The Effect of Maternal Scent in Dutch and Chilean Day Care Settings

Master's Thesis

L.M. Orlandini

S1102273

Supervisors: R. Cárcamo M.A.

and Dr. H.J. Vermeer

Leiden University

TABLE OF CONTENTS

Abstract

Research has established the calming effect on maternal scent on newborn infants; however, little research has been done to investigate these olfactory responses outside this sensitive period following birth. Additionally, no research has investigated how scent impacts the cry and sleep behavior within the day care setting, an environment of increasing relevance for child development. In this vein, this study examined the effects of maternal scent on the cry and sleep behavior of infants within the Dutch and Chilean day care settings. During the morning nap time, the cry and sleep behavior of 26 infants between the ages 4-9 month was observed via video recording under three different conditions: Own mother scent, Other mother scent, and Neutral scent. Results indicate that infants exposed to Other mother scent cry less than those exposed to both own mother and neutral scent. Additionally, no effects were found for the amount of hours that the infants spent in day care per week. However, an exploratory analysis between the Dutch and Chilean infants revealed differences in cry behavior. Namely, Chilean infants cried less in both own mother and other mother conditions than the Dutch infants. These findings provide preliminary evidence for the continued calming effect of maternal odor, but suggest that as infants develop, they are no longer calmed by the scent of their own mother. Further investigation of such effects could prove fruitful in the development of effective sleep aids within the day care setting.

Keywords: infant, olfaction, day care, cry, sleep, cross-cultural

1. Introduction

It is a well-established notion that children's development is largely shaped by the environment in which they are raised, and nowadays, a child's environment oftentimes extends beyond the home. In families with working parents, children may spend more time with extended family, with professional caregivers, or within a day care setting. Specifically, early exposure to the day care environment has been shown to have a long-lasting effect on children as they enter school and begin to perform in an academic setting (National Institute of Child Health and Human Development [NICHD], 2005). Through a 2005 longitudinal study into the long-term effects of early child care, the NICHD Early Child Care Research Network has shown that the higher number of hours spent in day care in the first few years of life had a negative impact on both the social skills and academic work habits of third-graders (NICHD, 2005). As this study illustrates, the potential impact of the day care environment on a child's future makes further research imperative in modern society. Furthermore, the influence of the day care environment becomes especially pertinent when one takes into account the societal tendencies in many modern cultures. Namely, the number of women entering the workforce is increasing throughout the modern world. As such, working mothers are becoming the norm, and more infants are exposed to a day care environment. Specifically, studies need to investigate the distinct mechanisms that have the most impact on a child's development as well as the potential ways that such negative consequences of day care attendance can be curbed in the future.

In this vein, the following study examined two different populations, the Netherlands and Chile, in order to determine whether the scent of the mother affects the sleep and cry behavior of 4-8 month-old infants. Both countries are striking examples of the increase in day care attendance in recent decades. Because female labor force in Chile is one of the lowest of the Organization for Economic Cooperation and Development (OECD) countries, strong policy initiatives have been applied in order to foster female labor participation; such initiative is seen in the government actions increasing access to public day care centers (OECD, 2011). In fact, the number of public day care centers increased by 240% between 2005 and 2007 (Medrano, 2009). However, Chile still has much ground to cover in bridging the gap of female labor participation, as demonstrated in its comparison to a country such as the Netherlands, in which the number of women in the Dutch workforce increased from 31% in 1975 to 69% in 2006 (Euwals, Knoef, & van Vuuren, 2011). It should be noted, however, that the Netherlands leads OECD countries in female part-time employment, making infant day care attendance part-time as well. This phenomenon of increased female labor participation is obviously taking a strong hold in both countries of interest. It, therefore, raises many questions and concerns regarding to the role of the day care environment and

whether such an environment has a positive or negative impact on an infant's development. Furthermore, questions arise as to whether the increase in quantity has taken a toll on the quality of the care provided (Vermeer et al., 2005; Villalon, Suzuki, Herrera, & Mathiesen, 2002). Chilean day care centers have seen an increased momentum at improving the quality of early education; such focus is seen in initiatives like Junta Nacional de Jardines Infantiles (JUNJI), a Chilean state funded program offering full-day education and care for 0-5 year old children living in poverty (Villalon et al., 2002). In fact, the quality of JUNJI day care centers showed a quality level similar to that of Austria, the country with highest standard of European countries as assessed by the European Child Care and Education (ECCE) study (Villalon et al., 2002). In this way, the JUNJI day cares are highly comparable to Dutch day care centers, and the inclusion of these day cares in our study provides a broader range of hours spent in day care for investigation.

In this context, this study investigates a specific element of the infant's day care experience, which could have a potential influence on the sleep and cry behavior: the scent of the mother. Through experiments carried out in day care centers in the respective countries, this study examines the morning naps of participating infants to determine whether exposure to the scent of the mother increases sleep time and decreases the amount of crying/fussing. This is done by exposing each infant to three different stimuli: the scent of own mother, the scent of another mother, and a neutral scent. In observing how the scent of the mother during sleep exposure potentially influences the sleep and cry behavior of infants, this study will not only contribute to the knowledge on the olfactory systems of infant, but it will also explore how an evolutionary strategy, such as olfactory cues, can be a viable solution for improving the quality of infant sleep experience in the day care setting.

1.1. Smell and Infant Behavior

Olfactory recognition has been proven to be a strong evolutionary mechanism for mammalian species (Halpin, 1991). According to kin selection theory, as a way to increase reproductive fitness, organisms should exhibit more favor toward more closely related kin in comparison to more distant kin (Hamilton, 1964). In fact, a study conducted by Dubas, Heijkoop, and van Aken (2009) revealed that parents reported a closer bond and more investment in children whose scent they were able to accurately identify. This suggests that olfactory cues may, in fact, be so influential that they direct parental investment in children. Whether animal or human, infant or adult, olfactory cues have been show to serve an evolutionary strategy for mammals to easily identify closely related kin, and this olfactory mechanism has been shown to be especially pertinent and sensitive following birth (Balogh & Porter, 1986; Nishitani

et al., 2009; Romantshik, Porter, Tillmann, & Varendi, H, 2007; Sullivan & Toubas, 1998; Winberg & Porter, 1998;). This can be attributed to the vulnerability of infants and, therefore the evolutionary incentive to be in close contact with and well cared for by a parent. Additionally, olfactory recognition in infants is thought specifically to aid in guidance toward the nipple during breast-feeding and, more generally, to assist in a smooth transition into life outside of the womb (Varendi, Porter, & Winberg, 1994). Research has established that scent has a strong effect on the behavior of infants; namely, that smells can influence the facial expressions, respiration, crying/fussing, sucking, and general body activity. In fact, studies have even revealed that familiar scents, whether or not they were maternal, have a calming effect on infants (Goubet, Rattaz, Pierrat, Bullinger, & Lequien, 2003; Goubet, Strasbaugh, & Chesney, 2007; Nishitani et al,. 2009; Rattaz, Goubet, & Bullinger, 2005; Sullivan & Toubas, 1998). For example, a study by Lucassen, Assendelft, Gubbels, van Eijk, & Douwes (2000) showed that exposure to whey hydrolysate formula (a bovine milk-derived product) reduced the crying duration by 63 minutes per day in colicky infants.

However, research has not only established such an olfactory sensitivity among newborns shortly after birth, but has also shown that infants demonstrate a specific olfactory sensitivity to their mother (Romantshik et al., 2007; Sarnat, 1978; Sullivan & Toubas 1998). In studies that examine the effects of maternally infused stimuli rather than the effects of a familiar scent, it has been established that maternal odors have a calming effect on the pain responses of full-term infants (Goubet et al., 2003; Rattaz et al., 2005; Goubet et al., 2007; Nishitani et al., 2009). Such studies help to illustrate the effectiveness of maternal odor specifically in clinical settings. However, in what ways can the maternal scent have an impact in other settings? While some research regarding the scent of the mother has been conducted in the home setting (Burnham, Goodlin-Jones, Gaylor, & Anders, 2002), very few environments outside of the clinical setting have been considered in research. Naturally, a baby's environment is much more complex than simply the home and clinical setting, and it is, therefore, important for future research to take into account the variety of consistent settings that an infant will encounter in its development. In this respect, the current study will consider the day care environment, an environment that is of ever-increasing importance for a baby and for society as a whole. Similarly, surprisingly few studies on infant response to maternal scent have been tested outside of the sensitive period following birth. Through this study on infants from 4-8 months of age, we examine whether the response period to a maternal scent extends beyond the time soon after birth and into later infancy.

1.2. Infant Sleep and Maternal Scent

As previously mentioned, a vast amount of research has been conducted on infant olfactory cues. Similarly, much research has also been conducted on infant sleep (Anders & Keener 1985; Sadeh, Acebo, Seifer, Aytur, & Carskadon, 1995; Sadeh & Anders, 1993; Thoman, 1990). However, little research has been performed on how such olfactory cues influence the quality of sleep in infants. A study executed by Burnham, Goodlin-Jones, Gaylor, & Anders (2002) examined the longitudinal night-time sleep patterns of infants and orientation to sleep aids infused with the mother's scent. While this study yielded no results in regards to preference for sleep aids infused with maternal odor, this may be due to methodological issues regarding how the scent was infused with the sleep aid, namely that maternal scent was not refreshed throughout the course of the longitudinal study. Therefore, it is important to continue research of this nature using various methodologies and various sleep settings.

The significance of studying infant sleep becomes ever more apparent when one considers the major role of sleep in learning and development. Although the precise role of sleep in cerebral development has not yet been clearly identified, sleep is thought to be an interaction between biological and socio-emotional regulation that helps infants to manage the major developments and adaptations that occur in infancy (Scher, 2001). Although only confirmed in animal studies, it is thought that sleep plays a major role in synaptic plasticity and brain development early in life (Frank, Issa, Stryker, & Keck, 2001; Macquet, Stickgold, & Smith, 2003). Research has also established that sleep disruptions and fatigue in infants results in an increase in emotional reactivity and a decrease in mature emotional regulation (Ross & Karraker, 1999). In addition to emotional regulation, Freudigman and Thoman (1993) showed that sleep-wake state organization in the neonatal age is related to cognitive function in the future; they did so by proving that sleep qualities of infants in the days following birth were predictive of Bayley scores at 6 months. In particular, nap periods have been proven to be a facilitator of cognitive and, more concretely, language development in infants (Gomez, Bootzin, & Nadel, 2006). Through this current study, we hope to not only expand on research concerning the interaction of scent and sleep, but also to take a closer look at the nap-time as a specific period of the sleep state.

1.3. Infants in the Day Care Environment

As previously mentioned, infant sleep has been observed and examined in various settings, most notably, home and clinical; however, little prior research has developed upon infant sleep within the daycare environment. Through this research, we hope to develop understanding of infant sleep in relation

to the sleep environment. In this way, this study recognizes that sleep, itself, is not only a major element of infant development, but that the environment in which the children sleep is also a vital element. The higher quality of daycare environment has been shown to result in higher cognitive and academic achievement while higher quantity of hours spent in day care predict greater risk-taking and impulsivity in teenagers (Vandell, Belsky, Burchinal, Steinberg, & Vandergrift, 2010). Since prior research has established that experience within day care has an impact on future child development, it is of great interest to investigate specific elements of the day care experience. In this vein, if quality of day care has an impact on child development and if naptime is an element of daycare, then examining the quality of nap time deserves a more serious and in-depth investigation.

A highly relevant aspect of day care is the quality of care provided to the children in attendance. The quality of care involves a number of factors such as child-to-caregiver ratio, as the more children a single caregiver is responsible for, potentially less quality of interaction exists. Additionally, the training of the caregivers, the sensitivity of caregiver, the mental health/state of mind of caregivers, infrastructure of the day care, and quality of the day care itself are all factors to be taken into account. Similarly, it is important to account for variables involving the infant; for example, the number of hours the infant spends in day care, the age of enrollment, child characteristics, maternal employment, parent-child relationships, and social and family factors. For the purpose of our study, we look to investigate a specific quality of the day care environment: the quality of the naptime. The quality of the naptime can, of course, be affected by various aspects of the overall quality of the day care. In fact, researchers in the Netherlands have reported a significant decline in the quality of day care environment, as assessed in a 2005 study by Vermeer, van IJzendoorn, de Kruif, Fukkink, Tavecchio, Riksen-Walraven, and van Zeijl. This Dutch study established that the most evident declines in day care were in the features of space and furnishing, personal care routines, and activities (Vermeer et al., 2005). Two of these three features may impact the quality of the sleep experience for the infant, namely, the quality of the space in which the infant sleeps as well as the routine used by the caregiver. The inclusion of the Chilean sample in our research not only integrates a country with a similar rapid increase as seen in the Netherlands, but it allows for the incorporation of a country with infants who attend day care full-time. In this way, by broadening the range of quantity of care, this study makes it possible to investigate how the number of hours may impact infant's reaction to maternal scent during naptime.

1.4. Research Questions and Hypothesis

This Master's project aims to investigate the effects of a mother's scent on the sleep/cry behavior of her infant within the daycare setting. Through experiments carried out in day care centers in both the Netherlands and Chile, this study poses two main research questions and one exploratory question. First, do the various scents influence the naptime well-being of infants? In this investigation, we define naptime well-being in relation to three parameters: total amount of crying, total amount of sleeping time, and sleep ratio. As such, a low amount of crying and a high amount of sleeping are considered indicators of a high quality of naptime well-being, while high crying and low sleeping would be indicators of low quality of sleep. Additionally, a high sleep ratio (proportion of time asleep in relation to time in bed) will be indicative of high quality of naptime well-being. By combining the two samples, this study will provide a broad range in the number of hours that the infants spend in day care. We will examine how such effects may vary based on differing hours spent in day care. This leads us into our second research question: will the number of hours that the infants spend in day care have an impact on the naptime well-being of the infants? It has been found in various studies that the number of hours spent in day care can have long-lasting impact on a child's later development (Broberg, Wessels, Lamb, & Hwang, 1997; NICHD, 2005). In a similar manner, we examine how the number of hours in day care may have a more proximate effect on an infant's cry and sleep behavior. Finally, we pose the following question for exploratory analysis: will the Chilean sample experience greater naptime well-being than the Dutch sample? The basis for this question is on an assumption that differences between the two samples may extend beyond number of hours spent in day care. In essence, we look to explore how potential variations in cultural context may have an impact on the sleep/cry behavior of the infant.

We propose three hypotheses to the aforementioned research questions. Firstly, it is expected that the cry and sleep times of the infants will differently affected by the three stimuli. More specifically, we expect that the mothers scent will result in higher naptime quality (longer sleeping and lower crying) than the other two scents. Secondly, we hypothesize that the number of hours spent in day care will have an influence on the infants' reactions to the sleep conditions. Namely, we expect that infants who spend a high amount of time in day care will have a better quality of naptime well-being than those infants who spend fewer hours in day care. We expect this because infants who spend more time in day care are potentially more adapted to the daycare setting and will, therefore, experience a higher amount of sleep time and a lower amount of cry time. And, lastly, as part of our cross-cultural analysis, we explore whether there are differences in quality of naptime well-being between the Dutch and Chilean samples.

2. Methods

2.1. Dutch Sample

2.1.1. Participants. Twenty-four mothers were recruited along with their 3-8-month-old infants from the Leiden area of the Netherlands for participation in this study. Mother-infant dyads were recruited through their day care centers. Daycare centers within the Leiden area of the Netherlands were initially approached for participation in this study. After expressing interest in participation in the study, day cares were subsequently asked to distribute informative material regarding this study to mothers with infants in the specified age range and who were in attendance of daycare for at least two days per week. Interested mothers then filled out and returned applications forms for participation in the study. The application form included consent to join the study as well as basic information regarding the infant's daycare attendance schedule and best days for mother to be contacted.

Three infants were excluded from the study because of inconsistency of data collection. In one case, the infant fell asleep in the arms of the caregiver, in the second case, the appropriate T-shirt was not brought to the observation period, and in the third case, complete data was not obtained from the questionnaire. Additionally, the inclusion criterion was extended to infants who were in attendance to daycare for less than two days per week. This extension resulted in the inclusion of two infants who attended daycare only one day per week. In the end, 21 infants were included in the study (14 male and 7 female). The mean age of the infants was 5.52 months (*SD* = 1.03) and the mean age of the mothers was 33.67 years of age (*SD* = 2.78). Infants spent an average of 22.19 hours per week in day care (*SD* = 7.36). Nineteen of the 21 mother-infant dyads were of Dutch nationality while two were reported as other.

2.1.2. Materials.

Stimuli. In order to assess the sleep and cry behavior of infants, observation of infants sleep in the daycare setting were carried out during exposure to three distinct stimuli. Specifically, infants were exposed to a T-shirt worn by its own mother, a T-shirt worn by another mother, and a neutral T-shirt. Each mother participating in the study was asked to wear T-shirts on two separate occasions. The T-shirt wearing procedure was similar to that of Porter and Moore (1981) and was as follows: mothers were asked to wear each T-shirt for three consecutive nights. Each night that the T-shirt was worn, mothers were asked to shower before bed without the use of shampoos, soaps, or perfumes. Each morning the mother was asked to place the T-shirt in a plastic zip-lock, as to preserve her scent from the contamination of household smells. After three nights of consecutive use, the T-shirt was used in the morning nap time at the day care, following the last night of wear. Additionally, mothers were asked to

complete a questionnaire regarding the conditions under which the mother wore each T-shirt. Questions included whether the mother or infant were sick during the time the mother wore the T-shirt, whether the mother had worn perfume in the days in which she wore the T-shirt, and, lastly, whether the mother had successfully worn the T-shirt for three consecutive nights after taking a shower without soap or shampoo. The mother repeated the procedure twice, once for use with her own infant, and once for use with another infant. The third smell stimulus was the neutral T-shirt, which was a T-shirt which had been washed in a non-scented laundry detergent and stored in a plastic bag. Exposure to T-shirts was counterbalanced within the sample.

Recording instruments. As mentioned previously, the sleep and cry behavior of infants was comprised of two determinants: sleep time and crying/fussing time. Digital camera recordings were employed during the naptimes to observe these behaviors. This is a common method in studies carrying out infant observation (Nishitani et al., 2009; Romantshik et al., 2007; Sullivan & Toubas, 1998). As in similar studies conducting infant observation (Rattaz et al., 2005), the camera was mounted on a tripod and positioned in front of the baby's crib, so as to be sure that the infant's face and body were visible. In this regard, the camera was also set to a night vision setting, as sleep rooms were often dark.

2.1.3. Procedure. Each infant was observed during the morning naptime using the aforementioned recording devices. Infants were filmed under three different conditions: with T-shirt worn by own mother, with T-shirt worn by another mother, and with a neutral T-shirt. All filming procedures were carried out by one of three trained research interns, all implementing the same protocol. Upon the day of each observation the designated T-shirt was either brought to the day care along with the infant or was brought along by the researcher themselves; this would depend on whether the infant was exposed to its own mother's scent, another mother's scent, or a neutral scent on the day of the observation. In the case that the T-shirt had been worn by the mother, the T-shirt was brought along with the infant when dropped off by parent; in the case that the T-shirt was worn by another mother, the T-shirt was picked up by the researcher on the same day as the observation; lastly, if the T-shirt was neutral, it was brought along with the researcher.

Upon arrival at the daycare center, the researcher fixed the video camera in front of the crib so that the infant was easily visible during sleep time. The designated T-shirt was placed around the mattress on which the baby would sleep; the T-shirt was always placed with the front of the T-shirt on the top of the mattress. Researchers made notes regarding the condition of the sleep room as well as the health status of the infant. When the infant was ready for sleep (determined by daycare provider), the

camera was switched on for observation. The caregiver was asked to place the infant in the crib, at which point the researcher noted the start time of sleep. Following the waking of the infant, the caregiver was asked to take the infant out of the crib, after which the video camera was turned off and the T-shirt removed from the mattress. The research noted end time of the nap.

2.1.4. Coding. Five coders analyzed video footage of infants during naptime. Coders analyzed video in terms of various sleep behavior parameters, derived from various infant sleep studies (Anders & Keener, 1985; Nishitani et al., 2009). The sleep parameters taken from these studies include: Bed time, Sleep time and Crying/Fussing. Coders received equivalent training and instruction regarding each component. The first item coded was the total bedtime of the infant, namely, the second the infant was placed in crib to the second the infant was removed from crib. The second item coded was the total sleep time. This was observed in terms of seconds that infant was asleep, with no distinction between quiet or active sleep. As seen in similar studies (Nishitani et al., 2009), crying/fussing was coded second-to-second when the infant cried or fussed for longer than 5 seconds in an attempt to gain the attention of the caregiver. Similarly, a crying/fussing period was only scored coded to be over after the infant had ceased with crying and fussing for a period longer than 5 seconds. Inter-rater reliability for the coding of the Dutch sample was $\alpha = 1.00$ for total bed time, $\alpha = .93$ for crying/fussing, $\alpha = .99$ for sleep time.

2.2. Chilean Sample

2.2.1. Participants. Six mothers and their 4-9 month-old infants (4 male and 2 female) were recruited from the Temuco region of Chile. Recruitment procedure in the Chilean study differed from the Dutch sample, as Chilean daycares were recruited via a regional meeting with all daycares from the Temuco region. This meeting was comprised of JUNJI Daycares which expressed interest in the study at the time of the aforementioned meeting were sent all informative material to be distributed among the mothers with infants in the proper age range. Mothers who wished to participate in the study completed a consent and application form and were later contacted by research assistants to establish dates for T-shirt wear by the mother and observation days for infants.

The mean age of the participating infants was 6.58 months of age ($SD = 2.01$), and the age of the participating mothers was quite young compared to the Dutch sample (M=22.00, $SD = 2.19$). On average, infants spent 41.67 hours per week in day care ($SD = 8.17$). Five of the six infants were identified as Chilean and one as Mapuche (an indigenous group in Chile) while four of the mothers identified themselves as Chilean and two as Mapuche. Recruitment retention was a challenge in the Chilean sample

because many children had passed the maximum age limit when experiments commenced, or the infants had changed day care centers, or because the infants fell ill.

2.2.2. Materials.

Stimuli. The stimuli were the same in this study as in the Dutch study. Mothers were asked to follow the same T-shirt wearing procedure, wearing two separate T-shirts on two separate occasions, one for use with own infant and one for use with another infant. Additionally, following the completion of T-shirt wear, the mother answered a Spanish version of the same questionnaire regarding conditions under which the T-shirt was worn (i.e. showering, sickness, etc.). Mothers were instructed to bring the worn T-shirt after duration of maternal exposure to the daycare when dropping off their infant.

Recording instruments. The same recording instrument (digital camera) was used in this study; specifically, observations were made using the same digital camera in the same manner as in the Dutch study. The only two exceptions were that 1) the cameras were not set in night vision, as was done in the Dutch study. This was because sleeping rooms were not dark in the Chilean day cares, making night vision unnecessary. And 2) cameras were often held by the researcher as the sleep environment was much busier for the Chilean sample. Chilean researchers were trained in the use of the instrument by a supervisor who had taken part in the study conducted in the Netherlands.

2.2.3. Procedure. The procedure in Chile differed slightly from the Dutch study. In the Chilean study, infants were also observed during the morning naptime at the day care. However, in the Chilean sample five trained researchers were assigned to record a particular baby in the daycare. Like the Dutch study, the Chilean infants were filmed under three different conditions: T-shirt worn by own mother, T-shirt worn by another mother, and a neutral T-shirt. Upon the day of each observation the T-shirt was either brought to the daycare by the mother who had worn in the preceding three nights or, if neutral condition, was brought by the researcher. Upon arrival at the daycare center, the researcher set up the video in close proximity to the infant's sleep location, in such a way that the infant's face and body was visible. However, the procedure was adapted to the nap routine of the Chilean day care, as it differed from that of the Dutch day cares. In the Dutch day cares, children were always put to sleep in a crib, while in the Chilean sample, it was the norm for an infant to take its morning nap in an infant bouncing chair. Additionally, it is typical in a Chilean day care for the caregiver to intervene until the infant had fallen asleep. This intervention oftentimes involved the infant's removal from the crib by the caregiver. Researchers, therefore, adapted the procedure to fit the Chilean norm by fitting the T-shirt to the bouncing

chair with the front of the T-shirt facing the infant. Additionally, infants were often within a busy area with other children playing in the room; and so, when necessary, researchers held the camera while filming the infant, as to avoid any damage to the camera. When the infant was ready for sleep (determined by daycare provider), the camera and decibel meter were switch on for observation. The caregiver was asked to place the infant in the crib, at which point the researcher noted the time of sleep. Babies were then filmed in their bouncing chair and during any out-of-crib time with the caregiver. Researchers made notes regarding the condition of the sleep room as well as the health status of the infant. Following the waking of the infant, the camera was turned off and the caregiver was asked to remove the infant. The research noted end time of the nap.

2.2.4. Coding. Video footage was analyzed by two of the five researchers who coded the videos from the Dutch sample. Coders followed the same guidelines for observation as they did in the Dutch study. Researchers accounted for the difference in Chilean nap routine (i.e. more frequent caregiver interventions) by coding for out-of-crib time and any caregiver intervention occurring at the beginning or throughout the filming. Inter-rater reliability for the coding of the Chilean sample was α =.99 for total bed time, α = .96 for crying and fussing, and α = .99 for sleep time.

2.3. Reliability for both samples

The reliability of the coders was calculated for each sample independently, and both resulted in high inter-rater reliabilities. The same held for calculation of reliability of the combined sample, with inter-rater reliability of α = .99 for total bed time, α = .95 for crying/fussing, and α = .99 for sleep time.

2.4. Statistical Analysis

Our statistical analysis started with recoding the number of hours infants spend in day care per week into two categories by using a median split procedure: low (less than 25 hours per week) and high (more than 25 hours per week). An nearly equal number of infants were in each group (n= 14; n=12), in this way we are able to examine how infants who experienced a high versus low amount of day care are affected by the various scents. Additionally, we created a new variable that will be used in analysis of quality of sleep. This variable will be called Sleep Percentage and is comprised of the total number of sleep in proportion to the total bed time. This study was a within subject design, in which the same participants were exposed to the different conditions of the study. In our case, this involved the conditions

of the own mother T-shirt (MT), other mother T-shirt (OT), and neutral T-shirt (NT). For each of the three research questions, we will run a repeated-measure analysis of variance (ANOVA) in regards to the three parameters stipulated for quality of naptime well-being: Cry time, Sleep time, and the Sleep percentage. However, for the latter two of the research questions posed in this study, we will conduct separate factorial repeated-measure ANOVAs incorporating the Hours in day care and Country of the study as between subject factors in the analyses. For analyses in which the assumption of sphericity is violated, we will use the more conservative Greenhouse-Geisser correction, which corrects for the violation by adjusting the degree of freedom, thereby altering the F-ratio. All statistical analysis was carried out using the statistical software, PASW Statistics 18.

3. Results

3.1. Preparatory Analysis

An initial data inspection revealed a normal distribution for all of our response variables, namely, Cry time, Sleep time, and Sleep percentage in all three conditions: maternal T-shirt (MT), other mother T-shirt (OT), and the neutral T-shirt (NT). However, data inspection revealed very high standard deviation (*SD*) scores for all sleep parameters; these SD scores were nearly the same as the mean scores. To correct for such high variability, we performed a log transformation on the variables. Following log transformation, SDs normalized. We, therefore, carried out the subsequent analyses with the log transformed variables. In order to identify outliers, Z-scores were calculated. An outlier was defined as any score higher than 3.29 and lower than - 3.29. One extreme outlier was identified in the data set and was subsequently removed due to its extreme characteristics. This outlier could potentially skew the distribution of the data as well as bias the results of the study. We, therefore, concluded to exclude it from further analysis.

Table 1 provides a descriptive analysis following the removal of the outliers. With regards to Cry behavior, the mean was 2.12 (*SD* = .98) when exposed to Maternal T-shirt (MT), 1.74 (*SD* = 1.02) when exposed to Other mother's T-shirt (OT), and 2.31(*SD* =.79) when exposed to the Neutral T-shirt (NT). With regard to sleep behavior, the mean was 3.50 (*SD* = .27) when exposed to MT, 3.47 (*SD* = .23) when exposed to OT, and 3.34 (*SD* = .72) when exposed to NT. Lastly, mean sleep percentage was 1.80 (*SD* = .13) for infants who were exposed to the MT, was 1.85 (*SD* = .11) for those exposed to OT, and was 1.77 (*SD* = .38) for infants exposed to NT.

Table 1.

Descriptives for parameters of naptime well-being and conditions

Nap Parameter		Maternal (MT)		Other mother (OT)		Neutral (NT)	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*
Cry Behavior	26	2.12	.98	1.74	1.02	2.31	.79
Sleep Behavior	26	3.50	.27	3.47	.23	3.34	.72
Sleep Ratio	26	1.80	.13	1.85	.11	1.77	.38

3.2. Effects of T-shirt Conditions on Quality of Naptime Well-being

Our first hypothesis stated that infants would react differently to the conditions that they were exposed to (MT, OT, and NT). More specifically, it was expected that infants would cry less and sleep more when exposed to their own mother's scent. In order to test this hypothesis, we analyze each parameter of naptime well-being in order to determine whether infants react differently to the stimuli.

3.2.1. Cry behavior. A repeated-measure ANOVA was conducted to compare the effect of T-shirt scent on the cry behavior of the infants. Results indicated that there was indeed a significant effect of T-shirt on the cry behavior, $F(2, 50) = 3.44$, $p < .05$, $\omega^2 = .12$. We see in the profile plot for cry behavior in Figure 1 that infants in MT and the NT condition cry significantly more than in the OT condition. Furthermore, the results yielded a medium effect size for these results.

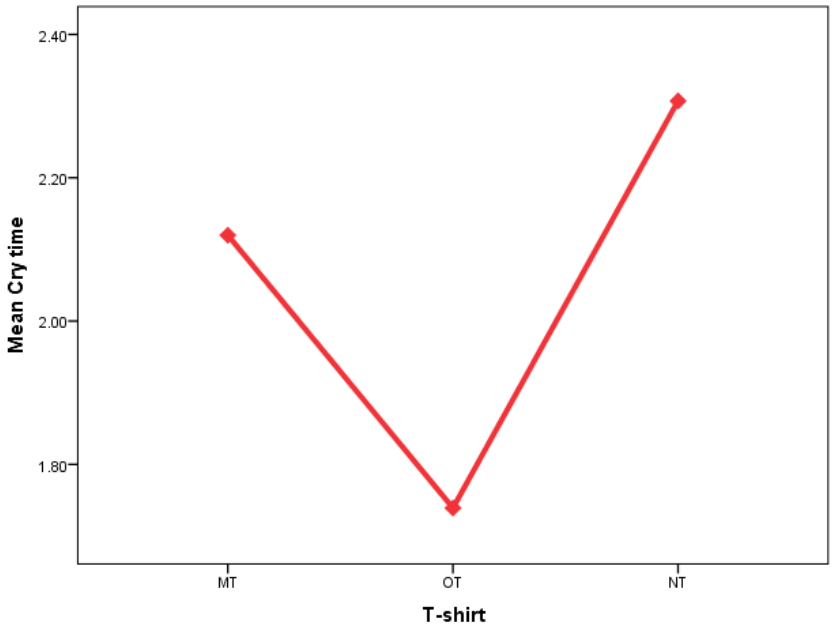

Figure 1. Profile Plot: Cry Behavior

3.2.2. Sleep behavior. Similarly, a repeated-measure ANOVA with a Greenhouse-Geisser correction was conducted to compare the effect of T-shirt scent on the sleep behavior of the infants. This test indicated that infant's sleep is not significantly affected by the T-shirt they are exposed to, $F(1.23, 30.63) = .92$, $p > .05$. $\omega^2 = .03$. More specifically, this shows that infants slept for a similar duration of time in all three conditions.

3.2.3. Sleep ratio. Lastly, a repeated-measure ANOVA with Greenhouse-Geisser correction was conducted to compare the effect of T-shirt scent on the sleep percentage of the infants. Results revealed that the T-shirt condition also did not significantly affect the percentage of sleep, $F(1.16, 28.89) = .808$, $p > .05$, $\omega^2 = .031$. Namely, the percentage of sleep does not vary based on the conditions of MT, OT, or NT.

3.3. Role of hours of day care attendance on responses

The second research question posed in this study investigated whether the influence of scent on the naptime well-being of the infant depends on the number of hours that the infant is in day care. In order to investigate this question, we ran a factorial repeated-measure ANOVA on each sleep parameter (Cry

behavior, Sleep time, and Sleep percentage) in regards to the three T-shirt conditions with between-subject factor, Hours in daycare.

3.3.1. Cry behavior. Cry behavior was examined using a factorial repeated-measure ANOVA with within subject factor of scents and between subject factor of Hours in day care (low and high). A main effect was found for T-shirt condition on cry behavior, $F(2, 48) = 3.20$, $p < .05$, $\omega^2 = .12$. However, the interaction of T-shirt condition and Hours in day care did not have a significant effect on cry behavior, $F(2, 48) = 1.21$, $p > .05$, $\omega^2 = .05$. Namely, infants who had a high day care weekly attendance did not differ in responses to scents as compared to the infants who had a low day care weekly attendance.

3.3.2. Sleep behavior. A second factorial repeated-measure ANOVA in regards to Sleep behavior, with within subject factor of T-shirt conditions and between subject factor of hours. This analysis was carried out with a Greenhouse-Geisser correction and revealed no main effect for T-shirt condition on sleep behavior, $F = (1.24, 29.70) = .77$, $p > .05$, $\omega^2 = .03$, as well as no significant interaction between T-shirt condition and Hours on Sleep behavior, $F(1.24, 29.70) = 1.21$, $p > .05$. $\omega^2 = .05$.

3.3.3. Sleep ratio. The same factorial repeated-measure ANOVA was carried out but with regards to Sleep percentage. We also conducted this analysis with Greenhouse-Geisser correction and results show that there was no main effect for T-shirt condition on Sleep percentage, $F(1.16, 27.93) = .71$, $p > .05$, $\omega^2 = .03$. Additionally, the impact of Hours was not significantly with respect to the infant Sleep percentages within the three conditions, $F(1.16, 27.93) = .1.27$, $p > .05$, $\omega^2 = .05$.

3.4. Influence of Country on Naptime Well-being and olfactory response

Our third and largely exploratory research question examined whether the influence of scent on the naptime well-being of the infant depends on the country in which the study took place. In order to investigate this question, we again ran factorial repeated-measure ANOVA on each sleep parameter (Cry behavior, Sleep time, and Sleep percentage); however, for the subsequent analyses, we used the Country in which the study took place as the between-subject factor.

3.4.1. Cry behavior. First, we examined the influence of Country on the cry behavior of the infants when exposed to the three different conditions. Results from the factorial repeated-measure ANOVA (see Table 2) show that the T-shirt condition has a main effect $F(2, 48) = 6.72$, $p < .05$, $\omega^2 =$

.22. Similarly, there was also a significant interaction of Country by T-shirt condition on Cry behavior, $F(2, 48) = 3.48$, $p < .05$, $\omega^2 = .13$. Namely, Chilean infants have different cry behavior responses to the conditions than the Dutch infants do. In examining the profile plot in Figure 2, we see that Chilean infants seem to cry less than the Dutch sample when exposed to the conditions of MT or OT.

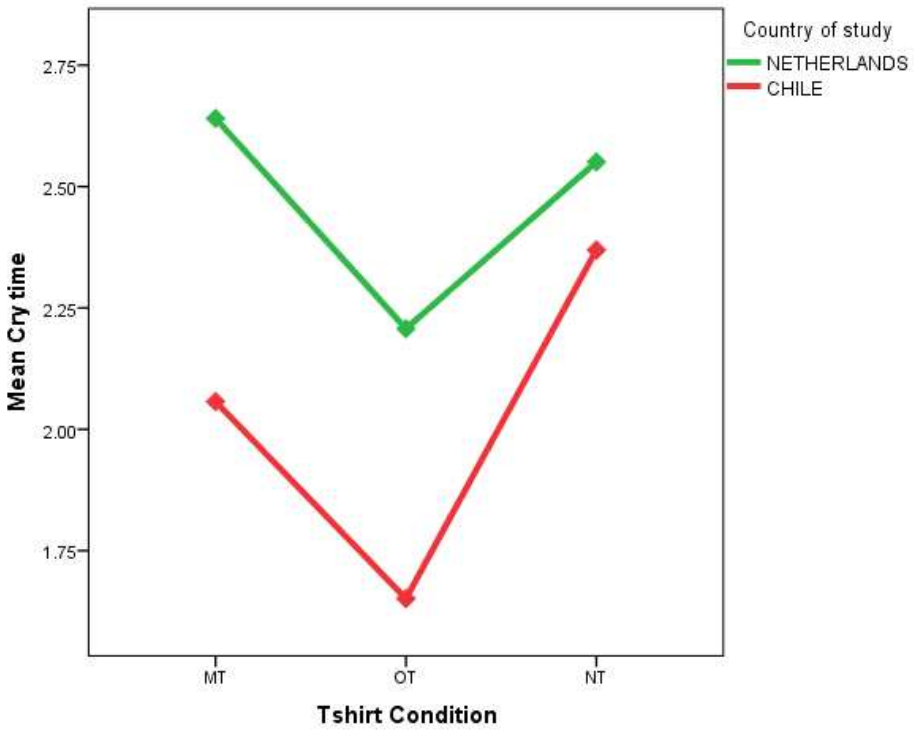

Figure 2. Profile plot of cry behavior in terms of country.

3.4.2. Sleep behavior. Next, Sleep behavior was also examined using the same repeated-measure ANOVA with between-subject factor of country. This analysis again revealed via the Greenhouse-Geisser correction that Sleep behavior was not significantly affected by the T-shirt conditions, $F(1.26, 30.30) = 3.57$, $p > .05$, $\omega^2 = .01$. As seen in Table 2, there was a nearly significant interaction between T-shirt condition and Country on the Sleep behavior, $F(1.26, 30.30) = 3.72$, $p = .054$, $\omega^2 = .13$.

Table 2. *Repeated measure analysis of variance for T-shirt condition and country on sleep behavior.*

Effect	*df*	*F*	ω^2	*p*
T-shirt	1.26	3.57	.13	.060
T-shirt*Country	1.26	3.72	.13	.054
Error	30.30			

Note: Significant at $p < .05$ level.

3.4.3. Sleep ratio. The final analysis we ran in order to examine whether the impact of the three conditions on naptime well-being is dependent on Country was in regards to Sleep percentage. Using the Greenhouse-Geisser correction, this factorial repeated-measure ANOVA indicated that T-conditions does not significantly affect the Sleep percentage of the infants, $F (1.18, 28.32) = 2.69$, $p > .05$, $\omega^2 = .101$, and also found no interaction between T-shirt condition and Country on the Sleep percentage, $F (1.18, 28.32) = 3.52$, $p > .05$, $\omega^2 = .13$.

4. Discussion

In this study we tested three different hypotheses regarding the influence of maternal scent on the naptime well-being of infants in the day care setting. The first hypothesis was that infants would experience a higher quality of naptime well-being when exposed to maternal scent as compared to the other two conditions (Other mother T-shirt and Neutral T-shirt). Our second hypothesis was that infants who spend a high amount of time in day care will have a higher quality of naptime well-being than those who spend fewer hours in day care, as they are more acclimated to the day care environment. Our last question explored any cross-cultural variations in the two samples that were included in this study.

In regards to the first hypothesis, results indicated that the naptime well-being of the infants only differed significantly between the three conditions. These results show that infants cry the least amount when exposed to the other mother scent (OT). As our study defined high quality of naptime well-being as low cry time, high sleep time, and high sleep ratio, these results do not support our formulated hypothesis that maternal scent would increase naptime well-being. One explanation of this unexpected result is that infants in the day care setting may be beyond an age at which they are comforted by their maternal scent. Studies with newborns have quite firmly established the comforting and calming effect of familiar and maternal smells (whether own or another) on newborn infants (Goubet, Rattaz, Pierrat, Bullinger, &

Lequien, 2003; Goubet, Strasbaugh, & Chesney, 2007; Nishitani et al., 2009; Rattaz, Goubet, & Bullinger, 2005; Sullivan & Toubas, 1998). As discussed in the introduction, few studies have investigated the calming influence of such odors outside of this sensitive period after birth. It is possible that as infants age and begin to form an attachment relationship with their mother (Bowlby, 1969), the scent of their own mother evokes aversive reactions in the infants, such as crying, especially when separated from the mother at day care. This becomes more striking when one considers that the infant cries the least amount when exposed to the condition of the other mother's condition as compared to the neutral condition, indicating that maternal scent of other mother results in less cry time. This implies that the other mother's scent has a calming effect in regards to cry behavior, and that infants are still calmed by maternal scent, just not their own, both at this stage of development and in this sleep setting. It should also be noted that infants do not respond differently in the three conditions in regards to the other two naptime well-being parameters, sleep time and sleep ratio. Although sleep percentage was not significantly affected by T-shirt condition in our analysis, it is possible that a study conducted with a larger sample size would increase the power of the observation and confirm this pattern.

Secondly, our hypothesis regarding the role of hours in day care on infant response to the scent condition was not supported by the analysis. Although results yielded no significant results for the influence of hours on naptime well-being, this could be due to the small sample size. However, as illuminated through our third hypothesis, this study does more than just provide insight into how infants react to distinct olfactory stimuli and how these reactions may be impacted by the amount of hours spent in day care. Additionally, this study presents a unique opportunity to carry out an exploratory investigation of any differences that arise between the Dutch and the Chilean samples. Our results indicate that infants' response to the scent conditions was not dependent on the country from which the infant was from. As previously stated, the Chilean infants spend a relatively larger amount of time in day care than the Dutch samples. This is in part due to the fact that Dutch mothers work part time, and their infants, therefore, are only in part-time attendance of daycare (Euwals et al., 2011). However, in Chile, in accordance with the JUNJI program, Chilean infants attend the public day care full-time, as to provide an enriching environment for the infants as well as to encourage mothers to participate in their own education or in the workforce. This distinction has been well accounted for in our analysis by conducting a separate analysis for hours in day care. However, as the analyses for hours revealed no results for influence on infant response to conditions, this implies that there may be differences between the countries that fall outside the scope of hours in day care.

One such difference between the Dutch and Chilean sample is the socio-economic status (SES) of the participants. The JUNJI program targets poor families, and, as is common with poverty stricken

samples, there is often a combination of risk factors that can contribute to aspects of child development (Bradley & Corwyn, 2002). For example, the mothers in the Chilean sample are much younger than the Dutch sample, and research has established that there is an association between young mothers an additional risk for adverse development for their children (Fraser, Brockert, & Ward, 1995). Additionally, the home environment, which is often a reflection of the low SES can have a negative effect on infant development, and, quite possibly, sleep and cry behavior. Additionally, cultural factors such as nighttime sleeping arrangements could also have an influence on the day care nap behavior. More specifically, the fact that co-sleeping is much more common in Chile than in the Netherlands could influence the responses of the infants to maternal scent within each sample. Lastly, there are also cultural variations in naptime routine that could create differences between the two samples. While this study looked to normalize the nap routine through its procedural measures, there were some striking differences in nap routine in each sample. Specifically, in the Dutch day care, it is customary for infants to be put down for a nap in their own crib in a room with other sleeping infants, separate from the rest of the day care. Furthermore, infants are typically left to fall asleep without their caregiver. On the other hand, the Chilean day cares tend to allow the infants to fall asleep in a bouncy chair within a common room of the day care environment. Additionally, it is common practice that caregivers stay to comfort or hold the infant if it is crying or fussing. In fact, in our study it was quite common for caregivers to stay with the infant until it fell asleep. Clearly, there are various aspects of each culture that could results in differing responses to the conditions, and although our study did not yield significant results, incorporating a larger sample size could contribute to uncovering the impact of the aforementioned differences.

This study was also limited in various ways. The first and most obvious limitation of this study is the small sample size. While significant results were revealed between infant cry reactions to the various conditions, the study failed to yield any results regarding sleep reactions of the infants. The small sample size reduces the power of the statistical test to detect any significant difference. It is, therefore, possible that the various conditions have an influence on sleep behavior as well as cry behavior, but were found to be insignificant due to the low predictive power of such a small sample size. Secondly, this study did not fully account for the condition of the infant on the day of the filming. More specifically, there was no assessment of the infant's quality of sleep on the nights prior to naptime observation in the day care. As this is a condition that could vary on each day of observation, it is possible that an infant had a poor night's sleep prior to the filming of a particular T-shirt and would, therefore, cry less and sleep more. In this way, it could skew the results of the study if left unaccounted for. Additionally, this study was subject to various limitation associated with a replication study. Although the procedure with the Chilean sample was a replication of the procedure carried out in the Netherlands, there were some inconsistencies in

procedure that should be noted. Namely, because the day cares and sleeping arrangements were much busier in Chile, it was at times necessary for researchers to hold the camera during the observation of sleep. As such, researchers were sometimes in the room with the infant as it slept. Therefore, it is possible that the presence of the researcher had an effect on the infant's behavior during the filming, which we cannot control for. Additionally, this brings in to question the integration of the two samples as well as the generalizability of the results.

This investigation into the effects of maternal scent on infant behavior has many strengths, both in its design and in its application. First, by incorporating the Dutch and the Chilean sample, the study provides a broad range of day care attendance hours, making generalizability of the results more valid. Of course, as previously discussed, it is also important to account for any cultural factors that may differentiate the samples. Second, there was a high inter-rater reliability for coding of sleep and cry/fussing time, establishing a very strong reliability of the measurement instrument. Thirdly, by carrying out a within-subject design, in which the same infants are exposed to different conditions, we are able to control for individual variations regarding cry and sleep behavior. Furthermore, the use of the three particular stimuli of this within-subject design is also a strength, as it allows us to compare how the infants respond in a condition with no scent (neutral T-shirt), how the infants respond to the familiar scent (maternal T-shirt), and how an infant responds to an unfamiliar smell (other mother T-shirt). Additionally, the incorporation of these three stimuli effectually builds on prior olfactory recognition research in infants. A possible departure for future research would be to investigate infant sleep and cry response to non-human, unfamiliar smells or to examine a familiar human scent that is not the mother (for example, father, sibling, etc.). As mentioned in the introduction, very little research has been conducted on infants sleep within the day care setting. Therefore, the investigation into this unexplored sleep setting offers a glimpse into an environment that is of growing significance to infant development. Similarly, relatively few studies have been conducted using olfactory responses of infants beyond the sensitive period following birth. In this way, this study also provides an additional strength by investigating a period of time in infancy that is under researched in regards to reactions to smells.

As this study has established, infants cry more when exposed to their own mother's scent and less when exposed to another mother's smell. Additionally, this study provided a preliminary exploration into the cross-cultural variation between the Netherlands and Chile in regards to infant responses to olfactory stimuli in the day care setting. These preliminary discoveries deserve deeper investigation in order to determine the specific factors contributing to such difference between the two countries. Furthermore, these results have potential implications both for practical application in day care settings as well as for future research. First, further research could expand upon the role of stress reactivity in expressions of

physiological responses, such as cortisol. In this vein, Vermeer and van IJzendoorn (2006) conducted a meta-analysis on children's intra-individual differences in cortisol level across day care and home environment. Results from this study revealed that children had higher levels of cortisol at day care as compared to their home setting; furthermore, this result was most prominent for children younger than 36 months of age (Vermeer & van IJzendoorn, 2006). In this way, the current study could be expanded upon by incorporating cortisol assessment before and after naptime. Similarly, it would be of additional interest to examine how infants who are in part-time day care attendance react differently during their naptime to the conditions, dependent upon whether they are at home or in the day care. Lastly, the integration of measures of attachment into the research design would also bridge a gap between research into day cares, research into sleep quality, and research into cortisol reactivity. Studies have established that attachment classification has an impact on sleep behavior of infants (McNamara, Belsky, & Fearon, 2003; Scher, 2001). Additionally, as stated, research has also established a relationship between cortisol and the day care environment (Vermeer & van Ijzendoorn, 2006; Watamura, Sebanc, & Gunnar, 2002). Lastly, studies have investigated the interaction of sleep quality and cortisol in toddlers (Scher, Hall, Zaidman-Zait, &Weinberg, 2009). Future research should not only aim to bridge this gap but also look to implement findings within the day care setting as a means of improving the well-being and development of children in day care centers.

References

Anders, T.F. & Keener, M. (1985). Development course of nighttime sleep-wake patterns in full-term and premature infants during the first year of life. *Journal of Sleep Research & Sleep Medicine*. 8, 173-192.

Balough, R.D. & Porter, R.H. (1986). Olfactory preferences resulting from mere exposure in human neonates. *Infant behavior and development*. 9, 395-401.

Booth, C.L., Leonard, H.L., & Thoman, E.B. (1980). Sleep states and behavior patterns in pre-term and full-term infants. *Neuropediatrics*. 11, 354-364.

Bowlby, J. (1969). Attachment and loss: Vol. 1. *Attachment.* New York: Basic Books.

Bradley, R.H.& Corwyn, R.F. (2002). Socioeconomic status and child development. *Annual Review of Psychology.* 53, 371-399.

Broberg, A.G., Wessels, H., Lamb, M.E., & Hwang, C.P. (1997). Effects of day care on the development of cognitive abilities in 8-year-olds: A longitudinal study. *Developmental Psychology.* 33, 62-69.

Burnham, M.M., Goodlin-Jones, B.L., Gaylor, E.E., & Anders, T.F. (2002). Use of sleep aids during the first year of life. *Pediatrics*. 109, 594-601.

Cernoch, J.M. & Porter, R.H. (1985). Recognition of maternal axillary odors by infants. *Child Development*. 56, 1593-1598.

Dubas, J.S., Heijkoop, M., & van Aken, M.A.G. (2009). A preliminary investigation of parent-progeny olfactory recognition and parental investment. *Human Nature*. 20, 80-92.

Euwals, R., Knoef, M., & van Vuuren, D. (2011). The trend in female labor force participation: what can be expected in the future? *Empirical Economics.* 40:3, 729-753.

Frank, M., Issa, N., Stryker, M., & Keck, W. (2001). Sleep enhances plasticity of the developing visual cortex. *Neuron*. 30, 275-287.

Fraser, A.M., Brockert, J.E., & Ward, R.H. (1995). Associations of young maternal age with adverse reproductive outcomes. *New England Journal of Medicine.* 332, 1113-1118.

Freudigman, K.A. & Thoman, B.E. (1993). Infant sleep during the first post-natal day: an opportunity for assessment of vulnerability. *Pediatrics*. 92, 373-379.

Goubet, N., Rattaz, C., Pierrat, V., Bullinger, A., & Lequien, P. (2003). Olfactory experience mediates pain response to pain in preterm newborns. *Developmental Psychobiology.* 42, 171-180.

Goubet, N., Strasbaugh, K., & Chesney, J. (2007). Familiarity breeds content? Soothing effect of familiar odor on full-term newborns. *Journal of Developmental and Behavioral Pediatrics*. 28, 189-194.

Gomez, R.L., Bootzin, R.R., & Nadel, L. (2006). Naps promote abstraction in language-learning infants. *Psychological Science*. 17:8, 670-674.

Halpin, Z.T. (1991). Kin recognition cue of vertebrates. In P.G. Hepper (Ed.), *Kin recognition* (pp. 220-258). Cambridge, UK: Cambridge University Press.

Hamilton, W.D. (1964). The genetical evolution of social behavior I & II. *Journal of Theoretical Biology*. 7:1, 1-52.

Jenni, O.G. & O'Connor, B.B. (2005). Children's Sleep: An Interplay between Culture and Biology. *Pediatrics*. 115, 204-216.

Lucassen, P.L., Assendelft, W.J., Gubbels, J.W., van Eijk, J.T., & Douwes, A.C. (2000). Infantile Colic: Crying time reduction with a whey hydrolysate: a double-blind, randomized, placebo-controlled trial. *Pediatrics.* 106, 1349-1354.

Macquet, P., Stickgold, R., & Smith, C. (2003). *Sleep and Brain Plasticity.* Oxford, UK: Oxford University Press.

McNamara, P., Belsky, J., & Fearon, P. (2003). Infant sleep disorders and attachment: Sleep problems in infants with insecure-resistant versus insecure-avoidant attachments to mother. *Sleep and Hypnosis.* 5, 7-16.

Medrano, P A. (2009). Public Day Care and Female Labor Force Participation: Evidence from Chile (SDT 306).Retrieved from Universidad de Chile, Departamento de Economía website: http://www.econ.uchile.cl/uploads/publicacion/25d848f1-0435-9623-b20cff7a36aaa.pdf

NICHD Early Child Care Research Network. (2005). Early child care and children's development in the primary grades: follow-up results from the NICHD study of early child care. *American Educational Research Journal*. 42:3, 537-570.

Nishitani, S., Miyamura, T., Tagawa, M., Sumi, M., Takase, R., Doi, H.,...Shinohara, K. (2009). The calming effects of a maternal breast milk odor on the human newborn infant. *Neuroscience Research*. 63, 66-71.

Organization for Economic Cooperation and Development (2011): Economic Policy Reforms 2011: Going for Growth. *OECD Country Notes 2011*. Retrieved from SourceOECD database Organization for Economic Cooperation and Development (2010)

Porter, R.H. & Moore, J.D. (1981). Human Kin Recognition by Olfactory Cues. *Physiology and behavior*. 27, 493-495.

Porter, R.H. (1999). Olfaction and human kin recognition. *Genetica*. 104, 259-263.

Porter, R.H. (2004). The biological significance of skin-to-skin contact and maternal odours. *Acta Pediatrica*. 93, 1560-1562.

Romantshik, O., Porter, R.H., Tillmann, V., & Varendi, H. (2007). Preliminary evidence of a sensitive period for olfactory learning by human newborns. *Acta Pediatrica*. 96, 372-376.

Russell, M.J. (1976). Human Olfactory communication. *Nature*. 260, 520-522.

Rattaz, C., Goubet, N., & Bullinger, A. (2005). The calming effects of a familiar odor on full-term newborns. *Developmental and Behavioral Pediatrics*. 26, 86-92.

Sadeh, A., & Acebo, C. (2002). The role of actigraphy in sleep medicine. *Sleep Medicine Reviews*. 6, 113-124.

Sadeh, A., Acebo, C., Seifer, R., Aytur, S., & Carskadon, M.A. (1995). Activity-based assessment of sleep-wake patterns during the 1st year of life. *Infant Behavior and Development*. 18, 329-337.

Sadeh, A. & Anders, T.F. (1993). Infant sleep problems: Origins, assessments, interventions. *Infant Mental Health Journal*. 43, 17-34.

Sadeh, A., Sharkey, K.M., & Carskadon, M.A. (1994). Activity- based sleep-wake identification: an empirical test of methodological issues. *American Sleep Disorders association and sleep research society*. 17, 201-207.

Sarnat, H.B. (1978). Olfactory reflexes in the newborn infant. *The journal of Pediatrics*. 92, 624-626.

Scher, A. (2001). Attachment and Sleep: A study of night waking in 12-month old infants. *Developmental Psychobiology*. 38, 274-185.

Sullivan, R.M. & Toubas, P. (1998). Clinical usefulness of maternal odor in newborns: soothing and feeding preparatory responses. *Biological Neonate*. 74, 402-408.

Thoman, E.B. (1990). Sleep and waking states in infants: A functional perspective. *Neuroscience & Biobehavioral Reviews*. 14, 93-107.

Winberg, J. & Porter, R.H. (1998). Olfaction and human neonatal behavior: clinical implications. *Acta Paediatrica*. 87, 6-10.

Vandell, D.L., Belsky, J., Burchinal, M., Steinberg, L., & Vandergrift, N. (2010). Do effects of early child care extend to age 15 Years? Results from NICHD study of early child care and youth development. *Child Development*. 81:3, 737-756.

Varendi, H., Porter, R.H., & Winberg, J. (1994). Does the newborn baby find the nipple by smell? *Lancet*. 344, 989-990.

Vermeer, H.J., van Ijzendoorn, M.H. (2006). Children's elevated cortisol levels at day care: A review and meta-analysis. *Early Childhood Research Quarterly*. 21, 390-401.

Vermeer, H.J., van IJzendoorn, M.H., de Kruif, R.E.L, Fukkink, R.G., Tavecchio, L.W.C., Riksen-Walraven, J.M., & van Zeijl, J. (2008). Child care in the Netherlands: Trends in Quality over the years 1995-2005. *The Journal of Genetic Psychology*. 169, 360-285.

Villalon, M., Suzuki, E., Herrera, M.O., & Mathiesen, E. (2002). Quality of Chilean early childhood education from an international perspective. *International Journal of Early Years Education.* 10, 49-59.

Watamura, S.E., Sebanc, S.M., & Gunnar, M.R. (2002). Rising cortisol at childcare: Relations with nap, rest, and temperament. *Development Psychobiology*. 40, 22-42.