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NEONATAL BEHAVIOR AS BIOLOGICALLY MOTIVATED BEHAVIOR

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Abstract

Objectives: To discuss the possibility that neonatal behavior can be understood as biologically motivated behavior. **Hypothesis:** Human newborns present a behavioral repertoire which corresponds to the phylogenetic evolution and adaptation of the human species to environmental circumstances. **Method:** The behavioral repertoire of the human newborn is discussed at the light of the neurobehavioral evaluation of babies at the first moments of extra-uterine life, namely the NBAS (Neonatal Behavioral Assessment Scale) by T. Berry Brazelton. This description is articulated with several aspects of human experience: a) adequacy for survival after birth; b) sequence from prenatal behavior to postnatal behavior; c) similarity between prenatal sleep/awake states and postnatal sleep/awake states and d) postnatal behavioral competence as a result of prenatal training (the performance of prenatal behavior as an exercise towards the enhancement of postnatal behavioral performance). **Conclusion:** The articulation above described will be used to enlighten future research in the fields of neonatal behavior and prenatal behavior. It will also be used to deepen possibilities of psychological interventions based at presentations offered to mothers, fathers or families when assessing newborns' behavior (Brazelton demonstrations).

Key words: neonatal behavior, fetal behavior, biologically motivated behavior, evolution, Neonatal Behavioral Assessment Scale

INTRODUCTION

Human newborns display a very interesting and complex behavioral repertoire as soon as they finish their transit across the birth canal. A few hours after this transition, expert observers may appreciate not only behavioral variety but also clues about behavioral quality and indicators that might be related to future development. Descriptive precision on newborns' behavioral assessment was made possible after Prechtl's contributions from the middle of the XXth century on (Prechtl, 1958; Prechtl, 1977; Einspieler, Prechtl, Bos, Ferrari & Cioni, 2004). After the publication of NBAS first edition (Brazelton, 1973), newborn's behavior could be assessed not only in specific terms but

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also in global terms, in terms of neurobehavioral areas as well as in terms of social interaction behavior. Systematic observations of newborns' behavior were responsible for the critical shift in perceptions about human babies; suddenly babies became active, capable of initiative, fully competent, attentive and able to participate in interactive dialogs with other humans. Consequently, interest raised about prenatal maturation of such competencies which raised scientific questions that were very hard to answer before sonograms took a place in medical advances of the last quarter of the last century. At the beginning of this century, prenatal behavior was already enough studied (Einspieler, Prayer & Prechtl, 2012) to allow significant relations between what happens before and after birth. This change is also an opportunity to discuss newborns' behavior as the result of human species' evolution and its significance for human survival, adaptation and successful reproduction.

OBSERVING POST-NATAL BEHAVIOR

At present, NBAS (Brazelton & Nugent, 2011) is organized around four domains: 1) autonomic/physiological regulation, 2) motor organization, 3) state organization and 4) regulation and attention/social interaction. This means that in general human babies are born with competencies related to homeostatic adjustments of the central nervous system, to exhibit motor movements with varying degrees of quality and tone, to control awake/sleep states according to stimulation offered by observers and to pay attention when facing visual and auditory stimuli and also when answering to it. This kind of observation is based in an interesting set of items that for the most part are directly observable in a precise moment (ex: reflexes are observed after specific stimulations). But it also includes another kind of items that result from the global observation that usually lasts around 30 minutes. Among these more global items we have quality of alertness, general tonus, motor maturity, general irritability, robustness and endurance, etc. Although the sequence of NBAS items varies according to babies' availability in each moment, an ideal sequence (Brazelton & Nugent, 1995) moves from the habituation package to motor-oral package, then to truncal package and after to vestibular package. Due to its dependence on the baby's behavioral state, the social-interactive package is to be introduced when babies are fully alert and cooperative between any two of the preceding packages or at the end of the examination.

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Adequacy for survival is easily assumed for some behaviors in these observations. Grasping reflexes of the fingers and of the toes resemble very similar competencies displayed by other species' pups. Grasping reflexes provided a competency for newborns of human ancestors to cling to their mother's chest hair. Moro reflex enabled those newborns to embrace their mothers when falling down. Self-regulation of the baby's organism allows adaptive reactions when facing stressful situations.

The evolution of the human species as we understand it today entailed very complex challenges which produced strong impacts in the selection of our present characteristics. To begin with, crucial consequences took place when our ancestors diverged from other primates evolving towards exclusive bipedalism. Among those consequences we have not only those related to increased chances for survival but also some that complicated survival chances at birth. It is the medical current opinion that exclusive bipedalism decreased possibilities for human females to enlarge the birth canal during delivery. As a matter of fact, a good deal of obstetrical knowledge is spent promoting the adaptation of the pelvic bone structure to the baby passing through the birth canal (Schaal, Akli & Riethmuller, 2007; Schaal, J.-P. & Riethmuller, D. (2007). Among several examples it is commonly agreed that: a) the fontanels of the baby's skull promote his adaptation while moving outwards, b) the relative immaturity of the baby's neo-cortex protect its fragile cells against the traumatic effort

required by birth and c) the fact that human babies are born much sooner than the achievement of required maturity to deal with environmental demands prevents against fetal-cephalopelvic disproportion that otherwise would be inevitable. On the other side, the idea that in the human species there are several mechanisms that can trigger labor (Cunningham, Leveno, Bloom, Hauth, Gilstrap III & Wenstrom, 2005) is also accepted as a preventive adaptation; if a mechanism fails to trigger labor other mechanisms will be present to activate parturition.

As a result of our adaptation, human newborns start their extra-uterine lives in a global premature condition. This prematurity requires more caregivers' attention than what it is usually observed in other primate species. In order to stimulate and reinforce caregivers' attention and dedicated protection, some anatomical and behavioral characteristics seem to play an important role. Probably the shape of the human face evolved into a special configuration that awakens adults visual interest; at least the exaggeration of the typical profile of babies' head, with a forehead that grows above the eyes as a consequence of prefrontal cortex being increasingly bigger, is preferred by human adults when comparing with alternative profiles (Hückstedt, 1965). Together with anatomical messages, behavioral messages displayed by newborns are able to associate with the former and to stimulate caregiver's development. As Bowlby underlined (1958) at the beginning of extra-uterine life at least five behavioral modalities are available: sucking, clinging, following, crying, and smiling. Some of these work in restricted areas (newborns only follow with their eyes and sometimes with their heads), some are limited to specific objects (newborns may cling to mothers' fingers) and some are difficult to observe (although smile is an item of NBAS it constitutes a rare observation). Nevertheless, mankind seems to have replaced newborns' maturity by a very important binomial: mothers' very subtle perception about babies' communication competences articulated with babies capabilities ensure mothers' proximity, protection and caregiving behavior. To support this idea we should underline the results of Meltzoff's (1977) experiences which provide evidence about newborns' (12-21 days of life) competence to imitate adult facial expressions and manual gestures.

FROM PRENATAL BEHAVIOR TO POSTNATAL BEHAVIOR

Recent developments in 4D sonograms allowed researchers to look at pre-natal behavior with unprecedented objectivity. Because of these developments it is now possible to look at both prenatal and postnatal behaviors and to establish innumerable links showing that something organized to function as adaptive behavior at the beginning of life after birth is already developed and exercised some weeks or months before birth. The following are just some of the easiest examples to understand. Palmar grasp reflex is usually observed when the examiner touches the inside of the baby's hand and fingers strongly close around the stimulus; the fetus' hand may grasp the umbilical cord at 27 weeks of gestational age (Video 7; Einspieler, Prayer & Prechtl, 2012). The newborn's ability to reach his face with his hand and to suck his fist or fingers is interpreted as a competence to self-regulate in moments of stress; the fetus hand may touch his face around the mouth and the thumb once inserted in the mouth can be sucked at 14 weeks (Video 10; Einspieler, Prayer & Prechtl, 2012). Alternating movements of the baby's legs may be triggered when the newborn is observed under the sequence "placing reflex-standing reflex-walking reflex"; inside the maternal womb, by 19 weeks, alternating movements of the fetus' legs may be observed (Figure 2.9; Einspieler, Prayer & Prechtl, 2012). For the observation of newborns' social interaction head movements from left to right and vice-versa are indispensable; similar movements of the fetus head may be observed at 36 weeks (Video 16; Einspieler, Prayer & Prechtl, 2012). Also for social interaction competences coordinated eyes movements are required; fully coordinated eyes' movements are observable at 30 weeks (Video 19; Einspieler, Prayer & Prechtl, 2012). Startles may be observed during newborns' examination and illustrate how babies are adapting to the stress induced by the situation; startles may be observed

by sixteen and a half weeks (Video 3; Einspieler, Prayer & Prechtl, 2012). Crying *per se* is not scored in NBAS evaluations but crying states are a fundamental piece of the baby's states assessment; fetal facial expressions of cry are also detectable by 4D sonograms (Figure 4; Campbell, 2002). Smiles are rare when observing newborns at the first days of life; although rare before birth they can be found by 4D sonograms (Figure 2; Campbell, 2002).

About smiles exhibited by human newborns, its interest as a reinforcement of caregivers' emotional attention should be underlined. As Spitz (1965) showed, at three months of life human babies instantly smile when stimulated by visual gestalts that summarize the human face. From that moment on, several researchers showed that the preference of human newborns for human face-like stimuli is observable very earlier in human life: by the first few days of life babies' visual concentration is longer for patterns summarizing the human face than for other patterns or for simply color stimuli (Fantz, 1963); by the first few minutes of life babies' visual tracking indicates preference for face-like patterns than for scrambled patterns (Goren, Sarty & Wu, 1975); newborns' visual tracking still shows preference for a face-like pattern even when the alternative pattern displays a vertical rearrangement of the elements of the face-like pattern (Johnson, Dziurawiec, Ellis & Morton, 1991); the fact that newborns' preference for a face-like pattern is a characteristic of human adaptation to the beginning of extra-uterine life is reinforced by the decline of this preference during the second month of life (Johnson, Dziurawiec, Ellis & Morton, 1991).

Once that a good number of neonatal behaviors can be found before birth and because they are repeated while that is allowed by available intra-uterine space we may suppose this repetition has the value of training. A few hours or days after birth the wide behavioral range observed is available not only because it is biologically motivated but also because fetal training resulted as a rehearsal.

SIMILARITY BETWEEN PRENATAL SLEEP/AWAKE STATES AND POSTNATAL SLEEP/AWAKE STATES

The determination of behavioral states is fundamental when observing neonatal behavior. Neonatal behavioral performances may undergo extreme changes and the explanation for this variability is not possible without knowing the baby's state when a particular behavior is observed (Prechtl, 1992). For this reason, neonatal observation with NBAS (Brazelton & Nugent, 2011) starts with a two minutes observation dedicated to the determination of the newborn behavioral state. Also in this method, each item has got an ideal state for observation; the observer only uses stimuli adequate to the behavioral state exhibited by the baby at a particular instant.

According to Brazelton and Nugent (2011) newborns' behavioral states should be considered in six categories organized in four areas. In sleep states we have State 1 (the baby is sleeping, spontaneous activity is rarely observed or no observed, the eyes are closed and do not move) and State 2 (the baby is sleeping, occasional spontaneous activity is observed, the eyes are closed and rapid eye movements are observed). Between sleep states and awake states an awake/transition state can be observed (the baby is drowsy, eyes may open for brief periods with a dull expression and eyelids are hesitant; spontaneous activity may be observed; responses to stimuli may have some delay; the baby's look is described as dazed). In awake states there is State 4 (the baby is alert, exhibits a bright look, his attention is focused at the stimuli's source and spontaneous activity is decreased) and State 5 (the baby is alert, spontaneous activity is increasing, reaction to observer's stimuli includes startles and motor activity and vocalizations of the fussy kind are observable for brief moments). Finally, State 6 is designated as the crying state (the baby is crying at most of the time, spontaneous activity may be very intense and soothing procedures do not easily bring the baby to a more quite state). Because this categorization includes a transition state between the sleeping states and the awake states it is somewhat different from Prechtl's (1974) categorization that only considers five states.

Due to developments in fetal behavior observation it is now possible to hypothesize that before

birth some level of behavioral organization is already occurring. More than that, it is possible to understand that fetal behavioral organization corresponds to some of the newborn behavioral states.

Using three fetal parameters (heart rate - HR, movements of the eyes - ME and gross movements - GM), Nijhuis, Prechtl, Martin and Bots (1982) identified four fetal behavioral states: State 1F (HR is stable with small oscillations and isolated accelerations, ME are absent and GM are incidental), State 2F (HR with oscillations wider than in State 1 and frequent accelerations, ME are present and GM are periodic), State 3F (HR is stable but with oscillations wider than in State 1 and without accelerations, ME are present and GM are absent), State 4F (HR is unstable and accelerations are easily observed, ME are present and GM are continuous).

As noticed by Einspieler, Prayer and Prechtl (2012): State 1F seems to correspond to the state of quiet sleep observed in newborns, State 2F is identical to the neonatal state of active sleep, State 3F corresponds to the newborn's state of quiet wakefulness and State 4F is similar to the neonatal state of active wakefulness. These similarities between prenatal and postnatal behavioral states open a new perspective about the beginning of psychological life. Not only are we moved to understand that some weeks before birth the development of the fetal nervous system is near complete but also, because of that, the fetal brain is able to cover very complex processes. Among these the already mentioned fetal emotions (Campbell, 2002) are the most intriguing ones. If they are present before birth (present and active so that they can be observed), we should underline its importance in the human babies' readiness to struggle with the stressful conditions of the outside world.

CONCLUSION

Due to the relevance of prenatal and postnatal behavior in human life, it would be important to connect these two kinds of information in future research. Because it is supposed that prenatal behavior induces some changes in pregnant women's psychological development (Justo, 2014), namely when fetal behavior becomes detectable by the future mother and when fetal behavior turns from unpredictable to predictable, it would be interesting to articulate prenatal behavior with maternal perception about fetal behavior. Compatibility between maternal perception and fetal behavior should be investigated as a potential predictor of crucial aspects in human life like attachment. The same should be investigated for compatibility between maternal perception and neonatal behavior. In this sense something more complex could be done. On one hand, maternal perception about fetal behavior should be assessed at the turning points of pregnancy (i.e., stepping from the first trimester into the second and stepping from the second trimester into the third). On the other hand, maternal perception should be assessed while the baby may be considered a newborn. Someday these two kinds of assessment about maternal perception will be assembled as a source of positive information (because it indicates maternal development), or as a source of negative information (because it shows that maternal changes are opposite to expected development) or even as a source of stability. It would be very interesting if this information would prove to be a good predictor of development, not only individual development of the child but also development of the relation between the mother and the child.

The articulation of prenatal and postnatal behavior should also be interesting from the intervention point of view. One of the most interesting consequences of Brazelton's observations with the NBAS is the observation of the impact induced at the baby and at his parents while the application is going on (Gomes-Pedro, Monteiro, Patrício, Carvalho, Torgal-Garcia & Fiadeiro, 1986; Das Eiden & Reifman, 1996; Martinez-Gertner, Costas-Moragas, Botet-Mussons & Fornieles-Deu, 2004). It has been repeatedly observed that several things change to the better when the mother, the father or both may share the baby's performance with the observer. Those changes may happen in the baby's behavior (namely in a second application of NBAS) but may also take place at the mother's behav-

ior or in mother-infant interaction. It is usually supposed that it is the mother's perception that changes during the NBAS evaluation. After that, possibly, the mother will become more competent when interacting with the baby. In this sequence, eventually, the newborn baby's competences will be stimulated and reinforced in a special way by the mother.

We think it would be promising to start this work with mothers even during pregnancy. As mentioned before, pregnant women are particularly aware about prenatal behavior. Because this sensibility is a stimulus for mothers' development the working through about the baby's behavior and characteristics could start earlier in order to prepare mothers' understanding about the competence they are going to perceive as soon as babies are born.

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