



Full Length Article

Active sleep is associated with the face preference in the newborns who familiarized with a responsive face



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ABSTRACT

Aim of this study was to investigate the preferential looking behaviour, subsequent to a familiarization task (8-min) with a previously responsive or motionless face, before and after a sleep cycle. Moreover, the role of the active sleep in memory consolidation of the responsive or motionless faces was explored. Hypotheses were that the newborns undergoing a motionless familiarization will exhibit a novelty effect (preference for the novel face) whereas the newborns undergoing a responsive familiarization will show a familiarity effect (preference for the known face) before and after the sleep cycle; moreover, the amount of active sleep will be associated with the looking time at the known face after a sleep cycle.

Forty-five healthy full-term newborns were randomly assigned to two groups (group 1: motionless-familiarization and group 2: responsive-familiarization); in both groups newborns were video-recorded during four post-familiarization face-preference tasks, two of them performed before and two after a sleep cycle.

During the pre-sleep-trials, there was not a significant preference for one face in both groups. During the post-sleep trials, the newborns showed a clear preference for the novel face. This effect was more evident in group 1. Only in group 2 there was a significant positive correlation between the active sleep duration and the looking duration at the known-face during the post-sleep trials ($r = 0.41$; $p = 0.040$). Multiple regression confirmed that only in the group 2 the total duration of the active sleep was associated with the looking duration at the known-face during the post-sleep trials (Adjusted $R^2 = 0.13$; $\beta = 0.41$; $t = 2.2$; $p = 0.040$).

Findings showed that in newborns the face representation can be recalled after a sleep cycle. Moreover, the amount of the active sleep predicted the post-sleep looking toward the known-face only in the newborns who interactively familiarized with the face.

1. Introduction

1.1. Face preference at the birth

The preferential looking paradigm (Bushnell, 2001; Pascalis, de Schonen, & Morton, 1995; Morton and Johnson, 1991; Horowitz, Paden, Bhana, & Self, 1972) demonstrated that newborn infants prefer to look at a human face-like stimulus (Morton and Johnson, 1991). Moreover, many studies demonstrated that newborns, in the first hours of life, prefer to look at a novel face (novelty effect)

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compared to an unfamiliar face previously known during an habituation paradigm in which the face was motionless (Bushnell, 2001; Horowitz et al., 1972; Pascalis et al., 1995). Others studies showed that this effect is absent when the known face is the mother's face which is favoured compared to a novel face suggesting a familiarity effect (Walton, Bower, & Bower, 1992; Slater and Quinn, 2001). It is possible that newborns are attracted by their mother's face (Field, Cohen, Garcia, & Greenberg, 1984; Sai, 2005) and not by an unfamiliar face (a stranger) previously known during an habituation paradigm as a still face, because the mother's face, being responsive, meets an expectation of communication. Recent studies demonstrated that three-month old infants (Bertin and Striano, 2006) and also newborns (Nagy, 2008) spent less time looking at a face when it became a freeze face (still-face situation). Moreover, when newborns were engaged in the habituation paradigm with motionless mother's face, they preferred the novel face in a successive preference task suggesting that the direction of infants' preference could depend on the habituation task used (Scott and Nelson, 2004; Cecchini, Baroni, Di Vito, Piccolo, & Lai, 2011). Recent studies showed that newborns may already be sensitive to a mismatch between the articulatory movements of the face and the corresponding speech sounds suggesting that interactive situations could play an important role in familiarity preferences observed at birth (Guellai, Mersad, & Streri, 2015; Guellai, Streri, Chopin, Rider, & Kitamura, 2016). An important implication of all these findings is that the newborns can retain in memory the visual information of a face for almost few minutes (the time duration between the end of the habituation task and the beginning of the preference task). The memory of the known faces is crucial for the social interaction and for the attachment relationship that the newborns establish with the caregivers (Cecchini, Lai, & Langher, 2010); however, how long the newborns since the birth can retain in memory the representation of a known face has not been investigated. In fact, an interesting study (Pascalis, de Haan, Nelson, & de Schonen, 1998) showed the permanence of the novelty effect after 24 h, in 3 months-old infants, in newborn-infants, whereas there are not studies on the permanence of novelty effect or on the memory of faces in newborn-infants less than 3 months old.

1.2. Sleep effect on memory consolidation

The relationship between sleep-wake cycle and psychological health has been investigated and it has been stated that sleep disturbances are directly related to a poor outcome in adults (Pompili et al., 2013). The role of sleep on memory consolidation of visual information has been studied a lot in adults, showing a clear consolidation effect of sleep and its components (Stickgold, 2005; Tononi and Cirelli, 2014). Many studies on adults have underlined the existence of a sleep-dependent consolidation in both declarative (Gais and Born, 2004) and procedural memory domains (Huber, Ghilardi, Massimini, & Tononi, 2004). A specific correspondence between sleep stages and the type of memory and performance improvement has been widely documented (Stickgold, 2005). Different findings seem to converge on the assumption that REM (rapid eye movements) sleep is associated with the regulation of neural plasticity (Ravassard, Pachoud, & Comte, 2009; Calais, Ojopi, Morya, Sameshima, & Ribeiro, 2015; Tononi and Cirelli, 2014) and with a selection and consolidation of significant information (Calais et al., 2015; Touzet, 2015; Blanco et al., 2015; Menz, Rihm, & Büchel, 2016).

Despite the strong interest of sleep effect on human performance, at today there are very few studies of the effect of different sleep stage in newborns where the homologue differentiation between REM vs. non-REM sleep has been conceptualized and investigated as active vs. quiet sleep (Cecchini et al., 2011a, 2012; Thoman, 1990). Recent encouraging findings in 6–12 month old infants have suggested a role of sleep on memory consolidation in the first year of life (Seehagen, Konrad, Herbert, & Schneider, 2015; Friedrich, Wilhelm, Born, & Friederici, 2015). Seehagen et al. (2015) demonstrated an enhancing role of sleep in the consolidation of declarative memories for novel actions after a 4-h and 24-h delay in 6–12 months old infants. Friedrich et al. (2015) showed that sleep could improve semantic generalization in infants aged between 9 and 16 months. Moreover, in a very interesting way, independently of age, the semantic generalization was correlated with sleep spindle activity during the nap, suggesting that sleep spindles are involved in infant sleep-dependent brain plasticity. These suggestive findings in infants aged between 6 and 16 months (Seehagen et al., 2015; Friedrich et al., 2015) together with the findings in adults about the association between REM sleep and the selection and consolidation of significant information (Calais et al., 2015; Touzet, 2015; Blanco et al., 2015; Menz et al., 2016) suggest the need to investigate the role of active sleep in the memory consolidation of the faces, familiarized in different contexts (responsive or motionless), since the birth.

1.3. Objective

The aim of the present study was to investigate the preferential looking behaviour subsequent to a familiarization task with a previously responsive or motionless face, before and after a sleep cycle.

The hypotheses were that, before and after the sleep cycle, the newborns undergoing motionless familiarization will exhibit a novelty effect (preference for the novel face) while the newborns undergoing an interactive familiarization will show a familiarity effect (preference for the known face). Moreover, the hypothesis was that the amount of active sleep will be associated with the looking time at the known face after the sleep cycle.

2. Method

2.1. Newborns

After the approval of the Local Ethical Committee and written consent of their parents, 86 healthy full-term newborns (weight: 3.4 ± 0.3 kg; age: 34.4 ± 10.0 h) were recruited. The study was carried out at the maternity ward of the Sapienza University

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