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FATORES ASSOCIADOS COM A CONDUTA VISUAL EM RECÉM-NASCIDOS

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Dissertação apresentada à Universidade Federal do Rio Grande do Sul, como parte das exigências do Programa de Pós-Graduação em Neurociências, para obtenção do título de Mestre em Neurociências.

Orientador: Profa. Patrícia Pelufo Silveira

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AIMS: *Alberta Infant Motor Scale*

AHEMD: *Affordance in the Home Enviroment for Development*

EPDS: Escala de Depressão Pós-Natal de Edimburgo

CIB: *Coding Interacting Behavior*

ABIPEME: Classificação Econômica Brasil

V1: Córtex Visual Primário

SGA: Pequeno para idade gestacional, do inglês *small for gestacional age*

HPA: Eixo hipotálamo pituitária adrenal

RESUMO

Objetivo: Descrever características biológicas e ambientais associadas a habilidades motoras finas, medidas por diferentes níveis de conduta visual em lactentes de 1 e 3 meses.

Desenho de estudo: 82 díades mãe-bebê foram recrutadas durante consultas pré-natais ou imediatamente após o nascimento e visitadas duas vezes para a coleta de dados (25-40 e 85-100 dias após o nascimento). Durante as visitas foram coletados fatores maternos (idade materna, escolaridade, tipo de parto, número de consultas pré-natais, tipo de amamentação e tabagismo), características biológicas do bebê (gênero, idade gestacional, nascimento, peso, circunferência da cabeça, Apgar), testes motores infantis (através da Escala de Avaliação do Comportamento Visuomotor Infantil e *Alberta Infant Motor Scale*/AIMS), perfil psicológico materno (através da Escala de Depressão Pós-natal de Edimburgo/EPDS e Escala de Ansiedade de Hamilton), variáveis ambientais (medidas pelo *Affordance in the home environment for development scale*/AHEMD), cuidados maternos (avaliado através do *Coding Interacting Behavior*/CIB), bem como a coleta de leite (medição de ácidos graxos totais, proteínas e cortisol) e sangue materno (medição de hormônios séricos e interleucinas).

Resultados: 51 crianças foram testadas em tarefas de conduta visual e outras medidas. As mães das crianças com baixos escores de fixação visual apresentaram maiores níveis de proteína no leite materno aos 3 meses. Quanto ao perfil metabólico materno, as mães das crianças que apresentaram melhores escores de fixação visual apresentaram melhores níveis séricos de T4 (no primeiro mês) e prolactina (no terceiro mês).

Conclusão: O desenvolvimento neuromotor precoce do bebê, especialmente as habilidades visuais e de motricidade fina, estão intimamente associados aos fatores biológicos maternos (fatores metabólicos maternos e composição do leite materno).

Palavras-chave: Desenvolvimento infantil. Fatores de risco. Leite humano.Hormônios tireóideos. Prolactina.

ABSTRACT

Objective: To describe biological and environmental characteristics associated with fine motor skills measured by different levels of visual tracking in infants of 1 and 3 months.

Study design: 82 mother-infant dyads were recruited during prenatal consultations or immediately after birth and visited at two times for data collection (25-40 and 85-100 days after birth). During the visits were collected maternal factors (maternal age, education level, type of delivery, number of antenatal consultations, type of breastfeeding and smoking), biological characteristics of the baby (gender, gestational age, birth, weight, head circumference, Apgar), infant motor tests (through the Child Visuomotor Behavior Rating Scales and Alberta Infant Motor Scale/AIMS), maternal psychological profile (through the Edinburgh Postnatal Depression Scale/EPDS and Hamilton Anxiety Scale), environmental variables (measured by the Affordance in the home environment for development scale/AHEMD), maternal care (evaluated through Coding Interacting Behavior/CIB), as well as milk collection (measurement of total fatty acids, proteins and cortisol) and maternal blood (measurement of serum hormones and interleukins).

Results: 51 children were tested on visual tracking tasks and other measures. The mothers of children with low visual fixation scores presented higher levels of protein in breastmilk at 3 months. Regarding the maternal metabolic profile, the mothers of the children who presented better visual conduct scores had better serum levels of T4 (in the first month) and prolactin (in the third month).

Conclusion: Early neuromotor development of the baby, especially the visual and fine motor skills, are closely associated with maternal biological characteristics (metabolic factors and composition of breast milk).

Key-words: Child development. Risk factors. Milk human.Thyroid hormones. Prolactin.

SUMÁRIO

1. INTRODUÇÃO

1.1 Sistema Visual

O processamento visual decorre do funcionamento interligado das áreas corticais e subcorticais. As células ganglionares da retina enviam projeções para áreas envolvidas tanto nos comportamentos visuais formadores de imagem (núcleo geniculado lateral - processamento visual) quanto para os não formadores de imagem (colículo superior - controle dos movimentos oculares) (Kandel *et al,* 2014; Cang *et al,* 2013; Rosander, 2007).

A informação enviada ao Núcleo Geniculado Lateral no Tálamo se projeta ao córtex visual primário (córtex estriado-V1), onde a informação se divide em duas vias decorrentes de suas projeções, uma projeção para o lobo temporal (via ventral) e outra para o lobo parietal (via dorsal). A via ventral, através do córtex temporal inferior (anterior e posterior), é responsável pelo reconhecimento dos objetos (formas e identidades) e faces; e está conectada reciprocamente às áreas do lobo temporal medial (papel no armazenamento e evocação de memórias de longo prazo e componentes cognitivos da emoção), córtex pré-frontal (papel na percepção visual categórica, memória de trabalho visual e evocação de memórias armazenadas) e área temporal superior polissensorial (áreas sensoriais multimodais do córtex) (Kandel *et al,* 2014; Mercuri *et al,* 2007; Rosander, 2007). Já a via dorsal, através da área intraparietal lateral do córtex parietal, está envolvida na atenção visual, rastreamento visual e movimentos oculares, onde os neurônios desta área descrevem as metas dos movimentos oculares sacádicos, se projetam para o campo ocular frontal no córtex frontal e são responsáveis pela integração visuomotora da informação visual com a direção dos movimentos dos olhos e membros (Kandel *et al,* 2014; Cang *et al,* 2013; Mercuri *et al,* 2007; Rosander, 2007).

Por outro lado, a informação enviada ao Colículo Superior no Mesencéfalo integra a via do controle de movimentos oculares, que via formação pontina (no tronco encefálico) enviam projeções aos núcleos motores extraoculares responsáveis pelos movimentos oculares (Kandel *et al,* 2014; Cang *et al,* 2013). Os movimentos oculares têm como finalidade estabilizar a imagem na retina quando a imagem se move no espaço e/ou quando a cabeça se movimenta e os olhos ficam fixos na imagem que está imóvel, e são compostos dos movimentos com o objetivo de desviar o olhar (são os movimentos *vestíbulo-oculares* e *optocinéticos* e ocorrem quando existem novos alvos para serem captados pela fóvea e/ou quando esses alvos na fóvea se movem) e com objetivo de estabilizar o olhar (são os *movimentos sacádicos, de seguimento lento e de vergência* e ocorrem quando a cabeça se move ou quando ocorrem movimentos de grande amplitude no campo visual). Além desses movimentos, existe ainda o sistema de fixação ativo, que tem o objetivo de manter o olho fixo durante o olhar intencional quando a cabeça não está em movimento e requer a supressão ativa dos movimentos oculares (Kandel *et al,* 2014; Purves *et al,* 2010; Lent, 2002; Rosander, 2007; Liversedge *et al,* 2000; Luna *et al,* 2008).

1.2 Conduta visual do recém-nascido e lactente

Ao nascimento as estruturas pertencentes a via subcortical estão mais desenvolvidas quando comparadas as estruturas da via cortical. Nos primeiros meses, os sistemas subcorticais envolvendo o colículo superior no mesencéfalo sustentam algumas capacidades visuais importantes como a capacidade inicial de fixação visual, atenção visual, rastreamento visual e movimentos sacádicos oculares. Embora as áreas corticais possam ser parcialmente ativadas neste período, elas são relativamente imaturas, começando a desempenhar sua função nos meses pós-natais, inclusive modulando as funções subcorticais. O sistema visual funciona principalmente em um nível subcortical nos recém-nascidos e nos primeiros meses após o nascimento, e se torna progressivamente integrado e dominado por processos corticais durante o primeiro ano de vida (Atkinson *et al,* 1992; Atkinson *et al,* 2012; Liversedge *et al,* 2000; Gagliardo *et al,* 2004b; Johnson, 2005; Mercuri *et al,* 2007; Atkinson, 2017; Kaul *et al,* 2016).

A fixação e o rastreamento visual de um alvo já estão maduros a partir de 35 semanas de idade gestacional, com a resposta mais completa à medida que o lactente se aproxima da idade a termo. O rastreamento visual é decorrente do predomínio dos movimentos sacádicos oculares (Hoyt, 2004; Romeo *et al,* 2012; Azmeh *et al,* 2013; Hitzert *et al,* 2014; Carrara *et al,* 2016).

A partir de 2 semanas de idade o lactente pode apresentar o comportamento de levar os dedos à boca, e esse movimento é precedido pela abertura da boca em antecipação à chegada dos dedos (Hofsten, 2009; Rosander, 2007).

No primeiro mês de vida os lactentes já são capazes de utilizar mais os movimentos da cabeça quando comparados ao período do nascimento, embora esses movimentos tendam a ser mais presentes a partir dos 3 meses (Rosander, 2007).

A preferência de fixação visual do lactente inicia por características geométricas, como os rostos (Stjerna *et al,* 2015; Farroni *et al, 2005;* Pereira *et al,* 2017; Johnson, 2005; Mercuri *et al,* 2007; Atkinson, 2017). Os lactentes são atraídos pelos rostos de outras pessoas, e podem perceber suas emoções e a direção da sua atenção (Hofsten, 2009). Entre os 2 a 6 meses de idade, o lactente apresenta uma predominância de contato visual, em comparação a fixação visual para outras regiões da face, como a boca, corpo ou outro objeto. Com o decorrer dos meses, o lactente começa a mudar sua atenção, observando também outras regiões da face, corpo, objetos e o próprio ambiente (Jones *et al,* 2013).

Aos 2 meses o bebê já é capaz de sorrir ao reconhecer os pais. Neste mesmo mês o bebê também tem a capacidade de estabilizar o olhar em um objeto em movimento através de movimentos dos olhos em perseguição, e o rastreamento do objeto é alcançado por uma combinação dos movimentos da cabeça e dos olhos (Casteels *et al,* 1998; Kaul *et al,* 2016).

Aos 3 meses o lactente é capaz de integrar mudanças de atenção visual através do controle cortical dos movimentos dos olhos e da cabeça (mediados pela via dorsal do processamento visual) (Mercuri *et al,* 2007). Neste período o lactente também é capaz de mudar a atenção de um objeto para outro, capaz de virar a cabeça para estímulos interessantes, descobrir seu corpo observando suas mãos e pesquisar e digitalizar o ambiente de forma consistente (Gagliardo *et al,* 2004b; Alva *et al,* 2015).

Aos 4 meses o lactente consegue realizar movimentos oculares mais suaves, realizando a perseguição visual horizontal aos níveis do adulto, sendo também capaz de alcançar objetos estacionários e em movimento. Quando a mão se move em direção ao objeto de interesse, ela entra no campo visual e seus movimentos finos podem ser percebidos visualmente e controlados por informações visuais. Assim, a função motora fina depende da coordenação olho-mão, que amadurece no início da vida, sendo o movimento de alcance guiado visualmente e ajustado para a correta abertura e fechamento das mãos ao agarrar um objeto (Casteels *et al,* 1998; Kaul *et al,* 2016; Hofsten, 2009; Rosander, 2007). Neste período o lactente também está apto a combinar o rastreamento visual aos movimentos da cabeça (Rosander, 2007).

Em torno dos 5 a 6 meses o lactente é capaz de integrar ações manuais e visuoespaciais através do controle visual do alcance e da compreensão (mediado pela via dorsal) que é associado a capacidade de reconhecimento de objetos (mediado pela via ventral). Neste período o lactente consegue utilizar a cabeça para seguir um objeto mais precisamente que os adultos (Kaul *et al,* 2016; Mercuri *et al,* 2007*),* e também conseguem perceber a direção do olhar das outras pessoas (Hofsten, 2009).

Em torno dos 12 meses o lactente é capaz de integrar ações locomotoras, controle de atenção e capacidade visuoespacial através do controle visual da locomoção mediado pela associação da via dorsal e ventral (Mercuri *et al,* 2007).

Em suma, as habilidades visuais ao nascimento são dependentes das vias subcorticais, já as habilidades de coordenação olho-mão e de motricidade fina são dependentes das vias corticais (via ventral e dorsal). Essas habilidades estão intimamente interconectadas, sendo imprescindível o correto funcionamento da conduta visual para o posterior desenvolvimento da motricidade fina.

1.3 Fatores associados à conduta visual do recém-nascido e lactente

As habilidades de conduta visual presentes desde o início da vida do recém-nascido são determinantes não apenas para o desenvolvimento do sistema visual, mas estudos relatam que elas podem predizer funções cognitivas, perceptivas e motoras no decorrer do desenvolvimento (Stjerna *et al,* 2015; Baum *et al,* 2016; Farroni *et al,* 2005; Johnson, 2005). Estudos relatam que essas habilidades predizem diversas capacidades do desenvolvimento motor a longo prazo, como quociente de desenvolvimento com 1 ano, capacidade de coordenação olho-mão aos 2 anos, desempenho visual-motor e raciocínio visual aos 5 anos, controle atencional e comportamental na primeira infância, bem como ao desenvolvimento e integridade da substância branca encefálica (Ricci *et al,* 2011; Stjerna *et al,* 2015; Baum *et al,* 2015; Bennet *et al,* 2012; Papageorgiou *et al,* 2014).

Alterações na conduta visual precoce estão relacionadas a diversos atrasos e incapacidades, como aos atrasos no desenvolvimento (Sandfeld *et al,* 2008), incapacidades/atrasos de marcha (Phadke *et al,* 2014), baixos índices de desenvolvimento mental (Phadke *et al,* 2014; Boot *et al,* 2012a; Boot *et al,* 2012b; Taanila *et al,* 2005), baixo coeficiente de inteligência (QI) (Boot *et al,* 2012a. Boot *et al,* 2012b; Sandfeld *et al,* 2008; Taanila *et al,* 2005), distúrbios psiquiátricos e comportamentais como autismo, transtorno de déficit de atenção e hiperatividade; distúrbios de coordenação e dislexia (Kaul *et al,* 2016), e alterações cognitivas posteriores (Jones *et al,* 2013).

Um estudo relata que características pós-natais podem estar relacionadas a alterações na fixação visual precoce, como o baixo peso e comprimento ao nascer, menor perímetro cefálico e menor idade gestacional (Phadke *et al,* 2014). Essas características pós-natais também estão associadas com alterações cognitivas tardiamente presentes em idosos (Raikkonen *et al,* 2013). Apesar desses estudos, pouco se sabe sobre os demais fatores (fatores biológicos, maternos, etc) associados a essas habilidades precoces dos recém-nascidos.

A maioria dos estudos atuais concluem que o desenvolvimento motor e cognitivo do bebê é formado por uma cascata de habilidades básicas fundamentais, como a conduta visual. Essas habilidades precoces refletem a integridade de áreas corticais e subcorticais, e estas áreas parecem estar interconectadas na execução de capacidades motoras e cognitivas. O desenvolvimento precoce dessas habilidades básicas fundamentais, associado a maturação dos circuitos neurais parece levar a um desenvolvimento mais favorável dos processos cognitivos e motores a longo prazo, sendo a avaliação do funcionamento visual um possível indicador sensível de alterações sutis no desenvolvimento neurológico (Stjerna *et al,* 2015; Clark *et al,* 2015; Taanila *et al,* 2005; Kaul *et al,* 2016).

2 OBJETIVOS

2.1 Objetivo Geral

Descrever características biológicas e ambientais associadas a diferentes níveis de habilidades de conduta visual em lactentes de 1 e 3 meses.

2.2 Objetivos Específicos

2.2.3 Avaliar a conduta visual de lactentes com 1 mês de vida pós-natal usando a escala de Avaliação da Conduta Visual do Lactente.

2.2.4 Comparar crianças com alto e baixo escore de conduta visual em relação às suas características neonatais (idade na avaliação – em dias, ganho de peso no 1 e 3 mês de vida, motricidade grosseira medida pela *Alberta Infant Motor Scale* com 1 e 3 meses de vida).

2.2.5 Comparar as características do leite materno das mães de crianças com alto e baixo escore de conduta visual (ácidos graxos totais, proteínas totais e cortisol com 1 e 3 meses).

2.2.6 Comparar o perfil metabólico das mães de crianças com alto e baixo escore de conduta visual (cortisol periférico, prolactina, T3, T4 e interleucinas com 1 e 3 meses de vida).

2.2.7 Comparar o perfil psicológico das mães de crianças com alto e baixo escore de conduta visual (ansiedade medido pela Escala de Hamilton e depressão medido pela Escala de Depressão Pós-Parto de Edimburgo/EPDS).

2.2.8 Comparar características do ambiente de crianças com alto e baixo escore de conduta visual (qualidade do cuidado materno avaliado pelo *Coding Interacting Behavior (CIB)* e disponibilidade de estímulos medido pela *Affordances in the Home Environment for Motor Development scale/AHEMD*).

3 ARTIGO

Factors associated with visual conduct abilities in human newborns.

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ABSTRACT:

Objective: To describe biological and environmental characteristics associated with fine motor skills measured by different levels of visual tracking in infants of 1 and 3 months.

Study design: 82 mother-infant dyads were recruited during prenatal consultations or immediately after birth and visited at two times for data collection (25-40 and 85-100 days after birth). During the visits, data on maternal factors (maternal age, education level, type of delivery, number of antenatal consultations, breastfeeding and smoking), biological characteristics of the baby (gender, gestational age, birth, weight, head circumference, Apgar), infant motor tests (through the Child Visuomotor Behavior Rating Scales and Alberta Infant Motor Scale), maternal psychological profile (through the Edinburgh Postnatal Depression Scale and Hamilton Anxiety Scale), environmental variables (through the Affordance in the home environment for development scale/AHEMD), maternal care (through Coding Interacting Behavior/CIB), as well as breastmilk collection (measurement of total fatty acids, proteins and cortisol) and maternal blood (measurement of serum hormones and interleukins) were collected.

Results: 51 children were tested on visual tracking tasks and other measures. The mothers of children with low visual fixation scores presented higher levels of protein in breastmilk at 3 months. Regarding the maternal metabolic profile, the mothers of the children who presented better visual conduct scores had higher serum levels of T4 (in the first month) and prolactin (in the third month).

Conclusion: Early neuromotor development of the baby, especially the visual and fine motor skills, are closely associated with maternal biological characteristics (metabolic factors and composition of breast milk).

INTRODUCTION

At the time of birth, the structures belonging to the subcortical pathway are more developed when compared to the structures of the cortical pathway. In the early months, subcortical systems involving the superior colliculus in the midbrain sustain some important visual capabilities such as the initial ability of visual fixation, visual attention, visual tracking and saccadic ocular movements of the newborn. Although cortical areas can be partially activated at this time, they are relatively immature, beginning to function a few months after birth and modulating subcortical functions. The visual system works mainly at a subcortical level in newborns at the first months after birth, and becomes progressively integrated and dominated by cortical processes during the first year of life[17-18-19-23-31-32-33-35-36-37-38-39].

The infant's visual tracking begins with the preference of visual fixation for geometric characteristics, such as faces[22-34-35-36-37]. Between 2 and 6 months of age, the infant has a predominance of visual contact compared to visual fixation for other regions of the face, such as the mouth, body or other object. Over the months, the infant begins to change its attention, observing other regions of the face, body, objects and the environment[21].

The visual fixation skills seen since the beginning of the newborn's life seem to be determinant not only for the development of the visual system, but predict the development of cognitive, perceptive and motor skills[2-20-22-23-25-26-27-35]. Studies show that newborn visual fixation abilities are associated with cognitive test scores and IQ at 1 and 6 years of age[1-29-30]. Newborn visual fixation abilities are related to visual-motor performance at both 2 and 5 years, as well as to visual reasoning at 5 years of age; better performance in visual fixation tasks is related to the development and integrity of the white matter[2]. In addition, when comparing to motor performance, early visual fixation abilities are better predictors of later to visuocognitive development[2-28].

Although visual fixation abilities are early important predictors or later neurodevelopment, little is known about the factors (biological factors, maternal factors,etc.) associated with these abilities in newborns. The objective of this study is to compare infants with different levels of visual fixation abilities on different biological and environmental markers that could highlight infants at risk for poorer later neurodevelopmental outcomes. Our hypothesis was that the visual fixation abilities would be associated with newborn characteristics, breastmilk features, maternal metabolic profile, maternal mental health and/or environmental variables.

METHODS

This is a prospective cohort study, in which 82 mother-baby dyads from the Hospital de Clínicas de Porto Alegre and the Grupo Hospitalar Nossa Senhora da Conceição, in the city of Porto Alegre, Rio Grande do Sul, Brazil. This study was approved by the Human Research Ethics Committee of the Hospital de Clínicas of Porto Alegre and the Grupo Hospitalar Nossa Senhora da Conceição (GPPG/HCPA 13-0507).This study was part of a large project that evaluated maternal behavior and variations in maternal care, where the sample calculation was based on differences in maternal care.

Sample and Logistics

These mother-infant dyads were recruited during antenatal consultations or immediately after birth, from February 2015 to January 2016, and met the inclusion and exclusion criteria. The criteria were: living in Porto Alegre, mothers over the age of 18 years, absence of abuse or history of drug use, single gestation of at least 37 weeks, no more than four pregnancies, and newborns with no history of congenital disease or need for hospitalization. After signing the Informed Consent Term, the mothers were approached for basic health history, obstetric data and economic criteria evaluation by the ABIPEME[5] instrument.

After initial contact, mother-infant dyads were visited at two times: 25-40 days and 85-100 days after birth. At the first and third month visits, questionnaires and tasks were carried out to investigate maternal factors (maternal age, education level, type of delivery, number of antenatal consultations, type of breastfeeding and smoking habits) and biological characteristics of the baby (gender, gestational age, birth weight, cephalic perimeter and Apgar in the first minute), infant motor tests, maternal psychological profile, environmental variables as well as milk and blood maternal collection.

Outcome

The motor evaluation of the babies was performed in two meetings where two instruments were used: the Visuomotor Behavior Assessment Guide for the Infant[6] and the Alberta Infant Motor Scale[7]. The Infant Visuomotor Behavior Assessment Scale evaluates and qualifies oculomotor functions (visual fixation, eye contact, smile in response to social contact, visual exploration of the environment, visual exploration of the hand, horizontal and vertical visual follow-up) and appendicular (increase of upper limb movement, extension of the arms towards the object displayed).All tests were performed at most on three trials, and the infant's response was classified dichotomically (perform = 1 or does not perform = 0). Considering the 9 points scales and the median of the elicited score in our sample, we divided the infants into those that had a sum of items of 6 or more as “higher score” and 5 or less as “lower score”.

Variables associated with the outcome

The Alberta Infant Motor Scale, a validated instrument[8] and standardized in Brazil[9], evaluates children in the prone, supine, sitting, and standing positions by observing the assumed posture, contra-gravity movement and weight support. In this study, the percentile that describes motor development was used in three categories: delayed (below 5), suspected (between 5 and 25) and normal (above 25).

The maternal psychological profile was evaluated by the Edinburgh Postnatal Depression Scale (EPDS)[10], which consists of a self-registration instrument composed of 10 items referring to the last 7 days, used to evaluate the presence and intensity of depressive symptoms; and by the Hamilton Scale for Anxiety,[11-12-13] performed on the first visit, which assesses anxious symptoms in the pregnant woman, is composed of 14 items with responses varying from 0 (not present) to 4 (severely present), ranking the scores in absence of anxiety or mild anxiety, mild to moderate and moderate to severe anxiety.

The home environment was evaluated by Affordances in the home environment for development scale[14] (AHEMD), performed on the second visit, which evaluates the stimulus opportunities that the environment offers the children. It is a scale filled by parents, and consists of 32 questions subdivided into items that evaluate the baby and his family, the physical space of the residence, daily activities and toys in the residence.

Maternal care was assessed based on 5 minutes of free interaction filmed through Coding Interacting Behavior (CIB) for newborns, which included the assessment of maternal gaze, affection, vocalization, touch, mother-baby positioning, child affection, alert and vocalization every 10 seconds; global assessment of parent affect, intrusiveness and acknowledging are also scored on a scale of 1 to 5, with 1 minimum of specific behavior occurring and 5 the maximum possible occurrence. CIB was performed by a psychiatrist trained in the coding system[15].

The maternal milk profile was evaluated through the measurement of total fatty acids, proteins and cortisol. Milk was collected between 2 and 6 p.m. and kept in cold transportation until stored and frozen at -80°C.The identification of the fatty acid methyl esters was performed by gas chromatography using the CG-17A Flame Detector model (FID), Shimadzu (GC-17A, Kyoto, Japan). For the recording and analysis of chromatograms, the device was attached to a notebook, using the GC Solution program. The compounds were separated and identified on a Carbowax capillary column (30 m × 0.25 mm). For the chromatographic separation, a sample of 1 µl was injected with the aid of 10 µl syringe Hamilton (Reno, NV, USA) in Split System = 5. Nitrogen gas was used as carrier with programmed linear velocity to 37.8 cm s − 1. The temperatures of the injector and detector were controlled isothermally at 220 °C and 240 °C. The initial column temperature was 200 °C (maintained for 2 min), increasing at 4 °C per minute up to 240 °C, in 20 min total analysis. The flow of carrier gas in the column was 1.0 ml min − 1. The identification of compounds was performed by the corresponding standard retention time (EPA and DHA). The analyses were performed in the Nutritional Biochemistry Laboratory at the Universidade Federal de Viçosa, Viçosa, MG, Brazil. Milk protein concentration was quantified using bicinchoninic acid (BCA) protein assay kit (Pierce Biotechnology, Rockford, IL, USA) and milk cortisol concentration was measured with commercial ELISA kits (ADI 901-071).

The maternal metabolic profile was evaluated through the measurement of serum hormones (T3, T4, prolactin and cortisol) and interleukins (Il-10, Il-1β, Il-6, TNF-α). Blood was collected between 2 and 6 p.m. and kept in cold transportation until centrifugedat -4°C for 10 minutes in the research facility. Serum was aliquoted and stored in -80°C.All serum hormones (T3, T4, prolactin and cortisol) was measured with the use of Centaur XP equipament from

Siemens by chemiluminescence methodology and all interleukins (Il-10, Il-1β, Il-6, TNF-α) was measured with the use of Milliplex® Map Human High Sensitivity T Cell Magnetic Bead Panel on first time-thawed samples (the minimum sensitivity for each interleukin is: Il-6 = 0.11pg / ml; Il-10 = 0.56pg / ml; Il-1β = 0.14pg / ml; TNFα = 0.16pg / ml).

Statistical Analysis

The significance level was set at 5% and the statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 18.0. Quantitative variables were described as mean and confidence interval, while categorical data were described using relative frequencies or median and interquartile range. For the data with normal distribution, the Student Test and One-Way ANOVA were performed, and for the non-parametric Fisher Exact Test data. Chi-Square Test was used for the categorical data. Multivariate Analysis of Variances (MANOVA) was used to evaluate differences between all groups.

RESULTS

A total of 82 mother-infant pairs were recruited. Of these, 26 were fully asleep or sleepy during the visit and could not be assessed properly; similarly, 5 children were actively crying during the task and therefore the data are excluded. Finally, 51 children were tested in the visual fixation task and have valid data at 1 month of age. The percentage of positive response for each of the nine components ofthe visual fixation scale were respectively: visual fixation (100%), eye contact with examiner (94,1%), smile in response to social contact (28,0%), horizontal visual tracking (92,0%), vertical visual tracking (98,0%), environmental visual exploration (94,0%), hand visual exploration (0,0%), increased arm movements when visualizing object (32,0%), extends arm in direction to the object (8,0%) and cephalic control (4,1%). Considering the 9 points scales, we divided the infants into those that had a sum of items of 6 or more as “higher score” (n=21 children) and 5 or less as “lower score” (n=30).

Table 1 compares the groups of children divided according to the visual fixation score in many confounders. We observe that there are no statistical significant differences between the groups.

Table 1-Description of the baseline characteristics of the cohort; children were classified according to their visual fixation score at 1 month of age.

	Higher score of visual fixation at 1 month of age		Lower score of visual fixation at 1 month of age		P
Gestational age (weeks)[b]	39.20	(38.50; 39.90)	39.10	(38.64; 39.56)	0.977
Birth weight (g)[b]	3261.3	(2974.1; 3548.6)	3417.4	(3303.4; 3531.5)	0.191
Head circumference (cm)[b]	33.77	(33.01; 34.52)	34.14	(33.62; 34.66)	0.398
Number of prenatal visits[b]	8.93	(7.64; 10.23)	9.41	(7.99; 10.84)	0.608
APGAR score 1 min[b]	8.27	(7.42; 9.12)	8.69	(8.40; 8.98)	0.311
Maternal age[b]	27.60	(24.54; 30.66)	26.76	(24.67; 28.85)	0.640
Males[a]	52.4	(31.04; 73.76)	50.0	(32.11; 67.89)	1.000
Smoking during gestation[a]	19.0	(2.22; 35.78)	13.3	(1.15; 25.45)	0.702
Maternal Schooling (< 8 years)[a]	71.4	(52.07; 90.73)	73.3	(57.47; 89.13)	1.000
SES (classes C/D/E from ABIPEME)[a]	47.6	(26.24; 68.96)	60.0	(42.47; 77.53)	0.408
Exclusive breastfeeding[a]	66.7	(46.54; 86.86)	66.7	(49.84; 83.56)	1.000
Vaginal delivery[a]	57.1	(35.93; 78.27)	60.0	(42.47; 77.53)	1.000

[a]Chi-square test. Data expressed as relative frequencies (%) and 95% confidence intervals. [b] Student t-test. Data expressed as mean and 95% confidence intervals.

We explored the relationship between the visual fixation abilities and five dimensions of variables: a) newborn characteristics (age at evaluation, weight gain in the 1st and 3rd month of life, gross motor skills at the 1st and 3rd month of life); b) breastmilk characteristics (total fatty acids, proteins and cortisol at 1 and 3 months of age); c) maternal metabolic profile (peripheral cortisol, prolactin, T3, T4 and interleukins at 1 and 3 months of age); d) maternal psychological profile (anxiety and depression) and e) environmental variables (maternal care and toys available for stimulation).

A) Newborn characteristics

Children from higher or lower visual fixation scores were compared regarding the age at evaluation in days, weight gain in the 1st and 3rd month of life (in Z-scores according to WHO standards)[3] as well as their gross motor skills at the 1st and 3rd month of life in percentiles according to the local population[16]. All variables were tested for normality using the Kolmogorov-Smirnov test.

The groups did not differ on the age of evaluation [Student t-test t(49)=0.510, P=0.613]. When adjusting for length at the corresponding age, there were no differences between the groups on the weight gain from birth to 1 month [One-Way ANOVA, F(1, 44)=0.174, P=0.678], and from birth to 3 months [F(1, 35)=2.211, P=0.089]. There were also no differences in gross motor skills between the two groups at 1 [Fisher's exact test, P=1.000] and 3 months [P=0.773] (see Table 2).

A multivariate model including all the variables at 1 month (after log transformation of the non-normally distributed variables) is not significant [MANOVA F(3, 19) =0.186, P=0.905]; similarly, the multivariate model including all the variables at 3 month is not significant [MANOVA F(2, 28) =0.900, P=0.418].

Table 2- Newborn characteristics in the two groups of children divided according to the visual fixation score at 1 month of age.

	Higher score of visual fixation at 1 month of age		Lower score of visual fixation at 1 month of age		P
Age at evaluation (days)[a]	28.0	(25.51; 30.49)	28.30	(26.13; 30.46)	0.613
Delta Z score weight for age, 1 month – birth [b]	-0.18	(-0.73; 0.37)	-0.26	(-0.61; 0.08)	0.678
Delta Z score weight for age, 3 months – birth [b]	-0.01	(-0.87; 0.84)	-0.28	(-0.90; 0.34)	0.089
Percentile for Alberta Infant Motor Scale – 1 month[c]	37.5	(50.0)	50.0	(31.25)	1.000
Percentile for Alberta Infant Motor Scale – 3 months[c]	50.0	(50.0)	50.0	(35.0)	0.773

[a] Student t-test, [b] One-Way ANOVA adjusted by current Z score for length. [c] Fisher Exact Test. Data expressed as mean and 95% confidence intervals[a,b] or median and interquartile range[c].

B) Breastmilk characteristics

Children from higher or lower visual fixation scores were compared regarding components of their mothers' breastmilk: total fatty acids and total protein content at the 1st and 3rd month of life, and cortisol in the first month of life. All variables were tested for normality using the Kolmogorov-Smirnov test.

Breastmilk from mothers of the two groups were not different regarding the total fatty acids content at 1 [Student t-test t(25)=0.481, P=0.635, n=11-16/group] or 3 [Student t-test t(19)=0.241, P=0.812, n=9-12/group] months of age. There were no differences in the protein content of breastmilk at 1 month [Student t-test t(37)=0.990, P=0.328, n=18-21/group], but at 3 months the group with lower visual fixation scores had increased levels of milk protein [Fisher's exact test, P=0.047] (see Table 3). There were no differences in the milk cortisol levels between the groups [Student t-test t(37)=0.071, P=0.944, n=18-21/group].A multivariate model including all the variables at 1 month (after log transformation of the non-normally distributed variables) is not significant [MANOVA F(3, 21) =0.768, P=0.525]; similarly, the multivariate model including all the variables at 3 month is not significant [MANOVA F(2, 18) =0.484, P=0.624].

Table 3 – Breastmilk characteristics in the two groups of children divided according to the visual fixation score at 1 month of age.

	Higher score of visual fixation at 1 month of age		Lower score of visual fixation at 1 month of age		P
Total fatty acids at 1 month (µg/g)[a]	99.02	(98.29; 99.76)	99.24	(96.70; 101.78)	0.635
Total fatty acids at 3 months (µg/g)[a]	98.94	(98.19; 99.69)	98.35	(97.34; 99.35)	0.241
Total protein content at 1 month (µg/ml)[a]	11421.05	(9984.68; 12857.43)	11470.08	(7913.12; 15027.04)	0.328
Total protein content at 3 months (µg/ml)[b]	8688.10	(4134.82)	9930.22	(4843.55)	0.047*
Cortisol at 1 month (pg/ml)[a]	2949.63	(2365.26; 3533.99)	3350.40	(2473.60; 4227.19)	0.944

Milk collected immediately before or at least 50 minutes after nursing [a]	58,8	(28,29; 89,31)	50.0	(20.45; 79.55)	0,748

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[a]Student t-test, [b] Fisher Exact Test. Data expressed as mean and 95% confidence intervals[a]or median and interquartile range[b].

*Statistically significant difference ($p < 0.05$).

C) Maternal metabolic profile

The metabolic profile of mothers from the two groups of children were compared. We analyzed different serum hormones (T3, T4, prolactin, cortisol), as well as different interleukins (Il-10, Il-1β, Il-6, TNF-α) at 1 and 3 months postpartum. All variables were tested for normality using the Kolmogorov-Smirnov test.

Mothers of children of the two groups differ in terms of T4 at 1 month postpartum [Student t-test t(35)=2.826, P=0.008, n=14-19/group], with higher levels on the group that have higher visual fixation scores. At 3 months postpartum, mothers of the group with higher visual fixation scores had increased levels of prolactin [Fisher's exact test, P=0.031] (see Table 4). There were no statistically significant differences in the other measurements. A multivariate model including all the variables at 1 month (after log transformation of the non-normally distributed variables) almost reaches statistically significance [MANOVA F(8, 23) =2.331, P=0.054], in which T4 is significant [F(1, 31)=11.422, P=0.002]. A multivariate model including all the variables at 3 month shows that the visual fixation score at 1 month predicts maternal metabolic profile at 3 months [MANOVA F(7, 21) =2.988, P=0.024], in which Il-6 [F(1, 28)=6.646, P=0.016] and prolactin [F(1, 28)=8.948, P=0.006] are significant.

Table 4 –Maternal metabolic profile in the two groups of children divided according to the visual fixation score at 1 month of age.

	Higher score of visual fixation at 1 month of age		Lower score of visual fixation at 1 month of age		P
Maternal metabolic profile at 1 month postpartum					
T3 (ng/dL)^{a}	130.67	(109.84; 151.51)	120.41	(113.37; 127.45)	0.474
T4 (ng/dL)^{a}	1.20	(1.06; 1.33)	1.07	(1.03; 1.12)	0.008*
Prolactin (ng/mL)^{a}	215.12	(53.32; 376.92)	147.92	(90.20; 205.65)	0.494
Cortisol (μg/dL)^{a}	6.69	(2.90; 10.47)	5.26	(3.77; 6.75)	0.729
Il-10 (pg/mL)^{a}	6.18	(-0.17; 12.53)	6.70	(5.19; 8.21)	0.995
Il-1β (pg/mL)^{a}	1.30	(0.65; 1.95)	1.13	(0.87; 1.38)	0.644
Il-6 (pg/mL)^{b}	1.30	(1.53)	1.36	(0.55)	0.540
TNFα (pg/mL)^{a}	3.90	(3.18; 4.62)	4.28	(3.73; 4.82)	0.471
Maternal metabolic profile at 3 months postpartum					
T3 (ng/dL)^{a}	128.00	(105.33; 150.67)	111.40	(104.64; 118.17)	0.974
T4 (ng/dL)^{a}	1.16	(0.95; 1.37)	1.08	(1.02; 1.14)	0.110
Prolactin (ng/mL)^{b}	82.70	(76.95)	33.22	(34.42)	0.031*
Cortisol (μg/dL)^{a}	5.48	(2.40; 8.57)	5.52	(4.41; 6.63)	0.801
Il-10 (pg/mL)^{a}	6.49	(-0.76; 13.75)	6.59	(5.05; 8.14)	0.226

Il-1β (pg/mL)[b]	1.17	(1.12)	1.19	(1.11)	0.145
Il-6 (pg/mL)[b]	1.37	(1.83)	1.34	(1.04)	0.192
TNFα (pg/mL)[b]	3.82	(1.05)	4.45	(1.99)	0.839

[a]Student t-test, [b] Fisher Exact Test. Data expressed as mean and 95% confidence intervals[a] or median and interquartile range[b].

*Statistically significant difference ($p < 0.05$).

D) Maternal mental health

Maternal mental health was analyzed considering the Edinburgh Postnatal Depression Scale - EPDS (depression)[10] and Hamilton-A (anxiety)[11]. There were no differences in maternal mental health scores between the groups of children from higher and lower visual fixation scores [EPDS median (interquartile range): higher visual fixation score = 7 (7); lower fixation score = 6 (6), Fisher Exact Test P=0.415]; [Hamilton mean (95% CI): higher fixation score = 6.33 (3.74; 8.93); lower fixation score = 4.97 (3.09; 6.84), Student' t Test t(48)=0.907, P=0.369]. A multivariate model including all the variables (after log transformation of the non-normally distributed variables) is not significant [MANOVA (2, 44) =0.210, P=0.811].

E) Environmental variables

The children's environment was characterized in two “layers”[4]: maternal care and the affordances in the home environment for motor development scale (AHEMD). There were no differences between the groups considering the different components of the Affordance scale (physical space, daily activities, gross motor, fine motor, total score) and no differences in the different components of maternal care observed (Acknowledgement, Affect and Intrusiveness). A multivariate model including all the variables (after log transformation of the non-normally distributed variables) is not significant [MANOVA (8, 18) =0.716, P=0.675].

DISCUSSION

Visual fixation was present in all children evaluated at the first month visit, as well as the capacities of ocular contact with the examiner, vertical and horizontal visual follow-up, and visual exploration of the environment, the latter being present in most infants. Studies have corroborated our findings, reporting that initial maturation of the subcortical system at birth justifies most of the primitive visual functions found[36-45], and these primitive functions are fundamental for the subsequent development of fine motor skills[2-40-41-42-43-44]. On the other hand, our children had a greater positive response to the vertical visual tracking ability when compared to the children of the studies exposed above, which can be justified by the instrument used. In our study, we used the bull's eye instrument in black and white colors, the same used in standardization of the "Visual Test Battery" test[46] in contrast to the ring suspended by a cord used in the reference study[40]. It is known that children are attracted to color contrasting toys[36-37-47-48] and the preference of visual fixation are the faces[22-34-35]; our evaluation instrument may have attracted more attention from infants, a result that corroborates with the study by Ricci et al (2008), who found that 95% of the newborns evaluated were able to follow the bull eyes during the vertical course.

Some studies have evaluated the visual behavior of infants at various gestational ages. Preterm infants with an average of ± 28.9 gestational weeks (27.0-32.9) evaluated at 31 to 33 weeks post-menstrual show 90% visual fixation frequency, horizontal and vertical visual follow-up[49]. Another study evaluated preterm infants with an average of ± 28.2 gestational weeks (25.0-30.9) at 35 and 40 post-menstrual weeks, where 91% of the infants had visual fixation at 35 weeks and 97% at 40 weeks, 97% demonstrated horizontal and vertical visual follow-up at 35 weeks and 100% at 40 weeks[48]. In relation to the late preterm infants with mean ± 35.2 weeks of gestational age (34.0-36.9), 98% had visual fixation, 98% visual horizontal follow-up and 58% vertical visual follow-up. When evaluated at full-term age (between 39 and 41 weeks), 100% showed visual fixation and horizontal visual follow-up and 88% had vertical visual follow-up[50]. In relation to full-term newborns, 95% had visual fixation, horizontal and vertical visual follow-up[46-48]. These studies, in association with our findings, seem to demonstrate that some aspects of visual function have a progressive maturation with greater gestational age, and that extrauterine factors may play an important role in the maturation of these visual pathways.

The other evaluated functions, visual exploration of the hand, extension of the arms when viewing objects and cephalic control, are expected abilities from 2 to 3 months of life, and our findings are in agreement with the other studies found in the literature[38-41-42-43-44.] Our study found a greater frequency in the ability to increase the movement of the arms when visualizing the object, which can be justified again by the different instrument used in the evaluation, which seems to be more instigating to the infants. The frequency of smile ability to social contact is also in agreement with current studies, and this capacity is associated with positive social factors such as parental care[51], and predictors of cognitive, social and emotional development indexes[22-34-35-36-37].

The possible confounding factors (gestational age, birth weight, cephalic perimeter, Apgar in the first minute, Z score and gender) were not correlated in the visual conduction scores of the two subgroups of infants (classified as higher and lower scores). Studies report that some postnatal characteristics may be related to changes in early visual behavior, such as low birth weight and length, lower head circumference, lower gestational age and male gender[24-52]. Preterm infants present a high incidence of visual changes, which can be explained not only by retinopathy of prematurity and brain lesions, but also by the development of white matter in optical radiation. These infants when evaluated at postnatal corrected age of 35 and 40 weeks have most of the visual conduct abilities corresponding to full-term infants, justifying that possible postnatal visuomotor experiences would influence the maturation of the early subcortical system[43-53]. Other studies corroborate that gestational age, rather than birth weight, would be determinant for the maturation of cortical aspects of visual function[48-49-54]. On the other hand, one study states that small babies for gestational age (SGA) associated or not with prematurity show changes in the axonal processes, leading to a neuronal loss of the retinal nerve fibers and consequent brain atrophy, visuomotor difficulties and cognitive dysfunctions[55]. Our sample was community-based and our findings appear to demonstrate that minor variations in normality (in terms of weight and intrauterine growth) do not appear to affect visual behavior. Sociodemographic variables (age and maternal schooling and SES) were not related to visual conduct scores. One study confirms our finding, describing no association between impairment in newborn’s visual fixation of children and maternal sociodemographic characteristics[24].

In relation to gross motor function, evaluated through the Motor Development Scale of Alberta, we did not find a correlation between the early data of visual conduct and the results of gross motor skills. The link between visual conduct and fine motor skills is already established in newborns, although the successful functional scope does not appear before 4 months of life[56]. The development of fine motor skills depends on the attention and processing of visual information, since fine adjustments to the ability to reach and grasp are visually guided. Due to the characteristics of fine motor development, initial visual abilities are fundamental for fine motor skills and are also predictive of cognition and language[39-57]. On the other hand, the relationship between visual conduct and gross motor function seems to be more important for the infant's first three months of life, when they begin to demonstrate antigravity movements, and the alteration in visual behavior may interfere with the feedbacks of the proprioceptive and vestibular systems over the motor system[58]. This interdependence is corroborated by studies that found an incapacity to walk at 2 years in premature children with visual impairment, and in blind children without brain lesions who had incapacity for cephalic control in the prone position at 3 months[24-58].

It was observed that the amount of protein (one of the macronutrients in breast milk) at three months was higher in the group with low scores of visual conducts. Studies indicate that breastmilk contains several types of proteins with specific functions, such as the supply of amino acids necessary for the adequate growth of the infant, the contribution of breastmilk digestion in the immature gastric tract, aid in intestinal iron absorption and the optimization function of immune system and the physiological development of the intestine[59-60-61-62]. The amount of proteins in breastmilk are high in early life (in colostrum), decrease markedly after the first month and gradually in the progressive stages of lactation[60-61-63-64]. Protein in breast milk is a key nutrient for brain growth and development of the newborn; studies report that the average protein in the breastmilk of premature infants is twice as high compared to the average protein in breastmilk of children born with adequate age[63-64]. Breastfeeding facilitates the child's adjustment to the extrauterine environment, and it appears that changes in macronutrient composition occur in response to the needs of the offspring. We did not find in current literature studies that related maternal milk composition with visual behavior and possible associations and correlations, and our findings may be justified by the demand presented by infants who had alterations in early visual behavior, and prompt maternal adaptation in response to such demands.

Regarding the maternal metabolic profile, we found a positive association between maternal T4 serum hormone and the infant's visual conduction scores in the first month of life. During pregnancy, fetal thyroid function is immature, and the fetus is completely dependent on maternal thyroxine. Adequate levels of thyroid hormones during the fetal developmental period are required for axon elongation, dendritic branching, neuronal migration, differentiation and proliferation, and synapse formation[65]. Several human studies have linked maternal gestational hypothyroidism to developmental changes in infants, such as delayed verbal and non-verbal performance[66], mental and psychomotor retardation[65], impaired learning abilities[67-75], low general cognitive and perceptual-manipulative index and memory coefficients[68], impaired motor development[69], lower gross and fine motricity scores and lower socialization[70]. In rodents, models of maternal hypothyroidism have shown structural and functional alterations in the different brain regions of the offspring, especially in the hippocampus and cerebellum, regions closely related to cognitive and psychomotor function[71]. Our findings seem to demonstrate that even postnatally high indices of maternal serum T4 are related to high scores of early visual conducts. These findings demonstrate that the importance of adequate maternal thyroid screening expands beyond the immediate postnatal period, and even subtle variations in T4 (within the normal range) are linked to import developmental abilities in children at 1 month of age.

We also found a positive association between the serum prolactin hormone and the visual behavior of the baby at three months of life. Studies report that in the gestational and lactation periods, low levels of maternal serum prolactin are related to maternal depressive symptoms, with consequent increase in the level of serum cortisol and hyperactivity of the HPA axis[72-73]. Maternal depressive symptoms can impair mother-infant interaction, leading to an inability of the mother to respond to the demands of her offspring, a weak establishment of interaction with the child, and negatively influence the child's neuromotor development[72-73-74]. The positive association found shows that even high postnatal levels of maternal serum prolactin are related to high scores of early visual conducts. Possibly the proper mother-baby interaction facilitates and potentiates the early neuromotor development.

These positive associations found between thyroxine and prolactin may also reflect the functioning of the maternal hypothalamus. Studies indicate that the thyrotropin releasing hormone (TRH) in the hypothalamus stimulates the synthesis and release of both thyroid stimulating hormones (TSH) and prolactin[76-77]. Thus, the proper functioning of the maternal hypothalamus seems to be another determining factor for the maturation and development of the offspring neurological pathways responsible for the skills of visual conduct and fine motor skills.

In conclusion, our study demonstrated that early neuromotor development of the baby, especially the visual and fine motor skills, are closely associated with maternal metabolic factors (T4 and prolactin) and the composition of breast milk (protein). Postnatal changes in maternal serum hormones appear to influence the maturation and functioning of the primordial neurological pathways for early neuromotor development of the infant. The possible developmental demands of motor delay can be met by the physiological alteration of the composition of the breast milk, facilitating the adjustment of the child to the extrauterine environment. Further research is needed to understand the influence of these maternal metabolic factors and maternal milk composition on the development of gross motricity, since early changes in visual conduct and fine motor skills are responsible for delays in the acquisition of antigravity postures; and the early identification of these factors may aid in motor development early stimulation programs.

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4 CONCLUSÕES

A fixação visual esteve presente em todas as crianças avaliadas, bem como a maioria das demais capacidades de conduta visual e motricidade fina. Não encontramos correlação entre a conduta visual precoce e os resultados da motricidade grosseira, possivelmente porque utilizamos uma janela de avaliação curta para melhor compreensão da influência das habilidades visuais na retroalimentação dos sistemas proprioceptivos e vestibulares que interferem na aquisição das posturas antigravitacionárias.

As pequenas variações na normalidade das características neonatais (em termos de peso e crescimento intra-uterino) não afetaram o comportamento visual das crianças avaliadas. As variáveis sociodemográficas (idade e escolaridade maternal e ABIPEME) também não estiveram relacionadas aos resultados da conduta visual, bem como as variáveis psicológicas maternas, cuidado materno e características ambientais da moradia das crianças.

Os fatores metabólicos maternos (T4 e prolactina) e a composição do leite materno (proteína) apresentaram-se intimamente associados as capacidades de conduta visual e motricidade fina. Alterações pós-natais dos hormônios séricos maternos parecem influenciar no amadurecimento e funcionamento das vias neurológicas primordiais para o desenvolvimento neuromotor precoce do bebê. As possíveis demandas desenvolvimentais de atraso motor parecem ser supridas pela alteração fisiológica da composição do leite materno, facilitando o ajuste da criança ao ambiente extrauterino.

Embora nosso estudo tenha tido foco descritivo e tenha sido realizado com uma amostra relativamente pequena, é possível expandir os resultados encontrados. O conhecimento dos fatores associados precocemente às alterações na conduta visual e motricidade fina são necessários e importantes para melhor triagem neonatal do desenvolvimento neuromotor, bem como para a inserção precoce desses bebês em programas específicos de estimulação motora. Nossos resultados reforçam a importância do acompanhamento materno pré-natal e pós natal e suportam a idéia de que detecção precoce de alterações metabólicas maternas é relevante para a otimização do neurodesenvolvimento dos recém-nascidos.

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