, Du Mond, Tanenbaum, and Gunn (2012) and Ramamurthy et al. (2012) both found that parental presence at infant sleep onset was a significant factor in infant sleep outcomes.

Parental presence at bedtime is a well-researched phenomenon in the area of infant sleep. An intervention study by Burnham, Goodlin-Jones, Gaylor, and Anders (2002) of 80 independently sleeping infants found that three variables explained 40% of the variance associated with self-soothing at 12 months of age. This study found that at one month, infants self-soothed and went back to sleep following 27.6% of night awakenings. This increased to 46.4% of awakenings when they reached 12 months of age. The results reported that those infants who spent progressively less time out of their cots, those who started life with greater quantities of quiet sleep and those whose parents waited longer to respond to their infants when they woke in the night were more likely to engage in self soothing by 12 months old. Thus, it would appear that high parental involvement during bedtime routines might result in infants

not effectively learning self-soothing techniques. Consequently, this results in an inability to return to sleep upon night awakenings without parental assistance.

Similarly, St James-Roberts, Roberts, Hovish, and Owen (2015) found in their study of 101 infants assessed at five weeks and three months, that infants had the ability to resettle themselves to sleep within the first three months. Additionally, they found that settling without parental intervention and prolonged periods of sleep were involved in infants becoming settled during the night for that period.

Behavioural sleep interventions (BSI)

Many BSI have proven empirically successful for encouraging infants to sleep for longer periods during night hours. These findings are particularly important because sleep problems can be precursors to a number of psychological difficulties in both infants and parents. Infant sleep problems are often antecedents to disrupted childhood sleep patterns, which have been suggested to be correlated with difficult temperament, behaviour problems and psychopathological development (Sadeh, 2005). Additionally Simard, Chevalier, and Bédard (2017) found that sleep problems are associated with child attachment resistance. For that reason it is effortless to see why infant sleep interventions have been a relevant and successful area of research.

There are a number of different interventions available for improving infant sleep. Most interventions used currently employ educational and behavioural strategies to implement the intervention. Through these strategies, a number of techniques are commonly used including the use of extinction, bedtime fading and education around ways to improve infant sleep.

Generally sleep interventions have been focused on children aged six months or older. This is likely because sleep disturbance in early infancy is expected by parents and not seen as problematic. In addition, sleep interventions may disrupt the

feeding practices of infants prior to six months of age (Galland & Mitchell, 2010). There is also a lack of information in the literature surrounding the effectiveness of interventions for young neonates. Many behavioural interventions implemented prior to six months have been piloted on infants six months and older and then applied to younger infants and do not always prove effective. However, preventative strategies parents can employ to encourage self-regulated sleep in early infancy are used commonly as a means to prevent ISD. Preventative strategies routinely employed involve educating parents about how to encourage their infants to self-settle and gradually lengthening the time between when the infant wakes during the night to when they are fed and ensuring there is minimal stimulation at night-time. Once sleep disturbance is prevalent and infants are around the age of six months, the most effective interventions reported in the literature are behavioural extinction methods, which will be discussed below.

Interventions prior to six months. It is typically not common practice to implement behavioural sleep interventions during the first six months of life due to risk of secondary unintended outcomes such as early breastfeeding cessation, increased problematic crying and maternal anxiety (Douglas & Hill, 2013). Additionally, infants below six months may have a developmental need to feed at night to ensure high enough levels of nutrition. Sleep interventions prior to six months have been criticised because breastfeeding capacity may be most vulnerable during this time. In early infancy, most infants feed every few hours in order for the mother's milk supply to become well established. Literature suggests a correlation between breastfeeding and disrupted infant sleep and there has been suggestion that breastfed infant's wake more frequently than formula feed infants because breast milk is faster to digest than formula (Mindell et al., 2012; Ramamurthy et al., 2012). For this

reason, breastfed infants may need to wake and feed more frequently throughout the night than their formula fed counterparts. Douglas and Hill (2013) also proposed that during early infancy, many sleep related disturbances are likely due to unidentified and ineffectively managed feeding problems, and early sleep interventions could increase the risk of early cessation of breastfeeding, which would deny infants of important nutritional needs. In addition, they reported that if the young infant slept in a room separate to their parents in the first few months of life it could increase the risk for Sudden Infant Death Syndrome (SIDS).

From a developmental perspective sleep undergoes rapid change in the early months of infancy. Six months is a typical starting point for implementing BSI because prior to that, the sleep cycle is still maturing. Additionally, their wakings are not considered problematic in the first six months of life because of the on-going physiological changes (Field, 2017). Frequent waking during infancy is considered normal due to the lengthening of sleep cycles and establishment of diurnal rhythm. However, once infants are six months, the majority can sustain sleep for a minimum of eight hours. The systematic review of behavioural sleep interventions in the first six months by Douglas and Hill conducted a review of BSI that consisted studies including infants younger than 6 month of age. Their concern was that the interventions they had reviewed were appraised in populations of infant six months or older, then subsequently recommended they were applied to infants prior to six months without accounting for the neurodevelopmental differences between these age ranges. Overall, these authors found that behavioural interventions for infants prior to six months of age did not decrease infant crying, prevent behavioural or sleep problems in later childhood or act as a protective factor against postnatal depression in mothers. Douglas and Hill's concluded that behavioural management interventions

prior to six months of life are not optimal, nor effective in improving infant sleep patterns.

There are, however, prevention intervention studies that focus on ways to reduce the risk of the development of ISD. Preventative interventions typically focus on parental education around infant sleep patterns and ways to encourage good infant sleep hygiene. Crichton and Symon (2016) reviewed 11 studies that analysed infant sleep outcomes following preventative interventions. Of these studies, they found that eight reported positive results in behavioural management of sleep problems for infants under the age of six months, and improvement of both maternal and family outcomes. The studies in this review varied in subject age where behavioural management strategies were implemented. They ranged from the prenatal period, to just prior to six months of age. Interestingly, the advice given across the interventions differed immensely. The authors separated the types of recommendations given into three groups: focus on self-settling (minimal responding); focus on consistent responding (responding to all infant cues); and maternal focus (strategies centred on maternal behaviours such as sleep hygiene and relaxation). Unsurprisingly, the authors found that behavioural interventions with a focus on encouraging self-settling behaviours showed the most positive effects in improving infant sleep. The study that gave advice to respond to all infant cues showed no improvement in infant sleep and the maternal focus studies had inconsistent findings. The authors reported no harmful effects of the implementation of behavioural preventative interventions in early infancy. The interventions described were not extinction-based methods, however, some of the studies did provide parents with recommendations such as gradually lengthening time between feeds and keeping night-time responding to a minimum when infants woke.

As can be seen, the literature tends to support prevention methods rather than extinction based interventions to assist with healthy infant sleep development prior to six months of age in order to minimise potential harm. There also appears to be far fewer studies that focus specifically on behavioural interventions for infants under six months than there are for those six months and above. This is likely to be the reason many clinicians who specialise in behavioural interventions for ISD do not recommend intervening with infant sleep until six months of age. Prevention methods (such as putting infants to bed when they are awake and keeping night-time responding to a minimum) appear to be an effective and low risk way of reducing problematic sleep in early infancy. Based on the literature described above it would appear clinicians dealing with disrupted infant sleep would be best to recommend preventative methods prior to six months of age. If it continues into the sixth month of life, they could consider implementing extinction based interventions which have proven to be successful in infants over this age.

Commonly used interventions. Behavioural sleep interventions are common practice for infants over the age of six months and have consistently reported positive effects. A review of the evidence of behavioural sleep interventions by Mindell et al. (2006) found that these studies described improved well-being of parents that was outside the impact of the precise benefits in sleep arrangements in children. Across the studies reviewed, they found many benefits reported including improved parent mental health, fewer depressive symptoms, increase in efficacy of parenting, more marital satisfaction and a reduction in parenting stress. These results were reported to be consistent across studies. Benefits were also noted specific to the babies. Infants were found to be more predictable, secure (as measured by the Flint Infant Security Scale), to fuss less, and be less irritable following behavioural interventions.

More positive findings were reported in a randomised controlled trial, conducted by Price, Wake, Ukoumunne, and Hiscock (2012). They concluded that behavioural sleep interventions could improve infant sleep problems and reduce symptoms of maternal depression in the short to medium term. In addition, they found that at the five-year follow up there were no negative effects for infants' emotional development or mental health. Based on these results the authors determined that behavioural sleep interventions are therefore safe to implement. However, these results also established that the five year follow up showed no long lasting benefits to the child, although sleep improved in the short and medium term. These results, pertaining to long-term durability of intervention benefits were also replicated by Mindell et al. (2006), who found that although improvements described by the majority of the studies were present until six months post intervention, they decreased as time went on. Regardless, it would appear that the literature suggests a wealth of interventions that can safely be implemented for improving infant sleep and at least in the short to medium term improve maternal mental health.

Extinction methods. The majority of sleep interventions for parents are behaviourally based and include psychoeducation around infant sleep, behaviour traps and the importance of clear bed-time routines. The most commonly used methods of intervention for infants are extinction based techniques. These aim at reducing parental responses to night waking, in order for the infant to learn to settle themselves back to sleep without parental involvement. Genuine extinction programmes will see parents place their infant in bed awake at a designated bed-time, bid the baby good night and leave the room. The parent is instructed to not respond to their child's signals unless they are in danger or sick. In that case, parents are told to stop the intervention until the danger or illness has passed. Although extinction interventions

see an increase in infant crying and target behaviour initially, (referred to in the literature as the post-extinction response burst or PERB) after three days the worst of the crying is generally over and infants tend to learn to self-settle very quickly (France et al., 1996). As a result parents see improvements in their infants' sleep rapidly. Although true extinction methods have a wealth of empirical evidence supporting their effectiveness and lack of harm, they have also attracted criticisms due to the initial increase in crying.

Extinction based interventions have empirical evidence to validate their effectiveness that dates back as far as the late 1950's. Williams (1959) first applied extinction methods in a single subject case study to eliminate bed-time tantrum behaviour in a 21 month old. After the conclusion of the extinction procedure, the tantrum behaviour was reported to be eliminated for the next two years. Since then, numerous studies have reported on the effectiveness of extinction methods for treating other bed-time problems such as frequent night waking and delayed sleep onset. Mindell (1999) conducted a review of the literature of every treatment study that reported on the effectiveness of extinction-based methods in children under five. This review included eight studies of varying experimental designs that used a true extinction treatment in ISD. The author concluded that extinction programmes could be considered well-established with sound empirical evidence. However they did have concerns regarding parents' willingness to follow an extinction programme because of the need to ignore their children's cries.

Graduated extinction. Graduated extinction, also referred to as minimal check, is another method of improving infant sleep that arose as a slightly gentler approach than true extinction. It requires careful analysis of how much time parents spend tending to their infant during each night waking prior to initiating the

intervention. Once the time parents spend tending to their infants has been established, it begins to be systematically reduced every four nights by one seventh, until the parents are no longer attending to their infants night wakings. Parents are instructed to leave the room once the established time is up and to not attend to the infant until the next waking. France et al. (1996) suggest this method is only appropriate for committed and well-organised parents because of the extended intervention length. Hall, Saunders, Clauson, Carty, and Janssen (2006) piloted a graduated extinction intervention with 39 six to 10.5 month old infants and their parents. All infant subjects had identified sleep problems. Parents underwent a two hour long pscyhoeducation session surrounding infant sleep. Following the intervention period they found a significant increase in the average length of longest sleep period identified by both sleep diaries and actigraphy. In addition, they found a significant decrease in the amount of night wakings and duration of total infant crying as reported by the actigraphy and diaries. The parental report diaries also reported a significant decrease in infant crying during the night. To ensure the changes were stable, actigraphy and sleep diary data was collected at six and 16 weeks following the intervention. These data collection points revealed that the changes in LSP duration, night crying and number and duration of night crying episodes were stable between the six and 16 week follow ups. In addition the changes in the length and duration of diary and actigraph reported wakes were not significantly different during this period. Overall, the authors commented that most infants displayed an improvement in sleep as demonstrated by the increase in LSP. Also of importance, they reported that parents of the infants found the intervention helpful and effective.

Parental presence. There are some circumstances where true extinction methods may not be appropriate. For example, some parents feel unable to leave their

infants crying alone for extended periods of time and would not be able to effectively implement the programme. In other situations, parents with a sleep-disturbed infant may wish to continue co-sleeping with them. Extinction programmes would not be suitable for either of these situations. In these circumstances, France et al. (1996) suggest utilising another commonly used intervention method, parental presence. The parental presence procedure is similar to extinction methods, however rather than leaving the infant alone in the room once they have been bid goodnight, the parent sleeps in their own bed in the infants' room. Like with extinction, parents are instructed to not respond to infants crying (unless they are ill or in danger) and instead feign sleep. This method allows parents to continue sleeping in the infants' room if that is their desire and also decreases infant crying. Once the infant has learned to self-soothe and stops signalling for parental intervention during awakenings, the parents can go back to sleeping in their own room, should they wish.

Numerous studies have reported on the effectiveness of parental presence since its development. A randomised control trial by Hiscock et al. (2007) of 328 seven month old infants with sleep problems and their mothers found that infants in the parental presence or graduated extinction groups had lower prevalence rates of sleep problems than the control group following the intervention period. In addition they found an improvement in maternal mental health in both intervention groups than the control.

Some researchers have also investigated the effects of combining parental presence and graduated extinction on improving infant sleep. Matthey and Črnčec (2012) researched the effectiveness of parental presence alongside systematic ignoring in comparison to systematic ignoring with minimal check in their study of 16 six to 18 month old infants. They found that at the follow up period five to six months

after the intervention finished; almost all families reported a decrease in ISD as well as an improvement in parental mood. They also reported no noticeable disruption in their infant's emotional health. Subsequently, the authors concluded that parental presence with systematic ignoring and minimal check was as effective for reducing infant sleep problems as systematic ignoring and minimal check alone. Of contrasting results however, France and Blampied (2005) found in their multiple baseline study of 15 infants aged six to 15 months, that although systematic ignoring, systematic ignoring with minimal check and systematic ignoring with parental presence all lead to a decrease in night waking, infants in the systematic ignoring with minimal check woke more in the night and spent more time crying than infants in the other groups. The authors determined that the parental presence programme is most preferable as a gentle approach to combatting ISD, due to the decrease in likelihood of the PERB occurring, less crying and a more robust and marked improvement in infant sleep.

Evidence for effectiveness

Behavioural interventions in general have a wealth of empirical evidence supporting the effectiveness and efficacy of treatment. Mindell et al. (2006) reviewed 52 studies that reported the efficacy of differing behavioural interventions including (but not limited to) unmodified extinction methods, graduated extinction, and extinction with parental presence. The authors included studies that involved children between the ages of zero and four years, eleven months, with behaviourally based sleep problems that had no known developmental disabilities. In their study, they found that 17 of 19 separate research studies on extinction methods reported highly effective results in removing bedtime problems, eliminating night wakings and increasing continuity of sleep. In addition, they found 14 studies that all reported on the effects of graduated extinction methods. All of which were found to report

positive outcomes of treatment that saw reductions in the number of night wakings and bed-time problems. At the time of the review, Parental Presence was a more recent method and therefore had less empirical evidence to support it. However the authors still found that all of the four studies they found that analysed the effects of parental presence produced effective results.

A more recent meta-analysis by Meltzer and Mindell (2014) confirmed the effectiveness of behavioural sleep interventions in improving sleep disturbance in young children (birth to five years). Specifically, they found that four studies displayed significant improvements in sleep-onset latency (small to medium effect size, [$Z = 4.06$, $p < .001$; standard mean deviation = 0.33]) for post treatment, general reductions in night-waking frequency in seven studies with an overall, significant effect with small to medium effect size ($Z = 5.99$, $p < .001$; standard mean deviation = 0.40) and duration of night waking was included in four studies where they found a significant overall effect with a small to medium effect size ($Z = 5.50$, $p < .001$; standard mean deviation = 0.44).

For convenience purposes, behavioural interventions have also become available over the internet to help parents manage ISD cost effectively, and have been shown to be impactful (Field, 2017). Mindell et al. (2011) implemented internet based interventions for parents of 6-36 month old infants with sleep problems. The study cohort consisted of 264 parent infant dyads and saw them split into three groups: 1) internet based intervention alone; 2) internet based intervention plus prescribed bed-time routine; or control. The groups that included internet intervention were provided with advice to improve their infants sleep such as implementing a bedtime routine, increasing their infants sleep time, decreasing or stopping night-time feedings, moving the child from the parental bed to the crib and more behavioural

recommendations. The authors concluded that internet based interventions were an effective tool to improve infant sleep after the results showed children in the intervention groups displayed overall reduction in sleep-onset latency and number of night wakings and increased night-time sleep.

As can be seen, literature surrounding the effectiveness of sleep interventions is rich. However, very little research has looked specifically at the effects of sleep interventions on breastfeeding. There have been suggestions in the literature that the implementation of sleep interventions for infants have also resulted in undesirable, unintentional outcomes such as increased infant crying and maternal anxiety. The criticism that this study is concerned with is one that has suggested sleep interventions create barriers to breastfeeding potentially leading to its early cessation (McKenna & Ball, 2010). The next chapter will briefly touch on the physiology of breastfeeding, describe breastfeeding rates and prevalence in New Zealand and discuss the literature currently available on infant sleep and breastfeeding.

Breastfeeding

Physiology of Breastfeeding

A detailed description of the physiological components of breastfeeding is beyond the scope of this psychological research study, however a basic understanding is outlined below for contextual purposes. Infant and national health organisations clearly state that breast milk is the optimal choice of feeding method for infants less than six months (New Zealand Ministry of Health, 2016; World Health Organization & UNICEF, 2003). For these infants, human breast milk provides infants with the only form of nutrients necessary for optimal growth and development. Breast milk is comprised of nitrogenous components, fats, minerals, vitamins, waters, electrolytes and trace elements (Jensen, 1995) which are necessary for healthy infant development.

There are two stages of breastfeeding that undergo significant changes in milk composition before established lactation commences, lactogenesis I and lactogenesis II (Kent, 2007). Lactogenesis I prepares the mammary glands for lactation during the second trimester of pregnancy, while lactogenesis II occurs around 32-40 hours postpartum and results in an increase in milk volume (Kulski & Hartmann, 1981). Lactation becomes established when infants reach around one month of age, and from then until six months, milk production stays relatively stable. Butte and King (2005) cite evidence from a review by the World Health Organization (WHO) Programme of Nutrition (1998) that deposits that most exclusively breastfeeding women in developed countries produce between 710 and 787 grams of breast milk per day from one to five months and 640 and 687 grams for partially breastfed infants. This production decreases to 592 grams produced for partially breastfeeding mothers of six to eight month olds, and decreases again to 436 grams for 9-11 month olds.

Interestingly the authors reported that milk production increases to 448 grams for partially breastfed infants aged 12-23 months. Research by the WHO Programme of Nutrition (1998) also reported that mothers breast milk supply was finely tuned into infant demand for feeding so that when infant demand increased, so does milk supply.

Research suggests breast milk consumption varies significantly from infant to infant and consumption begins to decrease with the introduction of solids and other complementary foods. Kent et al. (2006) discovered there was much variation in the time between breastfeeds, and the amount infants aged one to six months were feeding. A study by Neville et al. (1991) of breastfeeding mothers found that as solids and complementary foods were introduce to the infant's diet after six months of age, breast milk output began to decrease. However, mothers who intended to continue breastfeeding until their infant was at least 1– 2 years continued to produce more breast milk than mothers who intended to gradually wean their infants. Noteworthy is the fact that this study found that only more than one breastfeed per day seemed necessary for the mother to be able to maintain milk production. Given that milk production stabilises at one month and one feed per day is enough to maintain breastfeeding; one would assume breastfeeding infants undergoing a sleep intervention at six months would cause no interruption to the mothers' breastfeeding capability, so long as they continue to feed throughout the day.

Importance of Breastfeeding

The protective effects of breastfeeding infants are well documented in the literature. Evidence suggests the greatest protection against infectious illnesses in infants are seen in those who are exclusively breastfed until at least three months (Heinig, 2001). Furthermore, breastfeeding is thought to be protective against persistent diseases, such as some paediatric cancer, diabetes, paediatric obesity and

atopic disease (Davis, 2001; Oddy & Peat, 2003; Woo & Martin, 2015). Breastfeeding is known to have beneficial health factors for infants, including enhanced cognitive development in childhood (Kramer et al., 2008), especially if it continues for longer than six months. Currently, recommendations by the New Zealand Ministry of Health for breastfeeding differ from those of the WHO. The New Zealand Ministry of Health recommends that mothers breastfeed their infants exclusively until around six months of age, and continue to breastfeed as a supplement to solid foods until at least one year (New Zealand Ministry of Health, 2016). Interestingly this differs slightly from The American Academy of Pediatrics, guidelines which recommend mothers breastfeed their infants exclusively until six months of age and continue to breastfeed as a supplement to solid foods until one year or longer as reciprocally preferred by mother and infant. In addition, differences can be seen in the recommendations provided by proposed Global Strategy on Infant and Young Child Feeding (World Health Organization & UNICEF, 2003), which suggest that mother's should exclusively breastfeed until at least six months of age and continue to breastfeed with the added supplement of safe foods until at least the age of two.

It is common knowledge that breastfeeding is a safe and often-preferred method of feeding for many mothers due to its health benefits for both mother and infant. However, despite this knowledge and these recommendations, many mothers are not adhering to these guidelines. According to the New Zealand Plunket Society (NZPS), 66% of mothers were either breastfeeding their infants exclusively, partially or fully at fourteen weeks to seven months of age in 2015. Only 18% of mothers reported exclusively breastfeeding for that time period (New Zealand Plunket Society, 2017). Unfortunately the report did not give breastfeeding statistics specific to each

month, nor did it report on breastfeeding rates after seven months. The report advises NZPS sees roughly 90% of New Zealand mothers and babies at birth, giving a reasonable estimate of breastfeeding practices in New Zealand. An article by Castro et al. (2017) in the New Zealand Medical Association Journal provided more detailed breastfeeding data that was gathered within the New Zealand contemporary child cohort study. The authors described the necessity for more representative breastfeeding data to be gathered owing to the fact that Māori and Pacific mothers are under reported in Plunket reports. They reported that at age six months, 65.6% of infants are breastfed infants in New Zealand are still breastfed. This drops to 36.6% by one year and 12.5% by two. The exclusive breastfeeding rates reported in this article were 53.4% at four months, and 15.7% at six months. The National Immunization Survey by the Centers for Disease Control and Prevention (2014) in America showed an estimation of slightly higher rates of exclusive breastfeeding at six months than the New Zealand, but slightly lower breastfeeding duration rates overall. In 2014 they reported an estimate of 24.9% of children being breastfed exclusively until six months, and 33.7% of children still being breastfed at one year. This number had dropped to 15.5% of infants still breastfeeding at 18 months.

Although breastfeeding rates are currently improving in western cultures they are still not as high as health organisations would like. There are many reasons women stop breastfeeding earlier than recommended. Hauck, Fenwick, Dhaliwal, and Butt (2011) suggest that young and unmarried mothers are generally more likely to stop breastfeeding early. Additionally, they suggested that early cessation of breastfeeding occurs for reasons including unrealistic expectations and physical concerns in regards to breastfeeding. Other research suggested mothers wanted the option for other people to feed their baby or to leave them for periods of time

(Kirkland & Fein, 2003). Subsequently, while the WHO recommends that mothers should exclusively breastfeed until their infants are six months, the reality is that many mothers do not. Exclusive breastfeeding is defined as the infant having consumed nothing except breast milk and prescribed medicines (New Zealand Plunket Society, 2017). While the importance of exclusive breastfeeding in non-developed countries is obvious (where there may not be access to clean water) in developed countries with clean and safe drinking water one wonders how important true exclusive breastfeeding is, so long as infants are continuing to breastfeed.

There are many reasons mothers stop breastfeeding early. Sometimes it can be due to a lack of support and knowledge about breastfeeding (Hauck et al., 2011) and at other times it could be due to lack of confidence or perceptions that their milk is insufficient. There are also cases where mothers for various reasons are not physiologically capable of breastfeeding. Additionally, there is evidence to suggest maternal, social and psychological problems may contribute to early cessation of breastfeeding (Kirkland & Fein, 2003). The evidence clearly demonstrates weaning from breastfeeding can be due to a number of factors. However, thus far no studies have evidence to suggest that sleep interventions have resulted in early weaning. These factors must all be taken into consideration when assessing the effects sleep interventions have on breastfeeding. There is evidently a need for research to specifically investigate the effects of sleep interventions on breastfeeding.

Breastfeeding and Infant Sleep

As the breastfeeding rates in western societies begin to grow again, so has literature around the relationship between infant sleep development and breastfeeding. That there is a relationship between infant sleep and breastfeeding is undeniable, however, thus far published research has been unable to reach consensus about what

the relationship is. Most research agrees that breastfeeding infants wake more frequently than their non-breastfed counterparts. Others have discussed apprehensions that current sleep research is out-dated due to a lack of acknowledgement of feeding method in sleep studies, and focusing primarily on infants sleeping in a separate bed and room to their parents. Ball (2014) expressed concern that professionals who promote the notion of infants sleeping through the night at a young age, undermine the promotion of breastfeeding and create false expectations about infant sleep. Despite that, Pinilla and Birch (1993) empirically demonstrated that breastfed infants do in fact have the capability to sleep through the night from as young as two months.

Theories of breastfeeding and disrupted infant sleep. There are two common notions that appear in the literature surrounding the relationship between disrupted infant sleep and breastfeeding. The first of which asserts that more frequent night waking in infancy is due to breast milk being more easily digestible in nature than formula (Ball, 2003). Consequently, this theory suggests that breastfed infants require feeding at more regular intervals than those who are fed by formula. However, the accuracy of those claims is so far questionable. Some research has provided evidence that breastfed infants do in fact have the ability to sleep through the night (using the 12am to 5am criteria) from as young as eight weeks of age (Pinilla & Birch, 1993) with behavioural intervention. In addition, research by Clarke (2014) found that breastfed infants between the ages of three and 12 months did in fact wake more often than their non-breastfed counterparts. However, this did not hold true for infants under three months. In fact, breastfed infants woke less frequently than non-breastfed infants during the first three months. These findings may provide more support for the second theory surrounding the relationship between breastfeeding and

infant sleep, which proposes that frequent night waking is mediated by parental interaction.

The second theory that seeks to clarify the relationship of disrupted infant sleep and breastfeeding seems more likely to explain why breastfed infants wake more frequently than their formula fed counterparts. This theory postulates that it is not the breastfeeding per se that insights the infant to wake more, but the parental interaction that infants receive from the mother as a response to the waking. Sadeh, Tikotzky, et al. (2009) suggest that although breastfeeding through the night in early infancy may be to satisfy their hunger, as the infant grows older and does not need to feed during the night the parents may mistake their continued waking for hunger. Consequently, the parents continue to respond to their child's signalling by feeding them and the infants fail to self-soothe and reinitiate sleep alone. In turn, this creates a behavioural trap where the infant signals, the parent responds by feeding, and the infant does not get the opportunity to initiate sleep alone.

There is also recent literature that may provide evidence supporting both of these theories of breastfeeding and infant sleep. Some studies have suggested that while breastfed infants wake frequently initially because of the easily digestible nature of breast milk, it is actually the parental interaction involved in breastfeeding that results in infants continuing to wake. A cross sectional study of 0-11 month old infants in the Asia-Pacific region by Ramamurthy et al. (2012) found that breastfed infants woke more frequently, for longer durations and had less consolidated sleep than infants who were not breastfed. However, they also found that of the infants who were breastfed, those who were breastfed back to sleep woke more frequently during the night and had a shorter LSP than those who were not fed to sleep. Similarly, a longitudinal study of infants by Mindell et al. (2012) found that breastfed infants

(mean age 6.92 months) at the baseline period had increased night waking's compared to non-breastfed infants (mean age 7.39 months). Difference in night wakings had disappeared by their nine month follow up period, suggesting that sleep disruptions impacted by breastfeeding may dissipate over time.

Some research has suggested that increased night waking of breastfed infants is not due to the breastfeeding itself, but rather the maternal involvement that irrefutably comes with it. Given that parental presence at bed-time interrupts an infant's ability to effectively self-soothe, it would be easy to accept that breastfeeding infants to sleep would also have this impact. Research by Touchette et al. (2005) found that at five months, parental behaviours after night time awakenings were the most significant factors associated with sleeping less than six hours in a row. Of most significant interest was the risk of an infant being a problematic sleeper was 2.6 times higher if they were fed to sleep by breast or bottle. This shows that although initially breastfeeding may increase the likelihood of more waking throughout the night, it is actually the interaction with the mother that sustains the night waking behaviour.

Breast milk contains numerous diverse components, some of which are important in the function of sleep homeostasis (Sánchez et al., 2009). Many mothers will breastfeed their infants back to sleep following a night waking, interrupting an infant's ability to reinitiate sleep alone. As breastfeeding requires parental involvement, it likely inadvertently interrupts the infant sleep cycle by encouraging them to signal to the mother to reinitiate sleep. Knowing this, it is easy to see why infants who are breastfed to sleep would have more episodes of problematic night waking than their non-breastfed counterparts.

Breastfeeding as a Sleep Onset Function

Breastfeeding serves as a source of comfort for many infants (Ball, 2003) so it is easy to see why infants may come to rely on breastfeeding to reinitiate sleep if they have not yet learned to self-soothe. In contrast to previous research, recent studies have suggested that breastfed and formula fed infants actually wake at the same rate during the night, however breastfed infants feed more. This could suggest that breastfed infants suckle as a source of comfort to reinitiate sleep after they wake.

Once infants are six months there is no developmental need for them to breastfeed during the night (France et al. 1996). At this age they begin to supplement their breastfeeding with other nutritional sources such as complementary or solid foods. Brown and Harries (2015) found in their study of 756 six to12 month old infants those who were breastfed did not wake more frequently than their formula fed equivalents despite being fed more often when they woke during the night. In addition, they found the number of feeds (both breastfeeds and complementary foods) an infant had during the day was negatively associated with more frequent night feeds. This research finding is pertinent for the current study, as it can alleviate parental misconceptions that infants older than six months wake during the night because of a need to feed. As previously mentioned, night waking in infancy is common and not abnormal. Infant sleep is only characterised as being problematic when the infant cannot return to the sleep state without signalling to their parent or caregiver. The research by Brown and Harries (2015) suggests that if infants are fed sufficiently during the day, there should be no need for them to feed when they wake at night. It is likely that infants above six months of age who wake and feed at night do so out of comfort and to reinitiate sleep rather than out of hunger.

Breastfeeding and Sleep Interventions

As described in Chapter One, extinction based sleep interventions for ISD are not implemented until infants are six months of age. This is a time when infants are physiologically capable of sleeping through the night without feeding (France et al., 1996). Despite the undeniable relationship between breastfeeding and infant sleep disturbance, very few studies have investigated the impact sleep interventions have on breastfeeding. There are several research articles that have reported on implementing preventative sleep interventions without jeopardising breastfeeding. Being preventative intervention studies, these were implemented for infants prior to six months of age. Adair, Zuckerman, Bauchner, Philipp, and Levenson (1992) implemented a preventative intervention to reduce infant night-waking in infants. When infants were four months, the intervention groups were given information on sleep-onset associations, asked to complete a sleep diary and involved in a discussion with a paediatrician about infant sleep. This included the paediatrician notifying parents that their infants would soon be physiologically capable of giving up night feedings. At nine months old, infants in the intervention group when compared to the control group were significantly more likely to go to sleep without the presence of a parent in the room (intervention = 21%, control = 33% $p < .05$). In addition they were less likely to wake during the night. However, breastfeeding did not diminish in the intervention group (intervention = 16%, control = 19%, $p = .47$). Similarly, Pinilla and Birch (1993) specifically looked at whether breastfed infants could be taught to sleep through the night (using the 12am to 5am criteria) by eight weeks of age by instructing parents of the intervention group to gradually lengthen the time that infants were fed when they woke during the night. Instead of feeding the infant

straight away when they woke, parents were instructed to engage in other parenting behaviours such as patting, swaddling and walking with them, and only to feed them if these options had been exhausted. They found that by the end of the eight-week intervention period, all infants in the intervention group were sleeping through the night, compared to 23% of the infants in the control group. Of particular relevance, they found no difference in daily milk intake between the treatment and control group. Intervention infants were found to make up for the lack of feeding throughout the night by consuming more milk as soon as they woke in the morning. The authors suggested that their findings provided evidence that continued lactation could in fact be compatible with sleep/wake patterns of the mother. Consequently, there is no compelling evidence to suggest that maternal breastfeeding capacities would be affected by an intervention aimed at increasing the amount and quality of sleep in infants aged six months, when infants do not physiologically need to breastfeed at night.

Dream-feeding. There are some rare cases where infants may require feeding through the night even after the age of six months. Meltzer and McLaughlin Crabtree (2015) discuss times where infants may need the option of an overnight feed such as where there are health concerns or a need for the infant to consume more calories because of growth issues. To combat this problem without withholding the option of implementing behavioural treatment for sleep disturbance, the authors suggest implementing a dream feed. They define a dream feed as feeding the infant while he or she is still sleeping. This provides the benefit of the feed, without the reinforcing behaviour that occurs if the infant wakes, cries and the parents respond with feeding. Therefore if parents do not think withholding a feed throughout the entire night is an

option, a dream feed could be a viable way for parents to proceed with behavioural sleep intervention.

In support of the above findings, the review of behavioural treatment of sleep interventions by Mindell et al. (2006) reported that studies they included that did investigate breastfeeding did not report any effect in maintaining breastfeeding or the infants daily total fluid intake. Additionally, research also suggests ways to ensure infants who do need more nutrition can do so through dream feeding while still undergoing sleep interventions. However, despite this evidence available in the literature, there is still unfounded criticism that sleep interventions deny infants a third of their daily nutrient intake and create a barrier to successful lactation (McKenna & Ball, 2010).

Sleep Interventions; A Barrier to Breastfeeding?

So, is there cause for concern based on the available research, that successful infant sleep interventions create a barrier to successful breastfeeding? It appears not. McKenna and Ball's claims that they do, came as a response to a journal published by the American Academy of Paediatrics (AAP), written by Henderson et al. (2010). This research presented prospective, longitudinal data on infant sleep to determine the age at which infants first began to sleep through the night. This was defined by three separate criterion: 12am until 5am; eight hours of uninterrupted sleep; and 10pm until 6am. Their findings revealed that the majority of infants were sleeping through the night by two to three months of age, irrespective of the criterion used. McKenna and Ball's criticisms were voluminous, however they failed to take several factors into consideration. One such criticism was that the feeding method of the infants studied was not identified, and as such overlooked the necessity of "regular night-time suckling" in order for mothers to maintain successful breastfeeding. The second was

that publication of the article underlined a universal problem in the sleep research field; that “solitary sleeping, formula-fed infants are appropriate subjects from which ‘normal’ infant sleep measurements should be derived.” Furthermore it expressed concern about paediatricians relying on articles published in the AAP (such as that of Henderson et al. (2010) and consequently giving advice to women that undermines the increase in breastfeeding rates. The third criticism pertained to the safety of infants McKenna and Ball believed would be at risk of experiencing self-soothing before they were ready. This is a risk they associated with an inability for infants to defend themselves against SIDS, cardiac perturbations or fatal breathing. Among these criticisms, McKenna and Ball failed to take into account the positive effects that sleep interventions can have on family and infant functioning. It should be noted here that the study by Henderson et al. was a descriptive one, concerned with reporting developmental phenomenon in the development of infant sleep and not concerned with sleep management interventions. Also of noted importance, McKenna and Ball, did not consider the age at which infant sleep interventions are implemented. As previously stated, breastfeeding becomes consolidated by one month of age and infant sleep interventions are not typically recommended until six months. McKenna and Ball’s claims, while they may have come from a place of good intention have overlooked some critical factors.

McKenna and Ball proposed that encouraging infants to sleep through the night denies infants a third of their daily nutrient intake. Based on aforementioned analysis of this research, this is an unreasonable claim. By the time infants are of an age where sleep interventions are an appropriate way of managing sleep (six months), breastfeeding has become stable. In addition, typically developing infants have no developmental need for feeding throughout the night. By this age, the New Zealand

Ministry of Health (2008) recommends that parents should begin to introduce other forms of nutrients to their infants' diets. While it is still recommended that mothers continue breastfeeding their infants at least until one year of age, it is still possible for this to happen during the day. Had McKenna and Ball recognised the fact that infant sleep interventions are not recommended prior to six months of age; there would have been no need for the concern that Henderson et al. (2010) were overlooking the crucial importance of night time suckling during early infancy. The article by Henderson et al. (2010) was not an intervention study aimed at reducing night waking in infancy. Nor did it promote sleep interventions for infants under the age of six months. The study sought to provide evidence of developmental norms in sleep patterns of typically developing, New Zealand one to 12 month olds. The authors expressed concerns that there was insufficient empirical data available in the literature for clinicians. Namely, that it lacked information on the developmental expectations for infant sleep that could provide a basis on which a discussion on infant sleep problems could be had. Based on the nature of their findings, the authors determined that the most rapid sleep consolidation transpires during the first four months of life. They therefore suggested prevention methods to encourage healthy sleep patterns in infancy. They did not, however, recommend the use of more drastic extinction methods as would be employed for older infants.

A second assumption made by McKenna and Ball was that all of the infants in Henderson et al.'s study were formula fed and solitary sleeping. These findings therefore could not be applied to breastfed infants. From an analytical perspective this argument is flawed as they fail to acknowledge the likely possibility that this study will have included a range of sleeping and feeding methods. McKenna and Ball's concern was that this is a common theme in infant sleep research and Henderson's

article perpetuates this. McKenna and Ball's concerns have arisen as a consequence of much of the sleep research being pioneered during a time when breastfeeding rates were drastically low in America where much of the data was gathered. During the 1950's and 1960's less than 9% of mothers were breastfeeding their babies when they left the hospital. Consequently McKenna and Ball expressed concern that breastfeeding infants could not be expected to be held to sleep norms established during this period (McKenna & McDade, 2005). However, the study by Henderson et al. (2010) was not performed during this period and due to the increasing rates of breastfeeding in New Zealand, it is likely that the sample included both breastfed and non-breastfed infants. In a secondary analysis using a subset of Henderson's sample Clarke (2014) found that although overall, breastfed infants were less likely to meet the most stringent criterion for sleep consolidation than their non-breastfed counterparts, a substantial number of them still met the three criteria (12 am-5am, 8 nocturnal hours uninterrupted or 10pm-6am) for sleeping through the night prior to six months of age. Clarke reported that when the data was analysed, four separate groups transpired. The groups comprised of those who were considered early to stop breastfeeding and began sleeping through the night prior to six months. Those who were considered early to stop breastfeeding and started sleeping through the night later than six months. Those who were considered late to stop breastfeeding and started sleeping through the night earlier than six months, and finally, those who were considered late to stop breastfeeding and began sleeping through the night later than six months. Clarke found that approximately 54% of infants reached the criteria for sleep consolidation prior to six months of age. Of particular interest, half of these infants belonged to the late to wean and early to sleep through category. This group consisted of 27% of infants in the study, the same amount of infants as in the early to

wean and early to settle group. This information shows that despite the majority of breastfed infants reaching the sleeping through the night criteria later than their non-breastfed counter parts, breastfed infants were still capable of reaching the sleeping through criteria prior to six months. Based on this evidence, parents can be reassured that breastfed infants do in fact have the capability to sleep through the night. Given that Clarke's research found that such a sizeable proportion of infants did in fact meet criteria for sleeping through the night before six months, it seems likely that breastfeeding and disrupted infant sleep is mediated by parental interactions. This perception is supported by a range of other literature on the topic.(Mindell et al., 2012; Ramamurthy et al., 2012; Sadeh, Tikotzky, et al., 2009; Touchette et al., 2005).

The final criticism of McKenna and Ball was in regard to the safety of infants whom they believed would be at risk of self-soothing before they were ready as a result of undergoing a sleep intervention. This is a risk they associated with an inability for infants to defend themselves against SIDS, cardiac perturbations or fatal breathing.. Mosko, Richard, McKenna, and Drummond (1996) suggested that SIDS has been associated with an arousal deficit in infants. In addition, they cited literature stating that environments that encourage extended periods of sustained sleep when infants are vulnerable to SIDS could reduce their risk of falling victim to SIDS. It is of critical importance to note that infant sleep interventions do not necessarily stop the infant from waking during the night or impact their ability to arouse themselves. Rather, they teach the infant to reinitiate sleep alone, without any involvement from parents. The vulnerable period McKenna and Ball and Drummond et al (1996) refer to in relation to SIDS is between one and six months of age. While research by McGarvey, McDonnell, Hamilton, O'Regan, and Matthews (2006) that studied all known cases of SIDS in the Republic of Ireland between 1994 and 2001 found that

the average age for SIDS deaths was 16.4 weeks. Once again what McKenna's criticism did not consider was the age that behavioural infant sleep interventions are typically implemented. To the best of my knowledge there is currently no evidence to suggest that infant sleep interventions place infants at greater risk for SIDS.

Rationale for the Current Study

Infant sleep interventions have proved to be very successful in eliminating infant sleep problems and reducing some of the negative effects associated with ISD such as maternal depressive symptoms, improving family relationships and reducing the likelihood of child behavioural problems in later life. Paediatricians report that their most common concern from parents is disrupted infant sleep. This highlights that behavioural sleep interventions are a necessary tool for those parents who want help managing their infants sleep. New Zealand parents are also increasingly aware of the importance and health benefits of breastfeeding for their infants. However, in light of the recent criticisms in the literature suggesting sleep interventions create an unnecessary barrier to breastfeeding, it seems important to provide evidence to reassure parents and professionals who work with infants and their parents that breastfeeding and behavioural sleep interventions for infants are not mutually exclusive. It will be particularly important during this study to consider whether the BSI's undertaken are successful at eliminating signalled night waking. The literature has highlighted breastfed infants are often resettled to sleep by breastfeeding. BSI's aim to reduce parental interaction throughout the night, in order to effect change on infant sleep. For this reason, the current study will also consider intervention effectiveness in relation to breastfeeding.

The current study sought to establish whether breastfeeding mothers of infants above the age of six months could undergo a successful sleep intervention with their infants, without experiencing any risk to their breastfeeding capacity. In addition, the study sought to document mothers' experiences and any perceived challenges they faced with breastfeeding throughout the intervention process. In order to do this the current research has been split into three parts.

The first part describes prospective data gathered from three mothers of six to 12 month old infants in the form of breastfeeding and sleep diaries to document changes in sleep and breastfeeding. The second part of the study sought to combine the above breastfeeding outcomes with breastfeeding outcomes of mothers of older infants who underwent (or chose not to) a BSI, while also considering whether the interventions were successful. Sleep diaries and videoed interviews of mothers who had previously participated in a sleep study with their 11-16 month old infants in a study by Akdoğan (2018) were analysed to achieve this. The third part of the study sought to document qualitative experiences of some of the mothers from the first two parts of the study through interviews. The research questions for both studies were as follows:

Research Questions

Part One.

1. Does breastfeeding duration change over a sleep intervention?

Parts One and Two.

2. Do mothers who wish to continue breastfeeding continue to do so during and following a successful BSI?

Part Three.

3. What were mothers' experiences with breastfeeding throughout the intervention?
4. Did mothers perceive any challenges to maintaining breastfeeding throughout the sleep intervention?
5. If mothers ceased breastfeeding during or after an intervention were their reasons related to the intervention or to other factors.

This study seeks to provide clinicians who work with sleep disturbed infants and their breastfeeding mothers with evidence about whether breastfeeding could be effectively maintained during a sleep intervention targeted at infants aged six months

and above. The study also endeavours to document any perceived challenges relating to breastfeeding experienced by mothers. These experiences will be beneficial for clinicians in order to ensure they are aware of any problems that may or may not arise relating to breastfeeding. The study also sought to record breastfeeding duration through the day and night to ascertain whether or not there were changes in breastfeeding. It is expected that the findings of this study will help provide parents and clinicians with expectations around potential changes to breastfeeding following behavioural sleep interventions. The findings will benefit agencies and professionals such as the Ministry of Health, General Practitioners who work with infants, breastfeeding mothers who have infants with sleep difficulties and Plunket nurses.

Method

Design.

The current study used a combination of prospective, experimental design for Part One of the study, which sought to document mothers' experiences of maintaining breastfeeding throughout a behavioural sleep intervention. Part Two of the study involved retrospective analysis of breastfeeding outcomes of mothers who participated in the sleep study with their infants conducted by Akdoğan (2018). Part Three of the study combined qualitative information from participant interviews from the first two parts of the study and involved a content analysis of the transcripts, from which a thematic analysis was undertaken. To separate the two groups of participants, the three case studies are referred to as 'Part One participants' and those from the research by Akdoğan (2018) are referred to as 'participants from the Akdoğan study.'

Ethical approvals.

Approval for Part 1 (infants 6-12 months) was granted in its own right by the University of Canterbury Human Ethics Committee (HEC). This committee had previously approved the other study, with infants over 11 months, which was conducted by Akdoğan (2018) and drawn on in Parts 2 and 3. The application for the Akdogan (2018) study explicitly mentioned that feeding practices were included in the data being gathered. Participants had consented to the use of sleep diaries and follow-up interviews for research purposes and they were notified, of Maddy Morley's involvement, with HEC's consent. A further application to the HEC was made to obtain consent to contact these participants and invite them to partake in a further follow-up telephone interview. Following completion of the study by Akdoğan (2018), participants were emailed a brief description of the study results. Those from

the intervention group were then informed of the current research, and invited to participate in a further follow-up phone interview to discuss their experiences of breastfeeding throughout the sleep intervention. Five mothers from the intervention group gave consent to take part in the telephone interview.

Participants

Part One. Participants recruited prospectively for Part One of the study were three breastfeeding mothers of six to 12 month old infants, who wished to receive help for their infants' sleep. Infants between six and 12 months were considered due to this being the youngest age that Canterbury Sleep Programme (CSP) offers sleep programmes, while still being young enough for stability of breastfeeding to be important. Recruitment was done via word of mouth and through the CSP. Mothers who contacted the CSP for help with their infants' sleep were considered for study participation if they were breastfeeding. Those who indicated their interest were provided with an information sheet (Appendix A) outlining the study involvement and were invited for an initial interview to determine eligibility for the research. If they met the criteria, mother and infant were offered the opportunity to participate in the study and subsequently signed a consent form indicating their willingness to participate (Appendix B).

Eligible subjects were biological mother/infant dyads with a mother able to speak and read English competently and who were currently breastfeeding with the intention to continue throughout the duration of the study. Infants eligible for participation were between the ages of six and twelve months at recruitment, with no identifiable medical conditions, and of either sex. Following participant selection, pseudonyms were allocated for each infant in order to maintain privacy of the participating families.

Part Two. Additional participants for Part Two of the study were 18 mothers recruited from Akdoğan (2018) a study with sleep disturbed infants. Ten of the participants underwent a behavioural sleep intervention and completed sleep diaries that included breastfeeding information. The remaining eight participants also completed sleep diaries, however they chose not to participate in a sleep intervention. These mothers did not seek help for their infant's sleep but participated simply to provide longitudinal data for the Akdoğan (2018) study. The ages of these infants were 12 to 17 months (rounded to nearest whole month) upon study beginning and between 18 and 21 months at the time of their video follow-up interview.

Part Three. Part Three of the study also involved participants from both groups. All three mothers from Part One participated in a follow-up interview. Five of the mothers from the Akdoğan study's intervention group also agreed to a further follow-up phone call to discuss their experiences of breastfeeding throughout the intervention. The interview for mothers from the Akdoğan study took place at least one year after the completion of the behavioural intervention. One videoed follow-up interview from an intervention participant from the previous study also contributed qualitative data. These interviews contributed to the content and thematic analysis in Part Three.

Measures.

Part One.

Parent breastfeeding diary. Participants from Part One were asked to record in a diary the frequency and duration of feeding when they breastfed their baby throughout the day and night (see Appendix C). This was filled in daily for the randomly assigned baseline period (one to three weeks) preceding the sleep programme, throughout the duration of the programme and for one-week follow-up,

two months after the intervention finished. This information was used to inform whether there was a change in breastfeeding habits during, or after the intervention. The data was recorded as daily frequency of breastfeeding, and the duration of time spent breastfeeding by day and by night. To assess changes in breastfeeding habits, the total amount of time breastfeeding occurred during the day and night was averaged for the baseline period, intervention and the follow up period.

Infant sleep diary. All parents from Part One recorded detailed information about their infants' bed-time, sleep duration, onset latency, night wakings and morning wake times. This information included the location the infant was sleeping in, behaviours infants were engaging in and soothing techniques parents used to settle their infant to sleep. The diaries used were those used in the study by Yılmaz Akdoğan (2018) with slight adaptions. The template is provided in Appendix D. Parents completed these diaries each phase of the study. These diaries were used to assess changes in: a) infant sleep onset latency (SOL), b) total sleep duration, c) frequency of night wakings d) duration of night wakings e) morning wake times and f) night time breastfeeding behaviours from the baseline period to the follow-up period.

Composite Sleep Score. The Composite Sleep Score (CSS) was used to determine the severity of infant sleep at each phase of the study for those in Part One. The CSS was developed by Richman (1981) as a means to consistently rate the severity of sleep disturbance in one to two year old infants. The CSS rates information on a five point ordinal scale (0-4) across six different sleep parameters, gathered by parent informed infant sleep diaries. These include the average time taken to initiate sleep each night or average time they fall asleep (whichever is worst of the two); average total time slept at night; number of nights waking per week, average number

of wakings per night; average time awake per waking; and average weekly hours in parents bed. Periods of illness are excluded from calculations. The total CSS score ranges from 0-24 with the higher scores representing infants with the most disturbed sleep. Typically, infants who receive a score of higher than 8 are considered to have a sleep problem, while those who receive a score higher than 12 are considered to have a severe sleep problem.

Minde et al. (1993) validated the sleep diaries of 12-36 month old infants against infrared video footage of the infant sleep behaviours that the CSS score is derived from. There was a medium intercorrelation for morning wake-up time and number of wakings during the night (0.44). In addition, they found that the number of wakings and duration of wakings displayed a strong correlation at 0.84. Overall, the internal consistency had a Chronbach alpha of .768. The authors also found that the average score for infants in the poor sleepers group was significantly different (d = 3.41) to the average score of those in the good sleepers group (mean 12.3, SD 2.55 and mean 3.6, SD 2.56, respectively). In addition, when Priddis (2009) used the CSS measure in their study of 7-18 month old infants, they found a comparable distribution of scores at the initial intake between their two groups of infants: good and poor sleepers, to the findings of Minde, Faucon, and Falkner (1994) who had a similar sample size of 12 to 36 month old infants. They found that although the sleep arrangements differed between the group younger than 12 months and those older, the mothers still managed to record the sleep behaviour in the same fashion.

Since its development it has been used in research to evaluate infant sleep disturbance in infants as young as six and seven months old (France, Blampied, & Wilkinson, 1999; Priddis, 2009). Henderson (2001) found in her study of 75 infants that at six months there was a bimodal distribution of CSS scores indicating two

distinct groups emerged from the sample: one made up of sleep disturbed infants and one without ISD. The results of this study also found that a score of eight separated the two groups of infants, and therefore used 8 as the cut-off score for identifying sleep disturbed infants. Consequently the cut-off score of eight has been used to identify sleep problems in the current study.

Video footage. A D-Link infrared camera was installed in the homes of the participants in Part One for 25% or three consecutive days of baseline, stage one of intervention and follow-up, and three consecutive nights for phase two of the intervention period. Due to a camera malfunction no recording was obtained for Sue at baseline. The cameras recorded to a 75 GB SD card and ran continuously from the time they were plugged in. However, only the night-time footage was monitored to provide data for reliability of the parent reported sleep diaries and ensure they were providing an accurate description of their infants' night-time behaviours. The cameras were set up to ensure visibility of the infant while they slept and any sounds that were made by the child. They usually recorded in cycles of three to four consecutive days. After which, the researcher would collect the camera and remove the footage from the SD card. This cycle was repeated until footage was collected for 25% or three consecutive days of each phase.

Infant weight. Infants were weighed at baseline and end of intervention. All infants were a typical weight at baseline for their age with the exception of Sue. Her mother chose to implement a dream-feed during the intervention.

Part Two.

Infant sleep diary. All parents from the Akdoğan study also recorded detailed information about their infants' sleep in a sleep diary. These were very similar to the

ones in Part One (Part One diaries were modelled on these), however they also included breastfeeding information pertaining to sleep-times only.

Composite Sleep Scores. Composite sleep scores were employed from Akdoğan's study to determine intervention effectiveness.

Follow-up interviews. Follow-up interviews from some of the intervention group taken in Akdoğan 's study were analysed for supplementary breastfeeding information. Follow-up interviews were only viewed when diary breastfeeding informationwas not available. As it was not always clear whether mothers continued breastfeeding from the sleep diary alone.

Part Three.

Follow-up interview. Participants from the current study and intervention participants from the Akdoğan study were invited to participate in a follow-up interview. Full description of the questions is given below. Mothers from the current study were interviewed two months after finishing the intervention. Five of the mothers from the Akdoğan study's intervention group participated in the interview, at least a year after finishing the sleep intervention they underwent with their infant.

Questions were asked about maternal experiences with breastfeeding prior to the intervention, throughout the intervention as well as current breastfeeding practices. In addition, mothers were invited to share any challenges they faced with breastfeeding, any changes in breastfeeding they noticed throughout the intervention period, and possible reasons for the changes. The researcher took written notes of participant responses.

Procedure.

Part One.

Mothers who expressed interest in participating in Part One of the current study were encouraged to ask any questions they had about the study. They were sent an information sheet and consent form outlining what involvement would be required of them throughout the study (see Appendix 1). Mothers were then individually invited to an initial interview to determine suitability for the study and to sign consent forms stating they were willing to participate. Subsequently, mothers were randomly assigned to a baseline period of one, two or three weeks, given breastfeeding and sleep diaries and taught how to record the required information. Mothers were also consulted about the presence of the camera in their infants' rooms for reliability purposes.

Once consent was obtained and participants understood their role in the research, they were then asked to begin recording information in the breastfeeding and sleep diaries for their assigned baseline period. Following this, a time was then arranged to meet participants in their home to discuss the intervention and give them the opportunity to ask questions.

All three participants from Part One chose to proceed with the parental presence intervention, described below, although it was modified to include a dream-feed in Sue's case. Details of the parental presence intervention were discussed with both parents to ensure consistency of the intervention.

Parental presence programme. Parents agreed upon a bed-time and wake up time for their infants, and discussed the criteria they would use to determine if their infants were ill, in which case they would abandon the intervention until such a time as their infants had recovered. In addition, they were told that if they felt their child

was in danger (for example, a leg through cot bars) they were to stop the intervention until the situation was rectified. Mothers were encouraged to offer their child a breastfeed just prior to settling them to bed, and again when they woke up for the day. Parents were instructed to put their infants down in bed awake, after their final breastfeed for the night. They were told to briefly bid them good night and then retire to another bed in the infant's room and feign sleep while the infant was awake. Parents were reminded not to otherwise respond to their child's cries unless the child was ill or in danger. Earlier in the evening, once the parent was asleep he/she could resume their usual nightly routine, returning to the bed, without attending to the child once the child woke up. From the parent's bed-time, he/she slept in the child's room, again not responding when the child woke. This part of the intervention lasted approximately one week (by which time there is a marked decrease in awakening and signalling) depending the extent of the infant's response and parents' willingness to move on to the next phase. The second phase of the intervention lasted four to six weeks. During this phase parents were instructed to place their child in bed awake, briefly bid them good night and return to their own room. Again, parents were told not to respond to their child's cries, except for illness and danger, until the agreed upon morning wake-up time. Parents continued filling out their sleep and breastfeeding diaries consistently throughout the intervention period to monitor any changes in sleep and feeding routines.

Modified parental presence programme. Sue's mother negotiated a change to the programme to include dream-feeds (where the mother picks the sleeping infant up to breastfeed him/her without waking them) owing to concerns about her child's daily nutritional intake. She gave her child two and then one dream feed during the night.

Throughout the intervention period, the researcher (a registration-track child and family psychology and Masters thesis student under the supervision of a Registered Clinical Psychologist) was in daily, then regular phone contact with the mothers in order to provide support and planning for any problems that arose as well as to gather information on breastfeeding changes. Once infants were consistently sleeping through the night without signalling to their parents upon awakening, the intervention was discontinued and the maintenance phase commenced. During the maintenance phase parents were instructed to briefly check their infants should they wake and then leave the room unless there was a clear need for parental assistance. Parents were expected to continue with this response for the remainder of the study. Finally they were reminded that they could return to the intervention for a few days should there be a regression in their infant's sleep following illness or a change in routine.

Final follow-up measures were taken eight weeks after the intervention had finished and required parents to complete the breastfeeding and sleep diaries for one further week.

Infant weight. Mothers recorded their infant's weight at the end of baseline and intervention period.

Programme fidelity. Programme fidelity was obtained by calculating the percentage of nights the programme was followed absolutely, by parents. A night of fidelity was calculated if (during Phase One of the intervention) parents bid their child goodnight and retired to a bed in the infant's room, not responding to their signalling until the specified wake up time. During Phase two of the intervention, a night of fidelity was calculated if parents bid their child goodnight, left the room and did not return (except for brief checks) until their specified wake-up time. This included

parents not responding to their child's wakings during the night (unless they had concerns about illness or danger). A 15-minute margin of error was allowed in getting the child up for the day. Therefore, if a child's agreed wake time was 6am and the diary revealed parents getting the child up for the day at 5.50am, it was recorded as a night of fidelity. Fidelity for Sue was adjusted to allow the dream-feed, so long as Sue was not being fed following a signalled awakening.

Reliability. Interrater reliability was determined by coding the sleep diaries against the infrared camera footage. Camera footage was obtained for three consecutive nights of the second stage of the intervention, and 25% of baseline, stage one of intervention and follow-up phases for each participant. However, due to a faulty camera, no reliability footage was obtained for Sue at baseline. Reliability results for parental report were evaluated for a) the length of sleep onset delay, b) the frequency of audible night wakings, c) the total duration of night waking each night, and d) the time the infant woke up in the morning. Agreement between sleep diaries and video footage was reported as agreement if it was recorded within a fifteen-minute window. If it did not occur within this timeframe then it was reported as a disagreement. The amount of agreements were calculated and then translated into percentages for each category. Because infants so often make sounds when self-settling and during active sleep, night wakings were only counted if the infant was continuously signalling to the parent for two minutes or longer.

Video recorded reliability data was not obtained for the breastfeeding diaries owing to the restriction it would place on the participants' ability to leave the house and carry out regular routines. However, research by Nyqvist, Sjoden, and Ewald (1999) tested the interrater reliability of the mothers' ability to record a comprehensive diary of their infant breastfeeding behaviours against an observer.

They found excellent interrater reliability agreement between the mother and observer for their breastfeeding behaviour items (with kappa values ranging from 0.77 to 0.94 (89–97%). In addition they found good agreement between the main observer and a second observer with kappa values of 0.68–0.84 (83–90%). Given the high rates of reliability recorded and complexity of the diary used in the aforementioned study, it would seem reasonable that the mothers in the current study would be able to accurately report on their daily breastfeeding duration and frequency.

Part Two.

Part Two of the study sought to combine the quantitatively measured breastfeeding outcomes of mothers from Part One with the outcomes from the intervention and comparison group mothers' retrospective data obtained from the Akdoğan study. The infant sleep diaries from the current study and from both the intervention and comparison groups collected by Akdoğan were analysed for breastfeeding information at each phase of the study. The video recorded follow up interviews of the intervention group from the Akdoğan study were analysed when no breastfeeding information could be obtained from the sleep diaries. The data available for each participant was triangulated and reported to display infant age, intervention outcome, breastfeeding status at each phase and a summary of how long they continued breastfeeding (if that data was available).

Part Three

Part Three of the study involved interviews with all mothers from Part One and five from the Akdoğan study participated in these interviews. One video-recorded follow up interview from the Akdoğan study also contributed data to the qualitative analysis. These interviews provided an opportunity for mothers to further discuss their

experiences of maintaining breastfeeding during and after the intervention. It was an open interview structure to facilitate an inductive reasoning process. This information was used to determine how the nature of breastfeeding changed during intervention (i.e. whether the baby was feeding more in the morning because they are feeding less during the night) and whether breastfeeding continued readily after the intervention. The questions asked in the interview were as follows: *How did you find the intervention? How are things now? Tell me about breastfeeding, this baby, and you right from the beginning. Tell me about breastfeeding prior to the sleep intervention. Were there any particular challenges you faced with breastfeeding during the intervention? What changes (if any) happened regarding your breastfeeding? How did you make sense of these changes? Were you still breastfeeding after the intervention?* Further prompting and questions were asked in response to participants replies.

Data analysis

Part One.

Visual analysis. Data from the sleep and breastfeeding diaries for Part One of the current study was entered into a Microsoft Excel 2011 spread sheet. This spread sheet contained details of the duration of sleep onset delay, duration and frequency of night wakings and breastfeeds, and the time the infant was put to bed and woke for the day. A visual analysis was performed on the data from the sleep diaries to ascertain change in sleep routines.

Modified Brinley Plot. CSS scores computed at the last week of baseline, intervention and follow-up were entered into a modified Brinley Plot to show sleep improvements. Modified Brinley plots are used in single case research as a way to discover and report systematic intervention effects (Blampied, 2017). This data is

observed on a single graph and displays the change in CSS scores for each participant by phase.

Reliability and fidelity. Hits and misses were calculated for reliability against the sleep diaries and nights of video-recorded footage and calculated as a percentage. Each night was also calculated for programme fidelity through analysis of the sleep diaries. Fidelity was then calculated and reported as a percentage.

Part Two.

Breastfeeding analysis and by group. The data collected from the sleep and breastfeeding diaries in Part One was combined with the sleep diary data from the Akdoğan participants. This information was sorted into tables to determine how many mothers from each group (Part One mothers, Akdoğan study intervention mothers and Akdoğan study comparison mothers) were still breastfeeding post-intervention.

Part Three.

Qualitative analysis. Part Three involved a content analysis of the interview transcripts of participants from Part One and six mothers from the Akdoğan study. Interviews were conducted with all mothers from Part One, and five from the Akdoğan study. Intervention participants from the Akdoğan study were invited to participate in a phone interview to discuss their experiences with breastfeeding throughout an intervention. Five participants responded and contributed their experiences. One of the mothers from the previous study underwent a second sleep intervention with her second child and also participated in the current study. She participated in two interviews, one for each child. One mother did not participate in a phone interview, however, her video recorded follow-up interview contained information about her experience of stopping breastfeeding, and her experiences were also included in the thematic analysis.

Conventional content analysis is a subjective method of interpreting qualitative data. This is done through a process of systematic coding and identification of themes and patterns with the aim of describing a phenomenon. Ordinarily, a lack of theory surrounding this topic would dictate when content analysis is applied. Rather than having predetermined categories, this process allows for them to be drawn from the content, resulting in an inductive approach to data categorisation (Shannon & Hsieh, 2005). Given there is little research surrounding the effects of sleep and intervention on maternal breastfeeding capacity, this process was applied to the analysis of the interview transcripts.

A conventional content analysis follows a logical sequence to analysing transcripts. The current analysis followed the process described by Shannon and Hsieh (2005), which provides an overview of the approach described in the literature. The researcher began by reading all interview transcripts several times to gain an in depth understanding of the data available. The second step involved reading the transcripts individually and highlighting units of meaning that capture key concepts within the text. Thirdly, first impressions and initial analysis notes were then recorded. This process was repeated until groupings of related units of meaning were organised and each category was given a name. This was an interactive process also contributed to by the researcher's supervisor who independently read the transcripts and identified categories. Any differences were discussed until a consensus on the themes to be included was formed.

These category names were then used to inform broader categories that described the overarching themes of the transcripts. These themes were then reported on and discussed in the text to provide an overview of maternal breastfeeding experiences.

Owing to the majority of interviews occurring over the phone, interviews were not able to be recorded and transcribed verbatim. The researcher took notes on a computer or notebook and recorded interviewee's responses as closely as possible.

Rigour of qualitative research. Important features of qualitative research are the level of trustworthiness and reliability of data, as well as trustworthiness in the interpretation of the data. Elliot, Fischer and Rennie (1999) provide guidelines for ensuring rigorous qualitative research within the field of Psychology. Most pertinent to this study is owning the researcher's perspective, providing credible checks to the data and providing grounding in examples.

To ensure transparency for the readers, it is best practice in qualitative research for the researcher to provide evidence of their perspective and background on the topic. During the time of the formation of the current study, I was undertaking my registration track training in child and family psychology and Masters degree. My interest in sleep interventions arose from my background working in a preschool nursery, where quality of infant and maternal sleep was a common topic. I believed a BSI would not compromise maternal breastfeeding capacity. This was owing to my knowledge that the sleep programme run at my University by my supervisors, the CSP had not encountered any known difficulty with maternal breastfeeding capacity while implementing BSI's. This perspective was also influenced by anecdotal evidence gained from conversations I had had with mothers whose infants had no trouble sleeping through the night without waking to feed. In order to balance my, and my supervisor's existing perspective, I asked open questions to ensure mothers could report a variety of experiences. I took care to ask specific questions about challenges with breastfeeding. I also made sure to gather detailed evidence of and report any

negative responses to breastfeeding that were raised by mothers during the intervention or interview.

To ensure credibility of the interpretation of the data, one of my supervisors, an Associate Professor and registered clinical psychologist assisted with reviewing the interview transcripts. This was to increase the likelihood that all the themes were represented. Where there was a difference between the themes noted, these were negotiated and reported once consensus was reached.

To ensure accurate appraisals of the data and the researchers' understanding, each theme is represented by a number of quotes. This ensures the readers also can synthesise any possible alternatives or meaning from the data.

Results

Part One

The following section examines changes in infant sleep and breastfeeding by phase across 3 six to 12 month old infants. It is comprised of four separate time-series graphs demonstrating changes in each phase of the study for the following variables: sleep onset latency, night wake frequency, night wake duration and breastfeeding duration. Next, a modified Brinley plot is reported to determine reliable change in Composite Sleep Scores for each infant, at each phase of the study. Lastly, interrater reliability is reported for the four variables: time put to bed, SOL, night waking frequency, total night waking duration and time up for the day, and programme fidelity is documented.

Effects of a BSI on breastfeeding. Changes in infant sleep patterns were examined using time series analysis for the three variables, specifically, sleep onset latency; night waking frequency; and night waking duration, and for breastfeeding duration, separately for day and night.

Data quality. There was occasional missing data for each participant in most phases. The longest consecutive break in data (16 days) occurred in Sue's baseline phase, due to her family going on holiday. It is not considered best practice to have a break in baseline data for research purposes. However, given the level of disruption and exhaustion Sue's sleep was causing her family, and their desire to begin the intervention before her mother started work, it was decided by the researcher that it would be unethical to delay her baseline period until after their holiday.

Follow-up recording for May was completed twice because she was ill with a disruptive stomach bug for four days during the attempt at follow-up. Consequently, a

further week of follow up recording was undertaken one week later and this data is shown for days 63 to 70.

Illness. All infants suffered periods of illness at times, noted on the sleep graphs with a short dashed line or one long line over the nights of illness. Periods of illness were also removed from CSS calculations. During follow-up, May also experienced one (summer) night of uncharacteristically prolonged sleep onset. Her parents discovered this was due to her room being very hot and removed her from the room until it cooled down. This particular score for SOL has also been removed from the CSS calculations.

Changes in sleep across phases. Single-case research designs require, first, that baselines be assessed for stability. Stability is assessed predominantly in terms of the variability in the data and any trends in the data path. Data with no overall trend is ideal, but so long as any trend evident is opposite to the direction of change expected in the intervention phase, the baseline can be deemed satisfactory to detect any subsequent change associated with the intervention. The level of the data relative to the measures maximum and minimum also warrants judgments that can be made about the nature and extent of any problems evident for a particular case. The second requirement, specific to a multiple-baseline across participants, is that when the intervention is introduced for the first case, baselines remain stable for the other cases, and that any treatment effect evident for the initial case is then replicated when subsequent cases enter the treatment phase.

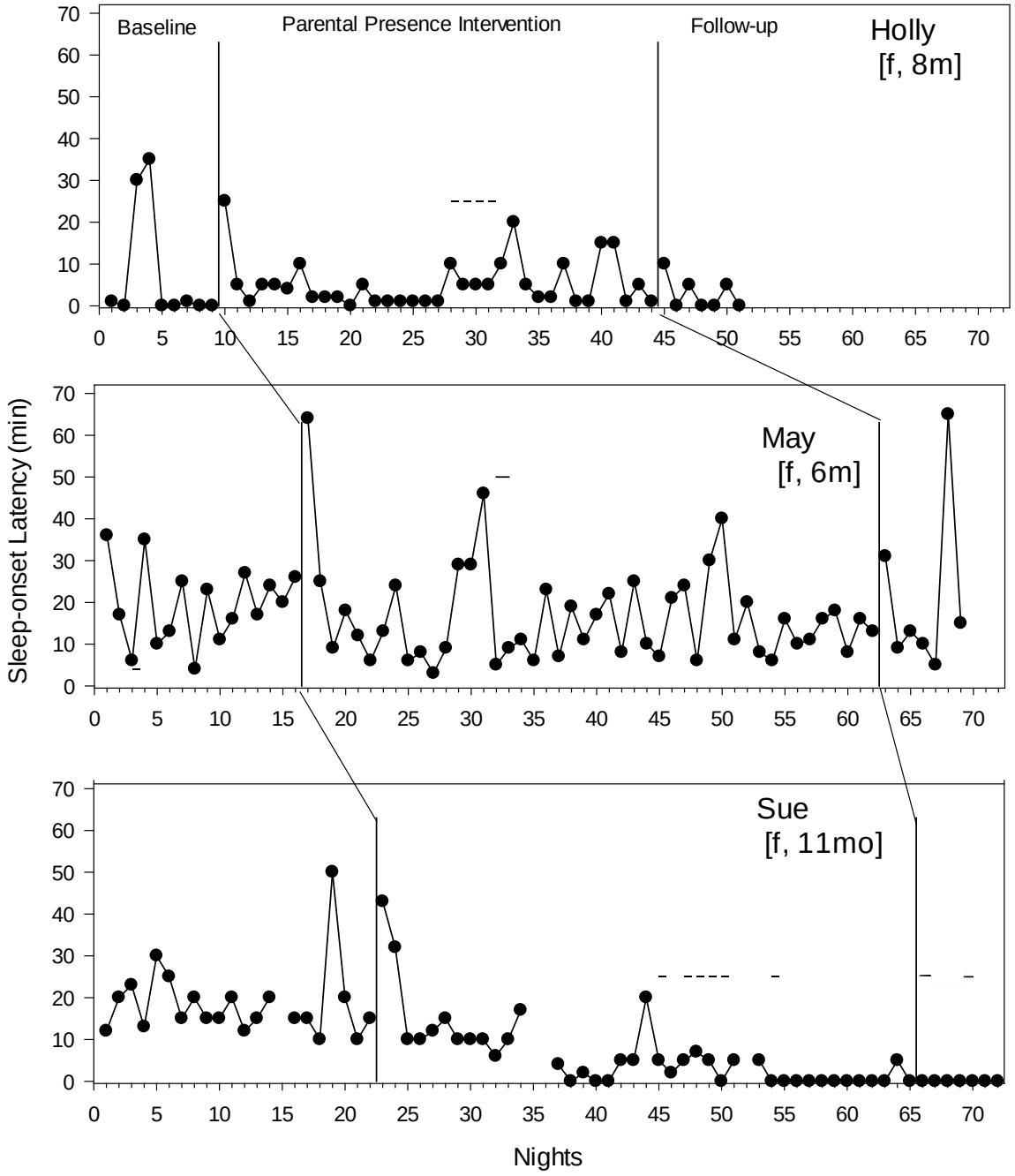

Figure 1: Sleep onset latency by phase

Note: Lines between graphs indicate breaks between phases. Any breaks in the graphs indicate missing data. Short, dashed lines indicate periods of illness. Pseudonyms and age (in months) are presented at the top of each graph. Night 68 for May represents an anomaly in SOL. Her parents reported on a hot summer night she was very distressed and took a long time to settle. After checking on her the realised her room was very hot and removed her from the room while her room cooled down, before placing her in bed again where she quickly settled and went to sleep. The gap in the data at baseline for Sue represents a 16-day break in follow-up recoding due to her family being on holiday.

Sleep onset latency. Figure 1 shows the SOL in minutes for each participant at each phase of the study. To judge whether any of the infants exhibited problematic

sleep onset, the clinical standard of SOL >15 minutes was applied. Based on this criterion, Holly did not demonstrate consistent problematic SOL. However, she did have two nights with long sleep onset duration, which were associated with her waking as she was being placed in the cot. The other two cases had a more consistent problem with settling to sleep on many nights. For May, SOL trended upwards towards the end of baseline. Sue had a relatively stable duration to sleep onset, ranging between 10 and 20 minutes per night, with a spike in latency where there was no clear reason evident in the diary. Note, that during baseline, all infants were being breastfed, held, or rocked (or a combination of the three) to sleep or almost asleep and so baseline data does not represent the infants' genuine ability to settle themselves to sleep.

On the first night of intervention, all three infants displayed an increase in the duration of SOL, above levels observed in the immediately prior baseline nights. This evidence of a PERB in SOL during the first (and sometimes second) night of the intervention was expected, as none of the infants were being placed in bed awake prior to the intervention starting. After the initial response burst, all infants SOL began to decrease. Holly, who did not demonstrate consistently problematic SOL at baseline, displayed levels of SOL during the first part of intervention that were at or slightly above baseline levels. Her SOL then worsened, associated with a period of illness and did not return consistently to the low levels before the commencement of the intervention period.

After her PERB, May displayed levels of SOL that were similar to the pattern exhibited in baseline, although the number of nights with lower levels of latency increased over the intervention phase and was low and stable for the last 10 intervention nights.

Following Sue's PERB, her sleep onset data didn't change from baseline. However, following a gap of several nights in the data, she began to have an increasing number of nights with zero SOL. This trend was somewhat disrupted by a period of illness, although by the end of intervention, Sue's SOL was characteristically non-problematic.

At follow-up, for all three cases, SOL closely resembles the pattern that manifests at the end of each intervention, for each participant. Only Sue shows evidence of sustaining the obvious gains in latency into follow-up, despite experiencing two nights of illness during this phase.

Night waking frequency and duration. Figures 2 and 3 show the night waking frequency and duration of each infant at each phase of the study. At baseline, the level of night waking was problematic for each child, for both frequency and duration. This was especially true for Sue. Overall, wakings typically occurred at least twice or more per night and the total duration spent awake was very long for the majority of nights. May displayed a decreasing trend in baseline (average total night waking duration 53.25 mins). This was most evident in waking duration, although waking frequency stabilised at the end of baseline. Holly demonstrated a stable number of wakings, with varied duration on average duration 82.67 mins). Sue's frequency of night waking trends down at first and then increases again. Correspondingly, her waking durations were initially stable, characterised by a high duration before they dropped abruptly to a lower, more stable level (average total night waking duration 101.19 mins). For all three children, (with the exception, perhaps of May's durations) baselines were sufficiently stable to permit the detection of a treatment effect, should one occur.

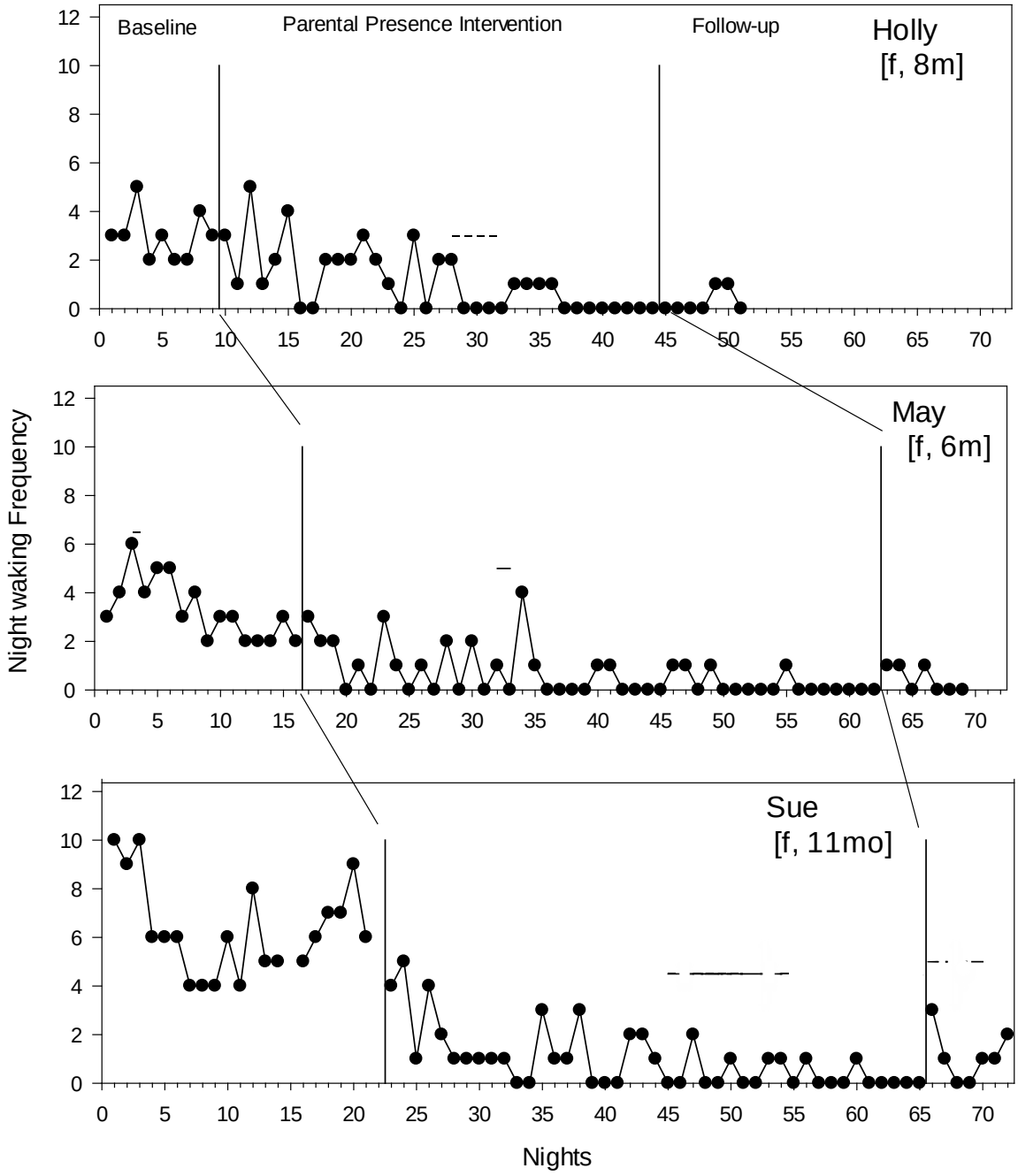

Figure 2: Night waking frequency by phase

Note: Lines between graphs indicate breaks between phases. Any breaks in the graphs indicate missing or inconsistencies in data. Short, dashed lines, or long lines indicate periods of illness. Pseudonyms and age (in months) are presented at the top of each graph. The gap in the data at baseline for Sue represents a 16-day break in follow-up recoding due to her family being on holiday

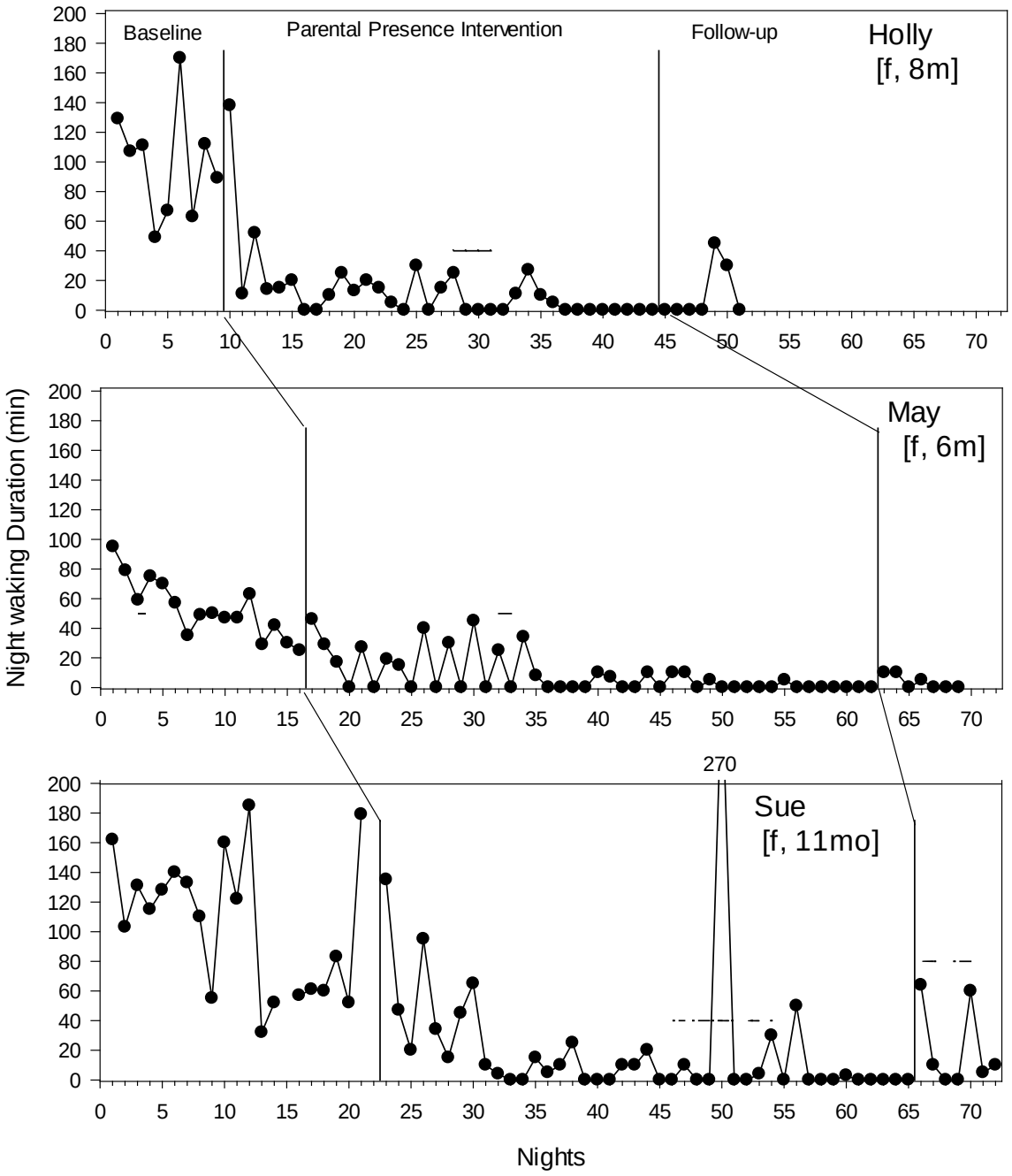

Figure 3: Night waking duration by phase

Note: Lines between graphs indicate breaks between phases. Any breaks in the graphs indicate missing or inconsistencies in data. Short, dashed lines, or long lines indicate periods of illness. Pseudonyms and age (in months) are presented at the top of each graph. Night 54 for Holly was explained as her being woken by her brother when the family was away on holiday. The gap in the data at baseline for Sue represents a 16-day break in follow-up recoding due to her family being on holiday. The '270' at the top of Sue's graphs represents the number of minutes she spent awake on night 50.

The most obvious treatment effects can be seen in the night waking frequency data for Sue, and for waking duration for both Sue and Holly. A clear, delayed

treatment effect can be seen for both waking frequency and duration for May, from night 35 onwards. All three infants were sleeping through the night at the end of their intervention phase. These gains were mostly maintained during follow-up, with the exception of Sue.

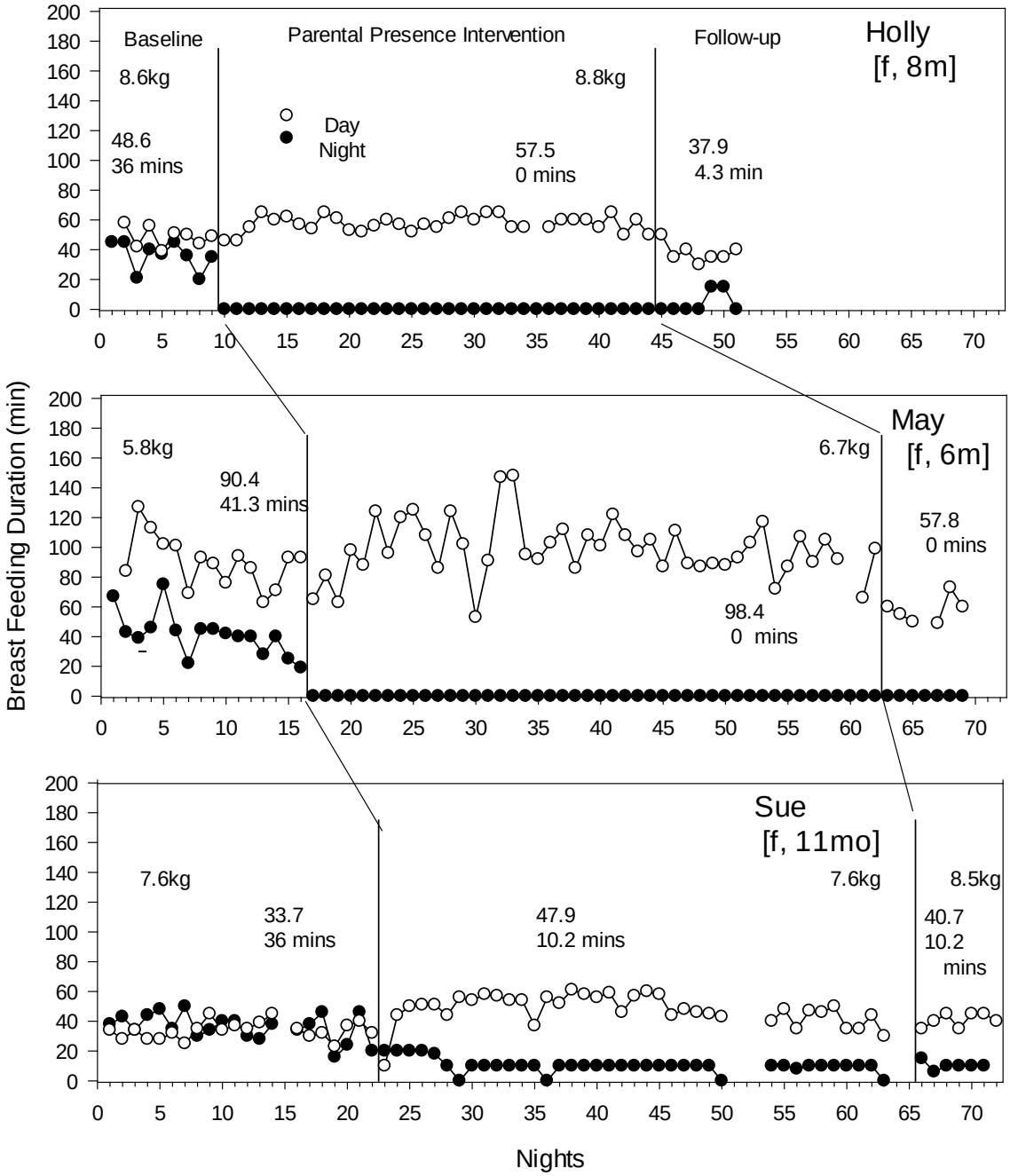

Figure 4: Breastfeeding duration by phase (day and night).
Note: Lines between graphs indicate breaks between phases. Pseudonyms and age (in months) are presented at the top of each graph. Open circles represent breastfeeding duration by night. Closed circles indicate breastfeeding duration by night. Any breaks in data represent missing data. Numbers

(in minutes) at each phase of intervention represent the average breastfeeding duration for each phase of intervention for both day (top) and night (bottom). Numbers in kg represent infant weight at each phase of the study. The gap in the data for May at night 66 indicates a day where the diary did not accurately reflect her breastfeeding, due to her receiving formula when her mother went out for the day. The gap in the data at baseline for Sue represents a 16-day break in follow-up recoding due to her family being on holiday.

Breastfeeding duration during day and night across study phases. Figure 4 represents day and night breastfeeding durations for each participant at each phase of the study. Each participant's graph illustrates extensive night time feeding at baseline. Both Holly and May were feeding more during the day than at night, although May was feeding noticeably more during the day than night. Holly's feeding during the day was relatively stable, while her night time feeding was more variable. May's feeding at night and during the day is noticeably variable, and there is evidence of a slight downward trend in her night feeding from night eight onwards.

Sue displayed the least amount of difference in night and day time feeding at baseline. There is no obvious trend in Sue's breastfeeding duration at baseline. However, it is interesting to note that she fed for longer at night than during the day.

The beginning of the intervention period predictably illustrates a decrease in night time breastfeeding for all participants, demonstrating parental compliance to the intervention. Breastfeeding at night was completely eliminated for both Holly and May, however continued for Sue because of her mother's desire to implement a dream feed. The first few days of the intervention period indicate a slight increase in day time feeding for Holly. This then stays relatively stable until the end of the intervention. There is also slight evidence of the beginnings of downward trend beginning on night 41 until the end of intervention.

There is also evidence of a variable upward trend in breastfeeding from the beginning of the intervention period until night 25 for May. Her breastfeeding then variably decreased before a marked drop that was followed by two marked increases.

Day 32 and 33 were both days of illness for May where a sudden increase in breastfeeding is evident. Following the illness, May's breastfeeding remained variable, with two marked decreases before the end of intervention.

During the intervention period, Sue's breastfeeding remained relatively stable. Sue displayed the most notable increase in her day breastfeeding when compared with the other participants. There was a marked decrease in day breastfeeding on the first day of the intervention, however this quickly increased and became relatively stable, despite some small fluctuations. Eventually a noticeable drop in day breastfeeding occurs, and there is a variable, slight downward trend until the end of intervention. Sue's night breastfeeding initially decreased to around 20 minutes per night until the dream-feeding was dropped to one. It then decreased to 10 minutes per night and remained stable until the end of the intervention with the exception of several nights where no night breastfeeds were recorded.

Breastfeeding during the day decreased slightly for both Holly and May by the follow-up period. However, Holly's night breastfeeding increased for two nights of this phase and correlate with the two night wakings she experienced. Sue's breastfeeding during the day and night stayed relatively stable and consistent with her breastfeeding at the end of the intervention phase.

Infant weight. Both Holly and May gained weight over the course of intervention. When it was evident that Sue had not gained weight from the end of baseline and intervention period, her mother was contacted to check that Sue was well. Her mother confirmed that she was healthy despite being underweight and confirmed that their doctor had been monitoring her weight since prior to the intervention beginning. The lack of weight gain was not seen as a result of the

intervention. It was decided by the researcher to also record her weight at follow-up to indicate any weight gain. She too had gained weight at this point.

Modified Brinley plots: Composite Sleep Scores.

Composite sleep scores were calculated (as described above) for the last week of each phase of the study, excluding sick days and shown via a modified Brinley plot (Blampied, 2017) in Figure 5. All three infants' scores were above the criteria for "severe" symptoms (severe clinical cut-off = 12) at baseline, but all infants' sleep had improved post-treatment to below the clinical cut-off level (clinical cut-off = 8).

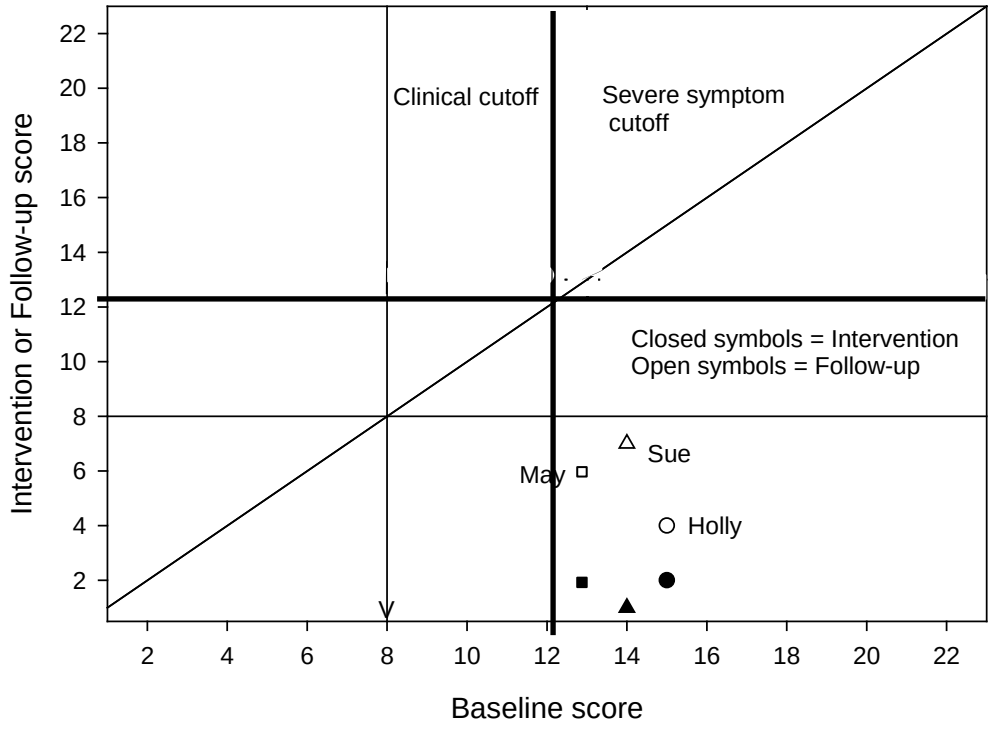

Figure 5: Modified Brinley plot
Note: Y axis indicates CSS scores at intervention (closed symbols) and follow-up (open symbols). X axis indicates CSS scores at baseline. Thick black line indicates severe cut off score, while lighter line indicates clinical cut off.

None of the infants maintained the improvements seen at the end of the intervention period, however their sleep had maintained enough improvement that none of the infants' scores reached or exceeded the clinical cut-off at follow-up.

Reliability

Interrater reliability is reported in Table 2 for four variables: time put to bed, SOL, night waking frequency, total night waking duration and time up for the day. As can be seen, there was significant variation between reliability scores at each phase, for each participant. Baseline yielded the lowest rate of reliability for May at just 53.3%. Reliability during baseline was taken at nights 13, 14 and 15, the nights where the downward trend began to emerge for night waking duration. May's mother fell asleep several times while feeding her following night wakings, contributing to the low reliability for night waking frequency and duration. Overall, video footage demonstrated that May's mother was under-reporting for both of these variables. Otherwise reliability was generally high for the sample, suggesting that the diaries yielded accurate depictions of parent and infant sleep behaviour.

Table 1: Video recorded reliability of sleep diaries by phase and participant

	Baseline	Intervention (Phase one)	Intervention (Phase two)	Follow-Up	Total Reliability
Holly	100%	90%	93.30%	100%	96.40%
May	53.30%	100%	73.30%	80%	74%
Sue	N/A	80%	93.30%	88.90%	89.74

Note: Baseline video footage was not available for Sue due to technical error with camera.

Programme Fidelity

Table 3 comprises of the percentage of time parents adhered to the parental presence (or modified) programme as reported by the sleep diaries. Fidelity was calculated on a night by night basis and took into account whether parents placed their infants in bed awake and did not respond to their signalling (unless they suspected illness or danger). Fidelity also ensured the time the infant got up for the day was no

earlier than 15 minutes of their agreed upon wake up time. As can be seen, May's parents exhibited the most programme fidelity, while Sue's exhibited the least.

Table 2: Percentage of nights of programme fidelity

	Holly	May	Sue
Percentage of total fidelity	90%	97.7%	85.3%

Part Two

Table 3: Summary of breastfeeding status by age, phase and intervention

Age at baseline	CSS at Baseline	Phase 1 Breastfeeding	Phase 2 Breastfeeding	Phase 3 Breastfeeding	Phase 4 Breastfeeding	Age at End of Study	CSS at Phase 3
Part One Participants							
5mo	13	Yes	Yes	Yes	N/A	10mo	6
8mo	15	Yes	Yes	Yes	N/A	12mo	4
10mo	14	Yes	Yes	Yes	N/A	15mo	7
Total still breastfeeding	**100%**	**100%**	**100%**	**100%**	N/A		
Akdoğan Study Intervention Participants							
15mo	14	Yes	Yes	Yes	Yes	21mo	8
12mo	13	Yes	Yes	Yes	No	19mo	2
12mo	10	Yes	Yes	Yes	Yes	18mo	5
12mo	10	Yes	Yes	Yes	Yes	18mo	1
12mo	15	Yes	Yes	Yes	Yes	19mo	10
12mo	17	Yes	Yes	Yes	Yes	19mo	8
17mo	9	Yes	Yes	Yes	No	21mo	2
14mo	11	Yes	Yes	Yes	Yes	20mo	7
14mo	14	Yes	Yes	Yes	Yes	20mo	7

13mo	16	Yes	Yes	Yes	Yes	19mo	5
Total still breastfeeding		**100%**	**100%**	**100%**	**80%**		
		Akdoğan Study Comparison Participants					
13mo	-	Yes	Yes	Yes	No	19mo	-
13mo	-	Yes	Yes	Yes	Yes	18mo	-
13mo	-	Yes	Yes	Yes	Yes	19mo	-
13mo	-	Yes	No	No	No	19mo	-
12mo	-	Yes	Yes	Yes	Yes	19mo	-
13mo	-	Yes	No	No	No	18mo	-
16mo	-	Yes	Yes	Yes	Yes	21mo	-
13mo	-	Yes	Yes	Yes	Yes	19mo	-
Total		**100%**	**75%**	**75%**	**62.5%**		

Note: Phase 1 for both studies was the baseline period. Phase 2 for both studies was the intervention period. Phase 3 for the Part One participants was follow-up (2 months after intervention completion) and was three weeks after intervention completion for the Akdoğan study. Phase 4 was only for the previous study, and was four to six months after intervention completion.

The table above represents a summary of breastfeeding status by phase of intervention and includes participants from both Part One of the current study and those in the Akdoğan study. It also includes the intervention outcome (effective or not). The Akdoğan study consisted of two groups: comparison (who chose not to receive an intervention) and intervention. All participants were included in this table.

Mother's breastfeeding by phase. As can be seen, all participants in all participant groups were breastfeeding during Phase 1. All mothers in the intervention groups also continued breastfeeding throughout Phase 2 and Phase 3. For the Akdoğan study, by Phase 4, 80% of mothers were still breastfeeding. The remaining 20% of mothers were either no longer breastfeeding, or no information pertaining to breastfeeding was available for the follow-up period. By Phase 2, only 75% of mothers from the comparison group were definitively still breastfeeding. This percentage of mothers stayed the same for Phase-3 before dropping to only 62.5% of mothers continuing to breastfeed at Phase-4.

Part Three

The final section of this study sought to provide an account of breastfeeding experiences for mothers who did decide to undertake a behavioural intervention to improve their infants' sleep. Areas of maternal experiences which contributed to themes are listed below with a summary, and examples of the range of responses. The final themes are listed in Table 4, under the relevant interview questions. Also given is the number of mothers who contributed to each sub-theme and further examples of their reported experiences.

Early breastfeeding experiences. Mother's early experiences varied greatly, and had both positive and negative experiences to share. Mostly mothers described having generally straightforward early experiences with breastfeeding and their

babies, "*he was a phenomenal feeder.*" Two of these mothers also reported having a delay in starting breastfeeding owing to small complications, however described having no problems once feeding was established. "*I was lucky with breastfeeding… it was easy from the beginning, apart from the first couple of days.*"

Several mothers reported more difficult experiences with breastfeeding, such as delays in milk coming through and issues with tongue-ties, which resulted in some stress, "*she latched well, but caused more nipple trauma [than her brother]"*. Of the eight mothers, only two mothers described breastfeeding as not an enjoyable experience. One stated, "*Breastfeeding has never been pleasant with her – she likes to acrobat. Except in the middle of the night where she's much calmer."*

Previous breastfeeding patterns. When asked about early breastfeeding with their baby, mothers reported varying patterns of feeding. Most mother's comments about breastfeeding were practical and down to earth, they made few affective statements. Some mothers reported feeding with a combination of demand and scheduled feeding and many of the mothers discussed choosing to feed their babies on demand. Some expressed pleasure at doing so. Two mothers gave positive affective statements, *"I comfort fed him – If he was crying, I fed him and I enjoyed it."* Another mother commented that her child was *"always content and happy. I feel like demand feeding does that to a child."*

One mother described her child as not one who fed for comfort, *"[She] was never into comfort suckling."* She also stated about her child, *"She would feed fast and furious during the day, and overnight less active with her feeding – more of a latch and cuddle, she never seemed like she was starving at night."*

Reasons for night feeding prior to the intervention. Almost all mothers relied on breastfeeding to get their infants to fall asleep. *"As soon as she cried or I heard her [sleep toy] bunny move I would go in. I thought if I get in there early and resettle her then I could go back to sleep. So I would go in straight away."* Some described using breastfeeding as a tool to get their babies back to sleep, however not all of them found it completely effective. *"Sometimes feeding back to sleep would work and sometimes it wouldn't. Breastfeeding wasn't a magic bullet…wasn't as reliable. Sometimes we would need to rock her to sleep."* One mother also described using breastfeeding inconsistently, sometimes feeding her child to sleep upon wakings, and other times choosing not to. *"Some weeks I would let him continue feeding at night and some weeks I didn't want to."*

Although resumption of mothers' own sleep was the major influence on mothers feeding their babies upon night wakings, some reported other reasons for continued night feeding. Two mothers were continuing night feeding because of concerns around their infants' nutritional intake. *"He was so busy and didn't take much solids. During that time I was reluctant to change that because I felt like he needed those calories."* One mother discussed her and her husband's shared desire to continue night feeding with their daughter. They spoke of concern that if they stopped feeding at night, she would lose interest in breastfeeding completely. Another mother described feeling obliged to feed her son at night when he woke, following a life-threatening medical experience when he was just one month old. *"I felt guilty leaving him...I didn't want him to feel any pain or be upset again after the operation."*

Feelings about stopping overnight breastfeeding for the intervention. Several mothers discussed how they felt about the prospect of giving up night feeds as part of the sleep intervention. For some mothers, by the time they had decided to seek

help with their infants' sleep and undertake a sleep intervention, they either did not find it difficult discontinuing with night feeds or spoke about stopping with neutrality. *"[I] don't feel like it was a tricky thing to balance giving up the night feeds."* For others it was much more difficult. Most mothers decided to stop breastfeeding their babies throughout the night. One mother, however, decided to implement a dream feed with both of her children who underwent the intervention. She reported about her second baby, *"We were concerned about going from feeding her eight to nine times a night to nothing. It seemed extreme. It was much more palatable, as a parent, to be able to feed at night."*

Experiences of maintaining breastfeeding throughout the intervention. When asked if they experienced any challenges in maintaining breastfeeding once the intervention had started, a range of perceived experiences emerged. Six mothers described experiencing no challenges or trouble physically. *"No challenges physically, no blocked ducts, shows how little he was feeding before that. It was a comfort thing."* Several of the mothers reported feeling as though they had more milk in the mornings, and one reported this was uncomfortable. One mother reported, *"I got a bit full. But I wasn't worried at any point."* However, one mother described that after starting the intervention she noticed a temporary change in her supply. *"For about a month in the evenings it seemed as though my supply was less because she would get a bit frustrated. I needed to make sure there was a big enough gap before feeding her again."*

None of the remaining mothers reported feeling as though they had any trouble with breastmilk supply throughout the intervention. One mother stated, *"It didn't affect my supply"* Another mother conveyed that there were no challenges for her son, however she stated of her own reaction *"Sometimes in the middle of the night*

it was hard because I knew I could stop the crying with a feed." One mother described no physical challenges, however described her daughter as being *"maybe slightly clingier in the morning."*

Changes in breastfeeding throughout the intervention. All mothers continued feeding their infants throughout the entirety of the intervention during the day with minimal changes. *"She was quite hungry in the morning and started having a bigger feed in the morning, but not extremely bigger."* When asked about any changes they experienced over the intervention regarding their breastfeeding, mothers did not report any that were determined by factors which were out of their control. Instead, mothers did report noticing natural changes in their infant's breastfeeding that ran parallel to the intervention. Three of the mothers reported a decrease in day time feeds during this time, however, all three suggested it was due to factors separate from the intervention such as increasing their intake of solids, starting preschool and becoming more easily distracted during breastfeeds. *"Her feeding during the day didn't change apart from age related changes to do with her attention and distractibility and needing less breast milk as she began to have more solids."*

Some of the mothers described being pleased with the changes that had come into effect following the intervention. One mother reported she was *"happy with the changes."* She conveyed that it was *"not a dramatic change, because I think he was feeding more for comfort at night and I knew he was getting enough food during the day."* Another mother described *"no big changes, other than not feeding at night. I felt he was feeding better. I was getting a better night sleep. Before the intervention started I was feeding all night so I don't think that was good for him."* She also reported, *"His feeding patterned out into more of a routine following the intervention."*

Continuation of breastfeeding. Perhaps the most overt theme that arose from all the interviews was that all mothers continued breastfeeding throughout the entirety of the intervention. Furthermore, all but two continued for at least two months after. By the end of the study, all three participants from Part One were still breastfeeding their babies without difficulty. When asked about their child's breastfeeding currently, or if they were still breastfeeding after the intervention, no mothers reported breastfeeding difficulty. *"She has a big feed in the morning and a couple of small ones in the day... I have no problems with supply. She gets what she wants."*

Timing of stopping breastfeeding. All mothers from Part One were still breastfeeding at the time of the interview while mothers from the Akdoğan study (who were interviewed at least one year following the end of the intervention) varied greatly in the timing of breastfeeding discontinuation. Four of the mothers from the Akdoğan study continued breastfeeding for a minimum of five months after the intervention finished. Only two mothers reported stopping breastfeeding completely, soon after the intervention finished. One mother reported that she and her husband decided to stop breastfeeding around one month after the intervention finished when she took an unrelated medication that rendered her unable to breastfeed for 48 hours. Another mother reported her child weaned himself within weeks after finishing the intervention once his teething trouble was over. However, the remaining mothers from the Akdoğan study continued breastfeeding for much longer. When asked if she was still breastfeeding after the intervention, one mother stated, *"Five months after the intervention I stopped."* Two of the mothers reported stopping breastfeeding a year from the start or end of the intervention, and one mother reported stopping just before her child was three. Two of the mothers from the current study reported about their intentions to continue breastfeeding in the future. One mother described wanting

to continue breastfeeding until she returned to work full time. She stated, *"We will hold off on weaning until I am back at work full time. I'm hoping it will happen naturally."*

Reasons for discontinuing breastfeeding. Mothers from the Akdoğan study discussed various reasons for the eventual discontinuation of breastfeeding. By the time of the interviews (at least one year following the completion of the intervention), no mothers from this group were still breastfeeding. None attributed this to the sleep intervention. Some reported making a decision to stop. One mother described making the decision to stop breastfeeding when she and her partner were considering having another child, while another decided she wanted to stop breastfeeding. Another mother reported the reason she discontinued breastfeeding was because of a medication she had to take. She stated, *"With the treatment I was given, I couldn't breastfeed for 48 hours. So we decided it was a good time to wean and she was fine with it."* Only one mother discontinued breastfeeding soon after the intervention finished. She reported, *"I was ready to give it up but I stuck to it as long as I could 'cause I enjoyed it."* She described the discontinuation of breastfeeding happening after her child finished teething and he stopped coming into her room to breastfeed.

Effects of stopping breastfeeding. Mothers from the Akdoğan study did not report many effects of the discontinuation of breastfeeding. One mother reported that the discontinuation of breastfeeding did not change anything for her and her son. Two mothers reported that by the time they stopped, their infants were not concerned, *"I wanted to stop breastfeeding and he wasn't bothered"*. Two more mothers reported that after they stopped breastfeeding, their infants increased eating other foods.

Table 4: Summary of themes by question.

Theme: Sub-theme	**Number of mothers represented:**	**Example quote:**
Tell me about breastfeeding and your baby right from the beginning		
There were mixed early breastfeeding experiences		
Straightforward	Six	*"No struggles. I had heaps of milk."*
Difficult	Three	*"She had a bit of reflux and a bad tummy for first couple of months which meant she needed to be upright after her feeds."*
Breastfeeding patterns prior to the intervention were largely on demand		
On-demand feeding	Four	*"I demand fed and I think that was the right thing to do."*
Schedule and demand	Two	*"I fed him with a rough schedule and a little on demand if he was grizzly or going through a growth spurt."*
Tell me about breastfeeding prior to starting the intervention		
There were several reasons for night feeding prior to the intervention		
Sleep resumption	Six	*"It was a much faster way of getting her down to sleep."*
Nutrition	Two	*"We were (still are) concerned about her weight."*
Guilt	One	*"I felt guilty leaving him."*
Mothers reported mixed feelings about stopping breastfeeding overnight		
Found prospect difficult	Two	*"[I] felt sick all day before the intervention first night. I was*

		told he doesn't need any feeding or nappy change in the night and I needed to hear it to believe it."
Neutral position	One	*"When the intervention started I stopped feeding her to sleep."*
Happy to stop	One	*"When sleep intervention started I was happy to stop doing night feeding."*
Did you face any challenges with maintaining your breastfeeding through the intervention?		
Maintaining breastfeeding during the intervention was predominantly straightforward		
No physical challenges	Six	*"There weren't really any challenges in terms of breast-feeding."*
Some difficulty	One	*"I needed to make sure there was a big enough gap before feeding her again."*
Were there any changes with your breastfeeding during the intervention?		
Outside of some changes in day feeding there were few changes to breastfeeding throughout the intervention		
Minimal (or no) changes aside from stopping night feeding	Four	*"Her feeding during the day didn't change apart from age-related changes to do with her attention and distractibility and needing less breast milk as she began to have more solids."*
Decrease in day feeding	Three	*"She stopped feeding as much… it has probably decreased a bit in the day too."*
Positive changes	Two	*"There was more quality in his feeding when the intervention started. He was feeding because he was actually hungry."*
Tell me about your breastfeeding now/after intervention		

Continuation of breastfeeding until end of intervention	Eight	*"Her breastfeeding now is fine…while I'm at work we will continue with the morning and night feed."*
Reasons for later discontinuing breastfeeding included both parental decisions and child-led weaning		
Decided to stop	Three	*"It was our decision as we were looking at having another child – thought it might help."*
Child lead weaning	One	*"We were doing it [breastfeeding] in my room. After teething he stopped."*
Timing of stopping after the intervention varied		
Still breastfeeding	Three	*"We both feel strongly that we want to breastfeed until at least two."*
Continued for five months or longer	Three	*"[We] continued until he was almost three however that was just the night time feed and mainly for comfort and routine as we had lots of changes around that time."*
Stopped within a month	Two	*"We continued breastfeeding] for about 1 month after…then I stopped feeding around 16 months [old]."*
Stopping led to no, or positive effects.		
Increase in other foods	Two	*"He's been eating more as a result and drinking a lot of milk."*
Children not concerned about cessation	Three	*"It was a good time to wean and she was fine with it."*

Discussion

The foremost aims of the current study were to a) determine whether breastfeeding mothers could continue breastfeeding readily, while carrying out a successful behavioural sleep intervention for ISD and b) report maternal experiences of breastfeeding while undergoing, and following, a sleep intervention. As can be seen from the results above, all three sleep interventions implemented for Part One were successful in reducing ISD to below the clinical cut off. Most importantly however, all three mothers maintained effective breastfeeding capacity throughout the entire intervention, and were still breastfeeding at follow-up. This was achieved despite two of the mothers not feeding their infants at night. Part Two of the study demonstrated that mothers of 12 to 17 month old infants who received a sleep intervention also continued breastfeeding. In fact, proportionally more of the mothers who received a sleep intervention from the Akdoğan study continued breastfeeding compared to those who chose not to intervene. Furthermore, the results of Part Three also demonstrated that no mothers faced any significant difficulties in maintaining breastfeeding throughout the intervention.

Having the two groups with differing age ranges of children meant the findings would benefit a wide range of breastfeeding mothers. Overall, the results of the current study suggest that mothers can implement a behavioural sleep intervention to treat ISD without risking their breastfeeding. All of the breastfeeding mothers in this study who participated in a sleep intervention continued to do so throughout the entirety of the intervention. Furthermore, the majority of them continued breastfeeding for months after, with the exception of two.

Intervention Effectiveness

All interventions were successful at reducing behaviours associated with ISD. At baseline, all Part One infants exhibited CSS scores that placed them in the severe sleep problem range, as defined by Richman's criteria. All infants' scores fell below the clinical cut-off for a sleep problem at the end of intervention, and although they did not maintain as significant gains in follow-up, none of the infants still met the criteria for ISD. It is important to note that this was also the case for Sue, despite her being sick during two nights at follow-up. When behaviour change is durable despite challenges like illness, it suggests it is also enduring.

Sleep onset latency showed the least improvement for both Holly and May, although Sue's improved drastically. As discussed above, because all infants were being breastfed or rocked to sleep prior to starting the intervention, sleep onset, we would not expect to see an obvious improvement when compared to baseline. That being said, both Holly and Sue's SOL at follow-up was below the problematic 15 minute mark (as reported by the CSS). May's was also mostly below 15 minutes, with the exception of two nights. One of which was explained above as being exceptional circumstances. During the intervention period, all infants displayed evidence of an increase in SOL prior to or following days of illness. Given this trend was apparent for all infants, it is likely an indication of them being unwell.

May was the only infant with a decreasing, whilst slight, trend in night-waking duration during baseline. However, the video-reliability results demonstrated that the diaries had under-reported both night waking frequency and duration, so this trend is not accurate. In fact, the video reliability footage indicated that night waking duration for the three, recorded nights at baseline were between 54 and 73 minutes. Had this

information been recorded accurately, it is likely there would not be evidence of a decreasing trend. Therefore, the effects on May's sleep can be assumed to be a result of treatment.

All three infants had reduced night waking frequency and duration at follow-up, relative to baseline. Holly and May experienced the greatest improvement. Sue exhibited evidence of the least durable change, despite her CSS score falling below the clinical cut-off. However, her most disrupted sleep nights were both nights of illness and could explain the extended night wakings for those nights. Although she woke most nights, on the nights her parents had not reported her sick, her waking durations were usually less than five minutes. There are a number of factors that may have had an effect on Sue's continued disrupted sleep. Sue experienced the most change during the intervention period out of all three infants. During the middle of the intervention, Sue started at preschool and her mother returned to work. Soon after this, Sue experienced a relatively long period of illness (as marked on the sleep graphs). Consequently, the intervention period was longer for Sue than it was for the other two children, as her sleep took the longest time to settle.

CSS scores also improved for all participants from the Akdoğan study after the intervention, despite three participants still considered as having ISD at Phase 3 (three weeks after intervention was completed). However, all three of these participants made great improvement in their sleep, and were no longer considered as having severe ISD. What's more, all parents reported a notable improvement in their infants sleep.

Breastfeeding Capacity

All mothers who underwent a BSI with their infants continued to breastfeed throughout the entirety of the intervention. These findings challenge the concerns of McKenna and Ball (2010), that sleep interventions create an unnecessary barrier to breastfeeding and can alleviate parent and clinician concern that may have arisen from their comment.

Most importantly, all Part One infants were still breastfeeding at the two month follow-up. Interestingly, they all also increased their day feeding when the intervention began, to compensate for the reduction in night feeding. Sue showed the most notable increase in day-time breastfeeding, despite an initial drop on the first day that may have been an initial response to the intervention. Following the second night of the intervention, she increased her day-time feed to above what it had been averaging at baseline. Given she had been breastfeeding more at night than she was during the day during baseline, this is not entirely surprising.

Across each phase of the study there was a small decrease in the average overall breastfeeding duration. This is unsurprising given that mothers were significantly (or completely) reducing their night feeding, due to their infants increasing ability to sleep through the night. Breastfeeding remained relatively stable across the intervention period for all infants, then decreased toward the end of the intervention, or at follow-up. The WHO recommends that infants between six and eight months receive solids two to three times per day, increasing to three to four times per between nine and 24 months (Organization, 2019). Given that the infants were between nine and 15 months at the end of the intervention, it is likely their

decrease in breastfeeding by follow-up is due to an increase in solid foods, and not a direct result of the intervention.

Given that the ages of the children from the Akdoğan study were between 18 and 21 months at follow-up, the proportion of mothers who were still breastfeeding is much higher than those reported by Castro et al. (2017). This is regardless of whether they participated in an intervention or not. They reported that only 36.6% of New Zealand mothers continue breastfeeding their infants at one, and a lesser 12.5% at two. Regardless, the results of this study suggest that behavioural sleep interventions implemented with older infants do not place mothers' breastfeeding at risk.

Relationship between breastfeeding and sleep disturbance

During baseline, there was an association between the duration of night waking experienced by the infants, and the duration of night time feeding. May, the youngest of the sample at just less than six old months during baseline had an average night waking duration of 53.25 minutes, and an average night time breastfeeding duration of 41.3 minutes. Holly, who was eight months, had an average night waking duration of 82.67 minutes, and average night feeding duration of 36 minutes. Lastly, Sue at 11 months had the most disturbed sleep, averaging 101.19 minutes of night waking per night and night feeding averaging 36 minutes per night.

This information suggests that as infant age increased, their night feeding and night waking duration decreased. It appears that the relationship between night waking and night breastfeeding may have been predicted by infant age. With May feeding the most over night and Sue the least. Both Holly and Sue's parents reported that breastfeeding was not always enough to get their children back to sleep following night wakings. Consequently they engaged in other behaviours such as rocking, and

holding them until they fell asleep. May's mother on the other hand, reported that May would fall asleep soon after she was breastfed. Touchette et al. (2005) and Sadeh, Tikotzky, et al. (2009) postulated that although young breastfed infants may need to wake frequently because of the easily digestible nature of breast milk, it is the continued parental interaction that inevitably comes with breastfeeding that encourages infants to continue waking. This theory also provides support for research by Blampied and France (1993) who reported that ISD is likely maintained through reinforcement from parental involvement at night time.

Maternal Breastfeeding Experiences

Ten themes emerged from the qualitative analysis: There were mixed early breastfeeding experiences; breastfeeding patterns prior to the intervention were largely on demand; there were several reasons for night feeding prior to the intervention; mothers reported mixed feelings about stopping breastfeeding overnight; maintaining breastfeeding during the intervention was predominantly straightforward; outside of some changes in day feeding there were few changes to breastfeeding throughout the intervention; breastfeeding continued until after the end of intervention; reasons for later discontinuing breastfeeding included both parental decisions and child-led weaning; timing of stopping after the intervention varied; and stopping lead to no, or positive effects. Early breastfeeding experiences, patterns and reasons for night feeding illustrated that many of the mothers demand-fed their babies and used breastfeeding as a means to get their infants to sleep. Two of the mothers also described feeding their infants overnight for nutritional purposes. Once the intervention began, none of the mothers reported any physical difficulty with maintaining breastfeeding, and continued to do so through the entirety of the intervention.

The majority of mothers in the study were using breastfeeding as a means to initiate sleep. The literature suggests that breastfed infants typically wake more and for longer periods than their non-breastfed counterparts Mindell et al. (2012); (Ramamurthy et al., 2012). However, several studies have suggested that it is not the breastfeeding that results in infants waking more frequently than their non-breastfed counterparts, but the parental involvement that comes with it (Sadeh, Tikotzky, et al., 2009; Touchette et al., 2005). Given that the majority of mothers were consistently using breastfeeding as a tool to get their infants to sleep, it seems likely the infants may have learned to rely on breastfeeding to return to sleep following a waking, disrupting their ability to learn to self-soothe.

Mothers gave numerous reasons for feeding their infants overnight. These ranged from feelings of guilt about leaving their infant to cry, wanting to settle their baby to sleep as soon as possible so they themselves could go back to bed, and for concerns about their infants' nutritional intake. Mothers can be assured that the majority of infants do not need to feed overnight after six months (France et al., 1996; Meltzer & McLaughlin Crabtree, 2015). However, one of the mothers in this study did have genuine concerns about her infant being underweight at the time of the intervention and consequently chose to implement a dream-feed. For parents with genuine concerns about their infants weight, including the option of a dream-feed to behavioural programmes may result in it being a more accessible option for helping with disrupted sleep.

Maternal breastfeeding capacity was not put at risk after undertaking the behavioural intervention. One mother described needing to be told that her son did not developmentally need to feed overnight, despite him being 13 months old. This is not an uncommon concern for parents considering the possibility of behavioural treatment

of ISD. France et al. (1996) summarise a list of common parental misconceptions about infant sleep and behavioural interventions, which includes the parental belief that infants need to wake and feed during the night. However, as previously stated, clinicians can reassure parents that healthy infants over six month do not share the developmental need to feed at night.

Mothers reported few negative experiences of giving up breastfeeding at night. One mother reported finding it difficult knowing she could stop her baby's cries by breastfeeding, and several reported having full breasts when they woke in the morning. However, none spoke of any difficulties in maintaining breastfeeding. One mother did describe feeling as though she needed to ensure there was a long enough gap between feeds, although breastfeeding continued readily throughout the entire intervention. These maternal experiences provide some evidence to challenge the concerns of McKenna and Ball (2010) that sleep interventions may lead to early cessation of breastfeeding.

Limitations

The current study was not without limitations. Perhaps the most obvious limitation to this study was the method of breastfeeding recording. Although the breastfeeding diaries gave an indication of the frequency and duration of breastfeeding during a 24-hour period, it did not give any indication of how much milk was being consumed. For example, two of the mothers from Part One reported that their infants' feeding patterns were different overnight when compared to during the day. One of the mothers reported that although her infant was latched on for a lengthy period over night, she was not feeding actively. Although the amount of milk infants were consuming was not measured, the breastfeeding diaries did provide enough evidence to determine whether breastfeeding was effectively maintained

during a sleep intervention. In addition, it provided enough evidence for a visual analysis to be carried out and assess any pattern of changes in breastfeeding.

A second limitation was in regard to the ages of the infants employed in the study. Infants were between the ages of six and 18 months at the beginning of intervention, however research suggests breastfeeding is more vulnerable in younger infants. Only one infant was six months old at the beginning of the study, the youngest age at which the CSP would implement at BSI.

Future Research

Future research should investigate the feasibility of sleep interventions improving ISD when dream-feeds are implemented. Sue was the only child in Part One who was fed at night (dream-fed). Interestingly, her sleep took the longest time to display a consistent treatment effect, and consequently she had the longest intervention period. Sue also displayed evidence of the most disrupted sleep at follow-up. It is impossible to know whether Sue's continued sleep disruption was a direct result of continued night feeding, periods of illness and disruptions to routine or a combination of the two. More research would be needed in order to determine whether behavioural interventions could be effectively implemented in accompaniment of dream feeding.

Future research could also address the aforementioned limitation that the breastfeeding diaries did not accurately represent breastfeeding capacity. Future studies would benefit from using measures that can record the amount of breast milk consumed by the infant per 24 hour period.

Finally, any future research should recruit more six-month-old infants. As mentioned, BSI's aren't typically implemented until this age, and McKenna and Ball's concern was in regard to younger infants requiring frequent breastfeeding.

Future research with bigger samples sizes of six-month-old infants would provide more evidence to reassure parents and clinicians that breastfeeding and quality sleep are not mutually exclusive.

Conclusion

In conclusion, this study provided preliminary evidence that BSI's can be safely implemented for infants between six and 18 months of age, without harming maternal breastfeeding capacity. Additionally, it provided qualitative accounts of maternal experiences when undertaking an intervention while breastfeeding. Breastfeeding mothers and clinicians working with sleep disturbed infants can be reassured that breastfeeding and good quality infant sleep are not mutually exclusive.

References

Adair, R., Zuckerman, B., Bauchner, H., Philipp, B., & Levenson, S. (1992). Reducing night waking in infancy: a primary care intervention. *Pediatrics, 89*(4), 585-588.

Akdoğan, G. Y., (2018). *To intervene or not to intervene: effects of behavioural sleep interventions on infant attachment quality.* (Doctoral thesis), University of Canterbury, New Zealand.

Ball, H. L. (2003). Breastfeeding, bed-sharing, and infant sleep. *Birth, 30*(3), 181-188.

Ball, H. L. (2014). Reframing what we tell parents about normal infant sleep and how we support them. *Breastfeeding Review, 22*(3), 11-12.

Blampied, N. M. (2017). Analyzing therapeutic change using modified Brinley plots: History, construction, and interpretation. *Behavior Therapy, 48*(1), 115-127.

Blampied, N. M., & France, K. G. (1993). A behavioral model of infant sleep disturbance. *Journal of Applied Behavior Analysis, 26*(4), 477-492.

Brown, A., & Harries, V. (2015). Infant sleep and night feeding patterns during later infancy: association with breastfeeding frequency, daytime complementary food intake, and infant weight. *Breastfeeding Medicine: The Official Journal of the Academy of Breastfeeding Medicine, 10*(5), 246.

Burnham, M. M., Goodlin-Jones, B. L., Gaylor, E. E., & Anders, T. F. (2002). Nighttime sleep-wake patterns and self-soothing from birth to one year of age: A longitudinal intervention study. *Journal of Child Psychology and Psychiatry, 43*(6), 713-725.

Butte, N. F., & King, J. C. (2005). Energy requirements during pregnancy and lactation. *Public Health Nutr, 8*, 1010-1027.

Castro, T., Grant, C., Wall, C., Welch, M., Marks, E., Fleming, C., . . . Morton, S. (2017). Breastfeeding indicators among a nationally representative multi-ethnic sample of New Zealand children. *New Zealand Medical Association, 130*(1466).

Centers for Disease Control and Prevention. (2014). *National immunization survey* U.S.A: CDC Retrieved from https://www.cdc.gov/breastfeeding/data/nis_data/results.html.

Clarke, A. E. (2014). *Effects of feeding method on infant sleep consolidation across 12 months.* (Unpublished master's thesis), University of Canterbury, New Zealand.

Coons, S., & Guilleminault, C. (1984). Development of consolidated sleep and wakeful periods in relation to the dav/night cycle in infancy. *Developmental Medicine & Child Neurology, 26*(2), 169-176.

Crichton, G. E., & Symon, B. (2016). Behavioral management of sleep problems in infants under 6 months–what works? *Journal of Developmental & Behavioral Pediatrics, 37*(2), 164-171.

Davis, M. K. (2001). Breastfeeding and chronic disease in childhood and adolescence. *Pediatric Clinics of North America, 48*(1), 125-141.

Dennis, C. L., & Ross, L. (2005). Relationships among infant sleep patterns, maternal fatigue, and development of depressive symptomatology. *Birth, 32*(3), 187-193.

Douglas, P. S., & Hill, P. S. (2013). Behavioral sleep interventions in the first six months of life do not improve outcomes for mothers or infants: a systematic review. *Journal of Developmental and Behavioral Pediatrics 34*(7), 497-507.

Elliot, R., Fischer, C. T., & Rennie, D. L. (1999). *British Journal of Clinical Psychology, (28),* 215-299.

Field, T. (2017). Infant sleep problems and interventions: A review. *Infant Behavior and Development, 47*, 40-53.

France, K. G., & Blampied, N. M. (2005). Modifications of systematic ignoring in the management of infant sleep disturbance: efficacy and infant distress. *Child & Family Behavior Therapy, 27*(1), 1-16.

France, K. G., Blampied, N. M., & Henderson, J. M. (2003). Infant sleep disturbance. *Current Paediatrics, 13*(3), 241-246.

France, K. G., Blampied, N. M., & Wilkinson, P. (1999). A multiple-baseline, double-blind evaluation of the effects of trimeprazine tartrate on infant sleep disturbance. *Experimental and Clinical Psychopharmacology, 7*(4), 502.

France, K. G., Henderson, J. M., & Hudson, S. M. (1996). Fact, act, and tact: A three-stage approach to treating the sleep problems of infants and young children. *Child and Adolescent Psychiatric Clinics of North America, 5*(3), 581-600.

Galland, B. C., & Mitchell, E. A. (2010). Helping children sleep. *Archives of Disease in Childhood, 95*(10), 850-853.

Hall, W. A., Saunders, R., Clauson, M., Carty, E., & Janssen, P. (2006). Effects of an intervention aimed at reducing night waking and signaling in 6-to 12-month-old infants. *Behavioral Sleep Medicine, 4*(4), 242-261.

Hauck, Y. L., Fenwick, J., Dhaliwal, S. S., & Butt, J. (2011). A Western Australian survey of breastfeeding initiation, prevalence and early cessation patterns. *Maternal and Child Health Journal, 15*(2), 260-268.

Heinig, M. J. (2001). Host defense benefits of breastfeeding for the infant: Effect of breastfeeding duration and exclusivity. *Pediatric Clinics of North America, 48*(1), 105-123.

Henderson, J. M., France, K. G., & Blampied, N. M. (2011). The consolidation of infants' nocturnal sleep across the first year of life. *Sleep Medicine Reviews, 15*(4), 211-220.

Henderson, J. M., France, K. G., Owens, J. L., & Blampied, N. M. (2010). Sleeping through the night: the consolidation of self-regulated sleep across the first year of life. *Pediatrics*, peds. 2010-0976.

Henderson, J. M. T. (2001). *The development of infant sleep: Implications for the prevention of infant sleep disturbance* (Doctoral thesis), University of Canterbury, New Zealand.

Heraghty, J. L., Hilliard, T. N., Henderson, A. J., & Fleming, P. J. (2008). The physiology of sleep in infants. *Archives of Disease in Childhood*.

Hiscock, H., Bayer, J., Gold, L., Hampton, A., Ukoumunne, O. C., & Wake, M. (2007). Improving infant sleep and maternal mental health: a cluster randomised trial. *Archives of Disease in Childhood, 92*(11), 952-958.

Jensen, R. G. (1995). *Handbook of milk composition*. London, United Kingdom, Academic Press.

Kent, J. C. (2007). How Breastfeeding Works. *Journal of Midwifery & Women's Health, 52*(6), 564-570.

Kent, J. C., Mitoulas, L. R., Cregan, M. D., Ramsay, D. T., Doherty, D. A., & Hartmann, P. E. (2006). Volume and frequency of breastfeedings and fat content of breast milk throughout the day. *Pediatrics, 117*(3), e387-e395.

Kirkland, V. L., & Fein, S. B. (2003). Characterizing reasons for breastfeeding cessation through out the first year postpartum using the construct of thriving. *Journal of Human Lactation, 19*(3), 278-285.

Kramer, M. S., Aboud, F., Mironova, E., Vanilovich, I., Platt, R. W., Matush, L., Ducruet, T. (2008). Breastfeeding and child cognitive development: new evidence from a large randomized trial. *Archives of General Psychiatry, 65*(5), 578-584.

Kulski, J., & Hartmann, P. (1981). Changes in human milk composition during the initiation of lactation. *Australian Journal of Experimental Biology and Medical Science, 59*(1), 101-114.

Matthey, S., & Črnčec, R. (2012). Comparison of two strategies to improve infant sleep problems, and associated impacts on maternal experience, mood and infant emotional health: A single case replication design study. *Early Human Development, 88*(6), 437-442.

McGarvey, C., McDonnell, M., Hamilton, K., O'Regan, M., & Matthews, T. (2006). An 8 year study of risk factors for SIDS: bed-sharing versus non-bed-sharing. *Archives of Disease in Childhood, 91*(4), 318-323.

McKenna, J. J., & Ball, H. (2010). Early infant sleep consolidation is unnecessary barrier to breastfeeding. *Pediatrics, 126,* e1081-1087.

McKenna, J. J., & McDade, T. (2005). Why babies should never sleep alone: a review of the co-sleeping controversy in relation to SIDS, bedsharing and breast feeding. *Paediatric Respiratory Reviews, 6*(2), 134-152.

Meltzer, L. J., & McLaughlin Crabtree, V. (2015). Sleep-onset associations and night wakings in young children. In L. J. Meltzer & V. McLaughlin Crabtree (Eds.), *Pediatric Sleep Problems: A Clinician's Guide to Behavioral Interventions*. Washington, DC, US: American Psychological Association.

Meltzer, L. J., & Mindell, J. A. (2014). Systematic review and meta-analysis of behavioral interventions for pediatric insomnia. *Journal of Pediatric Psychology, 39*(8), 932-948.

Minde, K., Faucon, A., & Falkner, S. (1994). Sleep problems in toddlers: Effects of treatment on their daytime behavior. *Journal of the American Academy of Child & Adolescent Psychiatry, 33*(8), 1114-1121.

Minde, K., Popiel, K., Leos, N., Falkner, S., Parker, K., & Handley-Derry, M. (1993). The evaluation and treatment of sleep disturbances in young children. *Journal of Child Psychology and Psychiatry, 34*(4), 521-533.

Mindell, J. A. (1999). Empirically supported treatments in pediatric psychology: bedtime refusal and night wakings in young children. *Journal of Pediatric Psychology, 24*(6), 465-481.

Mindell, J. A., Du Mond, C., Tanenbaum, J. B., & Gunn, E. (2012). Long-term relationship between breastfeeding and sleep. *Children's Health Care, 41*(3), 190-203.

Mindell, J. A., Du Mond, C. E., Sadeh, A., Telofski, L. S., Kulkarni, N., & Gunn, E. (2011). Efficacy of an internet-based intervention for infant and toddler sleep disturbances. *Sleep, 34*(4), 451-458B.

Mindell, J. A., Kuhn, B., Lewin, D. S., Meltzer, L. J., & Sadeh, A. (2006). Behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep, 29*(10), 1263-1276.

Moore, T., & Ucko, L. (1957). Night waking in early infancy: Part I. *Archives of Disease in Childhood, 32*(164), 333.

Mosko, S., Richard, C., McKenna, J., & Drummond, S. (1996). Infant sleep architecture during bedsharing and possible implications for SIDS. *Sleep, 19*(9), 677-684.

Neville, M. C., Allen, J. C., Archer, P. C., Casey, C. E., Seacat, J., Keller, R. P., . . . Neifert, M. (1991). Studies in human lactation: milk volume and nutrient

composition during weaning and lactogenesis. *The American Journal of Clinical Nutrition, 54*(1), 81-92.

New Zealand Ministry of Health. (2008). *Food and Nutrition Guidelines for Healthy Infants and Toddlers (Aged 0–2): A background paper*.

New Zealand Ministry of Health. (2016). *Breastfeeding is perfect for you and your baby.*

New Zealand Plunket Society. (2017). *Breastfeeding data analysis of 2010-2015*.

Nyqvist, K. H., Sjoden, P.-O., & Ewald, U. (1999). The development of preterm infants' breastfeeding behavior. *Early Human Development, 55*, 247-264.

Oddy, W. H., & Peat, J. K. (2003). Breastfeeding, asthma, and atopic disease: an epidemiological review of the literature. *Journal of Human Lactation, 19*(3), 250-261.

Peirano, P., Algarín, C., & Uauy, R. (2003). Sleep-wake states and their regulatory mechanisms throughout early human development. *The Journal of Pediatrics, 143*(4), 70-79.

Pinilla, T., & Birch, L. L. (1993). Help me make it through the night: behavioral entrainment breast-fed infants' sleep patterns. *Pediatrics, 91*(2), 436-444.

Price, A. M., Wake, M., Ukoumunne, O. C., & Hiscock, H. (2012). Five-year follow-up of harms and benefits of behavioral infant sleep intervention: randomized trial. *Pediatrics*, peds. 2011-3467.

Priddis, L. E. (2009). Tuned in parenting and infant sleep patterns. *Early Child Development and Care, 179*(3), 259-269.

Ramamurthy, M. B., Sekartini, R., Ruangdaraganon, N., Huynh, D. H. T., Sadeh, A., & Mindell, J. A. (2012). Effect of current breastfeeding on sleep patterns in infants from Asia-Pacific region. *Journal of Paediatrics and Child Health, 48*(8), 669-674.

Sadeh, A. (2005). Cognitive–behavioral treatment for childhood sleep disorders. *Clinical Psychology Review, 25*(5), 612-628.

Sadeh, A., & Anders, T. F. (1993). Infant sleep problems: Origins, assessment, interventions. *Infant Mental Health Journal, 14*(1), 17-34.

Sadeh, A., Mindell, J. A., Luedtke, K., & Wiegand, B. (2009). Sleep and sleep ecology in the first 3 years: a web-based study. *Journal of Sleep Research, 18*(1), 60-73.

Sadeh, A., Tikotzky, L., & Scher, A. (2009). Parenting and infant sleep. *Sleep Medicine Reviews, 14*(2), 89-96. doi:10.1016/j.smrv.2009.05.003

Sánchez, C. L., Cubero, J., Sánchez, J., Chanclón, B., Rivero, M., Rodríguez, A. B., & Barriga, C. (2009). The possible role of human milk nucleotides as sleep inducers. *Nutritional Neuroscience, 12*(1), 2-8.

Shannon, S. E., & Hsieh, H. F. (2005). Three approaches to qualitative content analysis *Sage Publications, 15*(9), 1277-1288.

Simard, V., Chevalier, V., & Bédard, M.-M. (2017). Sleep and attachment in early childhood: a series of meta-analyses. *Attachment & Human Development, 19*(3), 298-321.

St James-Roberts, I., Roberts, M., Hovish, K., & Owen, C. (2015). Video evidence that London infants can resettle themselves back to sleep after waking in the night, as well as sleep for long periods, by 3 months of age. *Journal of Developmental & Behavioral Pediatrics*, *36*, 324–329.

Touchette, É., Petit, D., Paquet, J., Boivin, M., Japel, C., Tremblay, R. E., & Montplaisir, J. Y. (2005). Factors associated with fragmented sleep at night across early childhood. *Archives of pediatrics & adolescent medicine, 159*(3), 242-249.

Twomey, J. E. (2016). A consideration of maternal developmental needs in the treatment of infant sleep problems. *Clinical Social Work Journal, 44*(3), 309-318.

Williams, C. D. (1959). The elimination of tantrum behavior by extinction procedures. *The Journal of Abnormal and Social Psychology, 59*(2), 269.

Woo, J. G., & Martin, L. J. (2015). Does breastfeeding protect against childhood obesity? Moving beyond observational evidence. *Current Obesity Reports, 4*(2), 207-216.

World Health Organization Programme of Nutrition. (1998). *Complementary feeding of young children in developing countires: a review of current scientific knowledge.*

World Health Organization. (2019). *Complementary feeding.*

World Health Organization, & UNICEF. (2003). *Global strategy for infant and young child feeding.*

Appendices

Appendix A: Parent information sheet

Child and Family Psychology Programme
Department: School of Health Sciences
Telephone: +64 27 640 0991
Email: maddy.morley@pg.canterbury.ac.nz
Date: 19/07/2018

Implementing a sleep intervention for infants while supporting mothers' breastfeeding.

Information Sheet for Parents

My name is Maddy Morley. I am a Masters student at the University of Canterbury and am currently enrolled in the Child and Family Psychology Programme. In 2018 I will be carrying out a study with the research aim being to implement a sleep intervention for infants while supporting mothers' breastfeeding throughout the intervention.

In order to carry out this research, I will be working with founder of the Canterbury Sleep Programme and Associate Professor, Karyn France (a registered clinical psychologist) within the Canterbury Sleep Programme. The Canterbury Sleep Programme has offered help with getting infants to sleep through the night by administering sleep interventions for over 30 years.

For this research we will include breastfeeding mothers with 6-12 month old babies who have difficulty settling or who wake often during the night, by offering a sleep intervention through the CSP. The research for this project will involve an additional breastfeeding diary to be completed alongside the CSP intervention and a follow up interview. There will be no cost to you. If this sounds appropriate for you and your baby I invite you to contact me.

If you choose to take part in this study, your involvement in this project will be undergoing a sleep intervention tailored to suit the needs of your baby and family through the Canterbury Sleep Programme. The study will cover a four-month period, with the intervention itself usually lasting four to six weeks. The intervention will be fully explained and we will keep in contact with you throughout. We will also discuss with you your plan to continue breastfeeding and work with you to remove any barriers there may be to this. To monitor any potential changes in breastfeeding and sleep in your baby during this time, you will be asked to complete a sleep diary where you will record the time and length of day-time naps, the time your baby settles to sleep each night, the number and duration of night wakes, time awake each morning and steps you take to encourage sleep during the night. Additionally you will be asked to complete a breastfeeding diary where you will write down how many times and how long you breastfeed your child for.

Before the intervention begins you will be asked to participate in an interview where we will talk about your child, their sleep and any questions you may have about the study. If we all agree this study will be a good fit for you and your child, you will be offered a place in the study.

The Canterbury Sleep Programme employs evidence-based graduated sleep programmes, which aim to be a gentle as possible. These are tailored individually to families depending on circumstances and preferences. Once an appropriate intervention strategy has been chosen, you will be given a hard copy of the breastfeeding and sleep diaries. We will ask you to fill out the diaries for one to three weeks prior to starting the sleep intervention. This is called a baseline period of data collection. Whether you

complete the diaries for one, two, or three weeks will be decided at random. The random assignment of length strengthens the research design. Once baseline data has been gathered the intervention generally lasts four to six weeks. It is estimated that it will take you 30 seconds for each diary entry, and 15 minutes total a day to complete, during the one to three week baseline period and additional four to six week intervention period. You will also have Regular daily contact from Maddy regarding progress, which will step down to weekly as progress continues.

As a follow-up to this investigation, you will be asked to participate in an interview to discuss your feelings around the intervention and any challenges you may have faced with breastfeeding and your baby's sleep. Additionally you will be invited to give any feedback about your experience.

In the performance of the tasks and application of the procedures there are risks of potential mild distress to both parents and children. You will be provided with support around this distress if you would like it. If you are feeling stressed, please make sure you let us know and we can modify or cease the programme. If you are still feeling stressed beyond this point then we encourage you to seek help from your GP, or Plunket nurse.

Participation is voluntary and you have the right to withdraw at any stage without penalty. You may ask for your raw data to be returned to you or destroyed at any point. If you withdraw, I will remove information relating to you. However, once analysis of raw data starts, six weeks after the intervention begins, it will become increasingly difficult to remove the influence of your data on the results. If you choose to withdraw from the study, you may choose to continue with the intervention until its completion.

The results of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation: your identity will not be made public without your prior consent. To ensure anonymity and confidentiality, before my thesis is submitted the data will only be accessible to my supervisors and me. All data will be stored in password protected external hard drives and locked storage at the university. All raw data will be destroyed five years after the study. The data gathered in this study will be published in a Masters Thesis and potentially in an academic journal. Additionally it may be presented at a conference. A thesis is a public document and will be available through the UC Library.

Please indicate to the researcher on the consent form if you would like to receive a copy of the summary of results of the project.

The project is being carried out as a requirement for a Master of Arts qualification by Maddy Morley under the supervision of Associate Professor Karyn France who can be contacted at karyn.france@canterbury.ac.nz. She will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form and return to Maddy Morley, Child and Family Psychology Programme, School of Health Sciences, University of Canterbury Private Bag 4800, Christchurch, 8140

Maddy Morley

Appendix B: Consent form

Child and Family Psychology Programme
Department: School of Health Sciences
Telephone: +64 27 640 0991
Email: maddy.morley@pg.canterbury.ac.nz
Date: 29/06/2018

Implementing a sleep intervention for infants while supporting mothers' breastfeeding.
Information Sheet for Parents

- ☐ I have been given a full explanation of the project "implementing a sleep intervention while supporting mothers' breastfeeding" and have had the opportunity to ask questions.
- ☐ I understand what is required of me and my child if I agree to take part in the research.
- ☐ I understand that participation is voluntary and I may withdraw at any time without penalty. Should I wish, withdrawal of participation will also include the withdrawal of any information I have provided so long as this occurs prior to the end of the intervention (6 weeks after the intervention begins)
- ☐ I understand I will be asked to complete a sleep and a breastfeeding diary. These will be used to measure progress during the sleep intervention and to identify how often and for how long my baby breastfeeds, especially changes in this during or after the intervention.
- ☐ I understand that any information or opinions I provide will be kept confidential to the researcher and her supervisors, and that any published or reported results will not identify the participants. I understand that a thesis is a public document and will be available through the UC Library.
- ☐ I understand that the findings of this study may be published in a research journal or at a conference and that the anonymity of myself and my child will be maintained.
- ☐ I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form and will be destroyed after five years.
- ☐ I understand the risk that sleep interventions may be mildly distressing for parents and children involved and how they will be managed.
- ☐ I understand that I can contact the researcher Maddy Morley (maddy.morley@pg.canterbury.ac.nz) or supervisor Associate Professor Karyn France (karyn.france@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)
- ☐ I would like a summary of the results of the project.
- ☐ By signing below, I agree to participate in this research project.

Name: Signed: Date:

Email address *(for report of findings, if applicable)*:

[Instructions for return the consent form]

Maddy Morley

Appendix C: Breastfeeding diary

Name: _____ Date _____

Breastfeeding Diary

Date							
1	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
2	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
3	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
4	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
5	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
6	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
7	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
8	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
9	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :
10	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :	Time : Duration :

Comments, thoughts or any changes:

Appendix D: Sleep diary

Date							
Day sleep							
Time down							
Time awake							
Where							
Time down							
Time awake							
Where							
Time down							
Time awake							
Where							
Key:							
Night sleep							
Where							
Time put to bed/comment							
What did baby do e.g. sounds made, behaviours etc.							
What did you do							
Time asleep							
Night waking – please note time baby woke and duration they were awake, what you did/what baby did/breastfeeding							
1							
2							
3							
4							
5							
6							
7							
Time awake for day							
Comments:					Key:		